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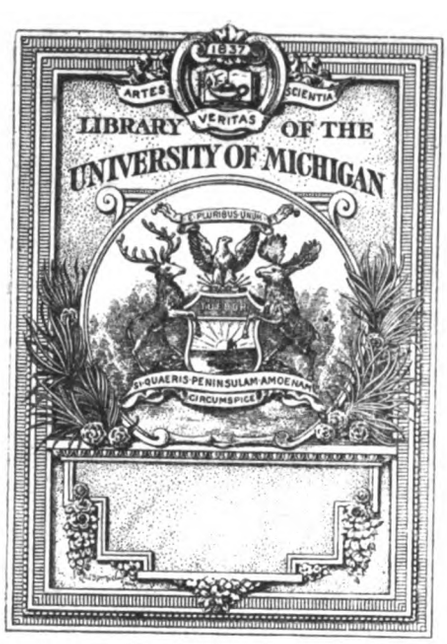

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THE

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NOTES.

The Marconi Patents.—What promises to be a most interesting litigation, even rivalling that over the Bell telephone patents, is expected to take place in the States before the end of the present year. The *causus belli* is the alleged infringement of the Marconi patents by the owners of the De Forrest patents, who are achieving considerable success with their system in America. The Marconi Wireless Telegraph Company of America are the plaintiffs in the action, and we understand that the matter is being pressed forward with a view to an early settlement of the dispute.

Madras Tramways.—It is stated in *Indian Engineering* that the Madras Municipal Commission has accepted Mr. T. Nunbaramal Chetty's revised scheme for construction, within municipal limits, of a mono-rail tramway on Ewing's patent system. The scheme comprises over 30 miles of line in the municipality of Madras itself and another 20 miles in the adjoining district of Chingleput. But within municipal limits, the line will, *pro tem.*, only carry minerals and parcels, owing to a misunderstanding as to the rights claimed by the electric tramways company.

Overhead Wires in London.—The Borough Council of Poplar have approached the London County Council with a view to the introduction in their General Powers Bill of a clause to prohibit electric current being supplied to consumers within the area of a local authority from an outside source, by means of overhead wires. We may state frankly that the subject does not appeal to us as justifying legislation. Such cases as are referred to are, to say the least, rare, although the Poplar Council complain that several instances have occurred in that borough. But, even so, as overhead wires for the supply of electricity can be erected only in accordance with the regulations of the Board of Trade, we do not see that matters would in any way be improved by legislation.

Honours.—We gather from our American contemporaries that a week or two ago the Columbia University at New York conferred the degree of Doctor of Science on Prof. J. J. Thomson, Cavendish professor of experimental physics in the University of Cambridge. In conferring the degree, President Butler, of Columbia University, welcomed Prof. Thomson as "comrade of Maxwell, Helmholtz, and Kelvin, in the mastery of Nature's intimate secrets, standing as they stood on the outermost edge of the boundary of knowledge." We have great pleasure in offering our best congratulations to Prof. Thomson, whose association with American universities is every day becoming closer. Among those who shared with Prof. Thomson the honour of receiving a similar mark of distinction were Mr. Peter Cooper Hewitt and Prof. Humphreys.

The Pacific Cable Surveys.—In the House of Commons on Friday Sir John Colomb asked the Secretary of State for the Colonies whether he could state if the capital outlay in connection with the Pacific cable included the cost of special surveys made by the Royal navy. Mr. Chamberlain replied that the cost of special surveys was not included. The soundings made by the surveying ships of the Royal navy on the route of the Pacific cable, though of great value, were incidental to and made in the course of their ordinary operations. The special detailed survey required for the determination of the exact route to be followed by the cable was carried out, not by the Royal navy, but by the contractors for the construction and laying of the cable. Mr. Chamberlain added the information that the question of a connection with the United States cable at Honolulu had been raised, but no action had yet been taken in that direction.

Wireless Telegraphy and Lightships.—That the officials of the Board of Trade fully recognise the exceptional claims of wireless telegraphy as a means of communication between lightships and shore stations, is shown by the following statement that was made in the House of Commons on Monday by Mr. Bonar Law. Replying to Major Seely, he said it was proposed, in the first instance, to connect with the shore stations by wireless telegraphy the following six lightships: the East Goodwin, South Goodwin, the Gull, the Tongue, the Sunk, and the Cross-Sand. The matter was being pressed forward, but, as the terms of the contract for the supply of the apparatus have not been settled, he was not able to say when the installation would be completed. The Board of Trade, however, were pressing the matter forward as far as they could, and hoped it would be finished before the autumn.

High-Voltage Transmission.—In a printed reply to a question by Mr. Markham, M.P., Mr. Bonar Law, secretary to the Board of Trade, states that the Board have not yet made any regulations relating to the transmission of electricity at high voltages by bare overhead wires. He has no information as to injury or loss of life to the public caused by bare wires carrying high-voltage supply in America or on the Continent, or as to the relative dangers to the public from wires used for tramways (where constructed under Board of Trade regulations) and from those used for other purposes. Two schemes have recently been submitted, and are now before the Board's electrical adviser, who has been instructed that promoters may proceed with their works step by step under his supervision. The Board propose to give their best consideration to applications for the use of high voltages, dealing with each case on its merits.

Books Received.—Messrs. Harper and Bros., of Albemarle-street, are about to publish "Electrical Engineering," by E. Rosenberg, chief electrical engineer at Messrs. Körting Bros., Hanover. The translation is by Messrs. W. W. Haldan Gee and C. Kingbrunner. The work is an elementary text-book, and is described as being suitable for persons employed in the mechanical and engineering trades and for elementary students of electrical engineering. The published price of the book is 6s.

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Parts 1, 2, and 3 of a new series of telephone books, entitled "Telephony," by Mr. Arthur V. Abbott, have been published by the McGraw Publishing Company, of New York. They are devoted respectively to the location of central offices, the construction of underground conduits, and to cable plant. The last three volumes, which complete the series, will be issued shortly. They deal respectively with open wire lines, sub-stations and switchboards and the central office. The complete set is published at 24s., or 6s each volume.

Aluminium and Bauxite.—According to the report of Dr. Joseph Struthers, of the United States Geological Survey, the production of aluminium varies very little year by year. Thus, in 1901 the total output of aluminium was 7,150,000lb., while for last year it was 7,300,000lb. The sole producer in the States is the Pittsburg Reduction Company, which has large plants in operation at Niagara Falls and at Shawinigan Falls, Quebec, Canada, and is installing a large plant on the St. Lawrence River in New York State. The chief use of aluminium is for the transmission of electrical currents and for alloys possessing exceptionally physical and chemical properties, though a considerable part of the output is manufactured into domestic articles of various kinds. Two growing uses of the metal are for lithographic work and for the production of intense heat by the combustion of the metal as powder. The production of bauxite in the States during 1902 amounted to 27,274 tons, as against 18,905 tons in 1901, while the world's consumption of bauxite was 43,112 and 36,218 tons respectively.

Platinum Resistance Thermometer.—One of the difficulties to be overcome in constructing a sensitive platinum thermometer is to restrict the size of the coil of wire forming the bulb. In order to have a sufficient length of wire, it is often necessary to make the bulb inconveniently large, and thereby sacrifice quickness of register. A form of thermometer described by Messrs. H. T. Barnes and D. McIntosh overcomes this difficulty to a considerable extent. Briefly, the thermometer consists of two concentric glass tubes fused together at the end, with the wire wound on the inner tube in a thread etched into the glass. The main point about the thermometer is that a core passes through the centre of the bulb, through which the liquid or gas the temperature of which is desired can be made to flow. It is claimed to be quite as easy to construct, if not more so, than the mica-frame type, and it has unquestionably advantages over the latter for the particular use for which it was designed—the apparatus in question was specially adapted for the continuous-flow calorimeter—although it would be unsuited for certain types of temperature measurement.

Electrolysis of Potassium Iodide.—Messrs. F. Foerster and K. Gyr are responsible for the following statements with reference to the electrolysis of solutions of potassium iodide. For the electrolysis of a neutral normal solution of potassium iodide, an anodic potential of 0·52 volt (compared with the hydrogen electrode) is required; this is diminished by the addition of alkali hydroxide. Iodine is first liberated at the anode, and, in equilibrium with it, hypoiodious acid and hypoiodite. In neutral solutions, traces of hypoiodious acid exist in equilibrium with small quantities of iodine and hydroxyl ions in the electrolyte, but the main portion of the hypoiodite formed is at once converted into iodate. In alkaline solutions, the hypoiodite accumulates up to a certain concentration (depending on the concentration, temperature, and current density), which then remains unchanged during the electrolysis, the velocity of its change into iodate being equal to the rate of its formation. In alkaline solutions containing very little iodide, oxygen may be evolved at the anode, especially at higher temperatures and current densities. Periodate is formed only in traces, if at all.

Steam and Electric Traction in Germany.—We understand that next year the Railway Administration in Germany propose to carry out a series of comparative trials with electric automotors and steam locomotives, which will be conducted as follows: Runs will first be made for some weeks with electric automotors only. Then the permanent way will be thoroughly overhauled, and not until this has been done will the trials of the steam locomotives be begun. In this way it will be possible to judge what effect each method of traction has upon the line. But the main object of the trials will be to settle the comparative cost of hauling a given load with each system of traction. The steam locomotives will be of special construction, designed to attain a normal speed of 80 miles an hour, and this is to be capable of being increased to 93 miles. It is even stated that with a load of 90 tons these engines are expected to travel on the level at the rate of 125 miles an hour. Whether this dream of the advocates of steam traction will be realised is a moot point, but in any event the struggle for supremacy between steam and electric traction will be of the highest interest, both from a general and scientific standpoint.

New South Wales Tramways.—The tramways in New South Wales—now an extensive State property—are being converted to electrical working with a rapidity which reflects all credit on those responsible for the work. The total mileage of tramways open and in operation is 122, and of this some 68 miles are worked entirely by electric power, the remaining 54 miles being operated by steam motors, with the exception of a couple of miles run by cable. The ultimate object, of course, is to convert the whole of the metropolitan lines to electric traction. The earnings for the quarter ended March 31 last amounted to £199,769 and the expenditure to £156,987, increases of £26,912 and £25,315 respectively over the corresponding quarter last year. The expenditure per car mile now stands at 10¼d., a decrease of 3¾d., but the earnings per car mile also decreased from 1s. 6½d. in the quarter last year to 1s. 1d. this year. Some 6½ million more passengers were, however, carried this year, which enabled a larger profit to be made. On the whole the State has a very valuable asset in its tramway undertaking, which is every day growing more remunerative, and thus the Commissioners are enabled to make various concessions both to the public and their employés, which are much appreciated.

Rontgen Rays.—A long illustrated article appears in the current number of our medical contemporary the *Lancet* on the use of Röntgen rays in the diagnosis of pulmonary disease. The writer is Mr. J. F. Halls Dally, M.B., assistant resident medical officer, Royal National Hospital for Consumption, Ventnor. He has had great experience in the use of the Röntgen rays, and is thus able to present many interesting illustrative cases of their value in diagnosis. It would appear at first sight as if the Röntgen rays presented a royal road to the art of diagnosis, and that it is now no longer necessary to undergo much clinical labour in order to acquire manipulative and auscultatory skill; but this view is superficial, and the value of the older methods is enhanced by the presentation to the eye of the intra-thoriacic morbid appearances. Hence in many cases one method without the other is incomplete. The author does not claim that Röntgen rays are infallible, but, as in most things, experience leads to more accurate results. From his own experience Dr. Dally concludes that the Röntgen rays form an important

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adjunct to the methods of physical investigation previously in use, and that by the aid of these rays pulmonary tuberculosis can be diagnosed at an earlier stage than by any other means at present available.

Municipal Tramways Association.—This association will hold its annual conference in Glasgow this year on July 8, 9, and 10. The Executive Committee have arranged the provisional programme. On the morning of the first day the members will be received by the Mayor and Corporation of Glasgow, and the conference will be opened at 11 and proceed all day. In the evening they will be the guests of the Glasgow Corporation at dinner. The next day there will be a meeting of the Executive Committee, a business meeting, and the resumed conference, which will occupy the morning, and in the afternoon a visit has been arranged to the Pinkston power station, carworks, etc. The annual dinner of the association takes place that evening. Among the communications which will be presented at the conference are the following: "Presidential Address," by Mr. John Young; "Report on the Standardisation of Tramway Accounts," by Mr. J. Dalrymple; "Report on the Hours of Labour, etc., of Tramway Employés," by Mr. A. Baker; "Report on Permanent-Way Construction and Maintenance," "Tramway Conditions in America and Great Britain Compared," by Mr. C. R. Bellamy; and "Selection and Training of Motormen and Conductors," by Mr. L. Mackinnon. The conference is likely to be fully attended, a large number of town councils having appointed delegates, and several allied associations have been invited to send representatives.

Our Fiscal Policy.—Amongst business men engineers are not the least important section affected by the possible changes in the fiscal policy of this country as foreshadowed by the Colonial Secretary. Members of Parliament and others interested in the iron and steel, mechanical, and electrical engineering trades are combining in any action that may be decided upon, and the movement was formally started the other day at a preliminary conference held at the House of Commons. The upshot of the proceedings was that the following important resolution was unanimously adopted: "That, having regard to the present public discussion as to possible fiscal changes, it is desirable that a committee of those interested in the iron and steel manufactures and in the construction of all kinds of machinery be formed for the purpose of calling attention to the unfair and illegitimate competition arising from hostile tariffs, trusts, and cartels to which those trades are subjected; and to that end, and in anticipation of possible negotiations with foreign and Colonial Governments, reliable information should be invited from manufacturers to enable Parliament and the country generally to correctly appreciate the serious injury which threatens British manufacturing industries." We hope that manufacturers generally will accept the invitation thus held out to them to supply all the information they may be in the position to offer. Such concerted action as is aimed at above is more likely to make the new movement successful than the mere formal passing of resolutions by individual bodies.

Society of Arts' Conversazione.—The Society of Arts' conversazione at the Botanical Gardens on Tuesday night was an excellent idea well carried out. The weather also continued fine throughout the evening, which was a most enjoyable one. The inner circle of the gardens had been transformed into fairyland, with a central avenue of Chinese lanterns leading to the entrance of the conservatory, where the chairman (Sir William Preece, K.C.B., F.R.S.) and the other members of the council received the guests. Walking in the conservatory reminded one of being on the stage during the transformation scene of a splendid pantomime. There was much to see. The tropical house, containing a banana plant in fruit, the Victoria Regia, and other interesting tropical plants, was open to visitors; a collection of growing and cut roses, and other flowers, by Messrs. William Paul and Son, of Waltham Cross, was exhibited in a marquee on the west lawn; and Messrs. Barr and Sons, of London and Surbiton, had a special display of pæonies and irises, and their fine collection of Japanese dwarf trees aged 50 to 140. H.M. Scots Guards, directed by Mr. Fred. W. Wood, played in the conservatory, and the band of the Royal Engineers on the west lawn, Lieutenant J. Sommer, M.V.O., wielding the staff. Amongst those present we noted Sir Owen Roberts, Sir Owen Burne, Sir Thomas Wardle, Sir Edwin Durning-Lawrence, M.P., Sir John Wolfe-Barry, Sir Thomas Holdich, Sir Henry Trueman Wood (secretary), Dr. C. Le Neve Foster, Mr. Carmichael Thomas, Mr. Lewis Day, and Mr. H. B. Wheatley (assistant secretary).

Electric Traction on Canals.—In the issues of *Zeitschrift für Elektrotechnik* for the 3rd and 10th ult. will be found an illustrated description of a new system of electric traction on canals devised by Messrs. Ganz and Co., of Budapest, and submitted in competition with other systems for use on the Tetlow Canal, in Germany. The writer, in the first instance, refers to the disadvantages of the present systems, which are chiefly that the cost of road construction and maintenance of the rails on the towpath are high, and that the vibrations of the locomotive throw a great responsibility on the driver. If two rails are used on which the locomotive runs, the road-bed construction is less expensive, but there is the serious disadvantage that the adhesion is not sufficient for dragging heavy boats, unless very heavy locomotives are used; the road-bed construction becomes still cheaper if a single rail is used, but the adhesion difficulty is still in existence. This difficulty is claimed to be overcome by means of an idea of Fabre, developed by Messrs. Ganz. Instead of the usual two-wheel axles, each with two vertical wheels, they use two-axle pairs inclined against one another; on each axle a wheel is mounted, and each pair of two such wheels grips the single rail. To support the locomotive, one broad lateral wheel is provided which runs on the road. The purpose of this arrangement is to increase the adhesion and stability of the locomotive. The construction is described in detail and illustrated with diagrams. The author finally compares the cost of this system with that of three others designed for the same canal, which has a length of 2 miles, with an annual traffic of 1,500,000 tons. In the cost of operation the price of 1½d. for one kilowatt-hour is assumed. The first cost is given as follows: for the Siemens and Halske system, £125,000; the Rudolf system, £129,800; and the Ganz system, £50,399.

Dust-Arresting Respirator.—In the early part of the year we referred in these columns to the offer of a prize by the Society of Arts for a respirator intended to arrest dust in the various industrial processes in which the health of the workpeople suffers from their being forced to breathe a dusty atmosphere. The offer was made under the Benjamin Shaw Trust, the prize being a gold medal or £20 in money. We have not as yet heard that inventors have been particularly attracted by the offer, but as the competition will be open until Dec. 31 we trust that the Society of Arts will find plenty of competitors for the prize by the end of the year. The object is an exceptionally worthy one, and a successful apparatus would supply a want that has been felt for many years. It is interesting to note that as early as 1822 a protective device known as a magnetic guard gained for its inventor, Mr.

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J. H. Abraham, of Sheffield, the society's gold medal. The apparatus included a respirator to cover the mouth and nose. This respirator was fitted with magnets for the purpose of arresting the fine particles of steel thrown off in the process of pointing needles, and in other processes of dry grinding. Although the invention was greatly appreciated at the time, it appears never to have come into practical use, the main objection to it having been, it is believed, raised by the workpeople themselves, who feared that the lessened risk attached to their employment would lower their wages. We do not believe that any such prejudice would be raised at the present day, but similar considerations have stood in the way of the introduction of various appliances intended to lessen the risks associated with all trades in which the workpeople breathe a dusty atmosphere. It is hoped that the present offer of the Society of Arts may draw the attention of inventors to the matter, so that it may result in the production of some suitable piece of apparatus, despite the difficulties with which the solution of the problem is surrounded.

Society of Arts.—The annual report of the council of the above society speaks in high terms of praise of Prof. J. A. Fleming's course of lectures recently delivered by him on the subject of "Hertzian Wave Telegraphy," and duly recorded in this journal. The report describes the course as "one of the most attractive and interesting which has ever been delivered in the society's theatre." It formed the best popular description of wireless telegraphy in principle and in practice that has yet been published. In the words of the report: "Prof. Fleming is a strong advocate of the Marconi system, and his relations with the Marconi Company enabled him to carry out for the purpose of illustrating his lectures a very striking series of experimental tests demonstrating the non-interference of the currents used in Transatlantic telegraphy with those for communication over a shorter distance, and, in the lecturer's opinion, demonstrating the value of the syntonic system of Marconi." The council's report also records the fact that Mr. Alfred C. Eborall has been awarded the society's silver medal for his paper on "Application of Polyphase Motors to the Electrical Driving of Workshops and Factories"—"a valuable, if somewhat technical, discussion of the class of motors best suited for the electrical driving of workshops and factories." Prof. W. Smart has also gained the silver medal for his paper on "Industrial Trusts," while Mr. Gabriel J. Morrison has scored a similar success for his contribution on "The Construction of Maps and Charts." With regard to the constitution of the executive for the ensuing year, the new vice-presidents are the Lord Chancellor, Lord Kelvin, Sir Wm. H. Preece, and the Lord Mayor of London. The Lord Chancellor and Lord Kelvin have both served on the council on previous occasions. Sir Marcus Samuel has not. Sir Wm. Preece has served for the past four years as a member of the council, from which he now retires. The new members of council are Mr. Henry H. Cunynghame, C.B., Sir Robert Giffen, Lord Harris, and Sir Thomas Holditch. Sir Wm. Preece is followed in the chair by Major-General Sir Owen Tudor Burne, G.C.I.E., K.C.S.I.

Depreciation of Plant.—Mr. Shirley Price, M.I.E.E., was on Monday a witness before the Joint Committee of both Houses of Parliament appointed to enquire into the question of municipal trading. His evidence was mainly directed to the problem involved in making proper provision for depreciation of plant. He cited many cases of depreciation of machinery in order to make clear his point that the units forming a manufacturing concern should never appear in the accounts except at the price they were actually worth, regardless of the original cost. For instance, an electric lighting station which cost £50,000 10 years ago would not be worth half that now. Then all working charges, such as rent, rates, taxes, maintenance, etc., must be written off before any genuine profit was made. He took it, with regard to sinking fund, that that was provided to pay back loans, and not to replace depreciated machinery. He knew of no private concern which had such an item as a sinking fund, except for special conditions, such as the termination of leases, etc. Depreciation went on, however well the plant might be maintained, although, of course, it might be accelerated or retarded by the method of maintenance. With regard to the method of arriving at depreciation, it was only possible to deal with it accurately in one way, which was by actual examination by an expert valuer. He had not heard of any corporation which had adopted that system, but it was a common custom for high-class engineering firms to have periodical valuations. He had known a battery of boilers costing thousands of pounds destroyed in 18 months by bad water. If high-class firms, whose directors were trained to the business, felt it necessary to have periodical valuations, so as to write off the proper amount of depreciation, certainly it was more necessary in the case of municipal undertakings. The great objection was that of expense. In the case of Leeds, for example, he should think approximately the cost of such a valuation would be 2,000 or 3,000 guineas the first time, and £600 or £700 afterwards. In conclusion, Mr. Price advocated the employment by the Government of expert valuers who would be invested with power to value the corporation undertakings periodically, and to compel the writing off of depreciation.

International Telegraph Conference.—Delegates to the International Telegraph Conference are finding plenty of interesting diversion from their labours in the number of social functions provided for their entertainment. On Monday night the principal submarine cable companies—representing some 190,000 miles of cable—"fêted" the delegates at the Royal Botanic Gardens. The function was in the nature of a celebration of the forty-eighth anniversary of the first telegraph convention, which was held on June 29, 1855. It was an ideal summer's night, and the beautiful gardens looked their best lit by hundreds of multi-coloured lamps. The visitors found varied entertainment in the musical and other performances provided, which included the band of the Irish Guards. Sir John and Lady Denison-Pender received the guests, among whom were the representatives of Germany, Spain, Denmark, India, New Zealand, and Australia, and Sir Wm. Crookes, Prof. Ayrton, Prof. Perry, Sir W. H. Brooke, Sir H. Murray, Sir J. Wolfe-Barry, Sir H. C. Mance, Sir H. Tozer, Sir Wm. Preece, and many others. At the invitation of the directors of the India Rubber, Gutta Percha, and Telegraph Works Company, Limited, of Silvertown, delegates, numbering about 350, paid a visit to Warwick Castle on Saturday last, where they were received by the Earl and Countess of Warwick, and conducted over the castle and grounds. Lord Warwick welcomed the visitors on behalf of the Countess and himself, and M. Sins, the French delegate, replied on behalf of the visitors. A picnic luncheon was afterwards given in the park of Warwick Castle. To the directors of the India Rubber, Gutta Percha, and Telegraph Works Company, Limited, much praise is due for the admirable arrangements made for the comfort of the visitors, who were conveyed to Warwick by special trains from Paddington and Euston Stations. One party travelled to Warwick by Great Western Railway, returning *vid* London and North-

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Western Railway, and another by London and North-Western Railway, returning *viâ* Great Western Railway, which gave both parties the opportunity of seeing more of the country. During the afternoon the delegates drove to Stratford-on-Avon. Musical selections were given by the band of H.M. Scots Guards, and songs and choruses rendered by Madame Novello Davies's glee party. The foreign delegates were loud in their praises of their visit to Warwick Castle and the manner in which they were entertained.

Technical Training.—The munificent offer which Lord Rosebery has been privileged to make to the London County Council on behalf of certain public-spirited men of a grant of money for the establishment in the Metropolis of a national technical school, will be received with no mixed feelings by engineers. We in this country have long felt the want of such an institution, one that will provide adequate means for imparting to our young men an education of the highest order in technical and applied science, which will do for us what the technical high schools of Germany, Austria-Hungary, and Switzerland are doing for the youth of those countries. The proposal, which Lord Rosebery has communicated to Lord Monkswell as the head of the authority for technical education in London, is one which opens the way for the London County Council to bring technical instruction in this country at least up to the level of that provided by our Continental neighbours. As Lord Rosebery truly says, "A London Charlottenburg" is what we want, and the present opportunity is one which we expect to find will be eagerly seized upon by the London County Council. Indeed, the origin of the scheme may be indirectly traced to the report of the Technical Education Board for London last year. The connection between the present proposal and this report may be seen from the fact that one of the trustees of the proposed institution (Sir Henry Roscoe) strongly recommended the scheme in question to the committee which produced the report. The institution, when complete, together with the site, which is expected to be provided by the Royal Commissioners of the 1851 Exhibition at South Kensington, would represent a value of about £500,000, about £300,000 of which would be provided by the promoters, who include the great South African firm of Messrs. Wernher, Beit and Co., Lord Strathcona, Sir Ernest Cassel, and others. The London County Council are asked to provide an annual sum of £20,000 for the maintenance of the educational work of the proposed institution. As to the details of the organisation of the school, these have yet to be settled. But the proposal at present is that, whilst working in close co-operation with the Royal College of Science, the Central Technical College, and other branches of the London University, it should be organised as a distinct "school" of the university under the management of its own committee. Lord Rosebery's idea is that the new institution should supplement the provision made by other establishments for technical education by taking up subjects as yet undealt with, or only inadequately served. Such subjects would probably include, among others, chemical technology, mining and metallurgy, electro-chemistry, electric traction, and kindred subjects. The intention is to admit only advanced students able to profit by the instruction and facilities for original research which will be provided, but the institution will be made accessible by low fees and scholarships. The matter now rests with the London County Council, acting as the technical education authority for London, to whom the promoters look for the annual support of the institution to the extent indicated.

City and Guilds Institute.—A copy of the document issued annually by the City and Guilds of London Institute has just reached us. It includes the report of the council on the work of the institute for the year 1902, together with a number of subsidiary reports and appendices, and is dated April, 1903. The first item of importance in the council's report is the record that Sir John Wolfe-Barry, K.C.B., F.R.S., has accepted the office of chairman of the executive committee in the place of the late Sir Frederick Abel. The council at once proceed to indicate the direction in which the work of the institute is increasing and the needs of the immediate future. At the Central Technical College the congestion experienced a few years ago, owing to the rapid development of electrical science since the college was built and the steady increase in the number of qualified candidates seeking admission, has been met by leasing adjacent premises. There remain, however, many directions in which the curriculum of the college must be extended before it can cover adequately the subjects included in the faculty of engineering in the university. But neither the present accommodation nor the present staff is sufficient to allow of any substantial increase in the subjects included in the courses of study. There is also the important question of further extending the regular courses to a fourth or post-graduate year. Of the needs of the technical college at Finsbury, reference is made to the anonymous offer of £10,000 which has been made towards the extension and better equipment of the college provided that an additional £20,000 can be raised. Of this latter sum over £8,000 has been provisionally promised by the Livery companies. Reverting to the Central College, it is noted that Prof. Unwin succeeds Prof. Henrici in the deanship for the current session. Passing on we find a reference to the arrangement made with the London University under which Prof. Unwin became an "appointed teacher of the university," and the university agreed to devote £1,425 a year for the extension of the work of the engineering department of the college. As showing the development of engineering science during recent years, the council remark that the engineering faculty of the university will in all probability soon take a foremost position in the university as regards the number of its students. As for the Central Technical College, the number of students taking instruction in electrical engineering in the year 1901-2 was greater than in any other department. Thus 119 attended the electrical engineering course, 116 the civil and mechanical engineering course, 25 the chemical course, and 24 special courses—a total of 284. The college now being a "school of the university," a scheme has been prepared and accepted by the Senate of the university, under which the latter associate outside examiners with the professors of the college, and accept the ordinary college examinations for first year students as the intermediate examinations of the university for the degree of B.Sc. in engineering. The research fellowships provided by the Salters' and Leathersellers' Companies for award at the Central College became vacant last year, and have been awarded to E. Frankland Armstrong, Ph.D., and Wm. Robertson respectively. In the report of the principal on the work of the Finsbury College in the last session, it is shown that of a total number of students of 211, some 110 attended the electrical department, 62 the mechanical, and 39 the chemical department. A number of interesting extracts from some of the examiners' reports on the results of the examinations of 1902 are also given, but space forbids our referring to them further than to say that they indicate the high standard of instruction which the City and Guilds of London Institute offers to young men, especially to those who are entering on an engineering career.

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ON BOOSTERS.

BY G. STEPHENS.

A prominent auxiliary in modern generating stations is a booster, owing to the many uses to which it can be applied; yet, in spite of its large adoption, almost everyone of these machines has a feature peculiar to itself. Generally speaking, a booster is a generator used for altering the potential of a circuit, its armature being connected in series with that circuit, and revolving in a field excited in various ways. The chief advantage of a booster is to save copper at the expense of power generated. It is usually motor driven, and when used in connection with a three-wire system the balancer is often used to drive it, thus doing away with the necessity of a separate motor and forming a set of four machines on one shaft. Possibly the most general work to which it is applied is in connection with accumulators, and in dealing with this subject it is first of all necessary to consider the conditions under which batteries are worked. The usual voltage

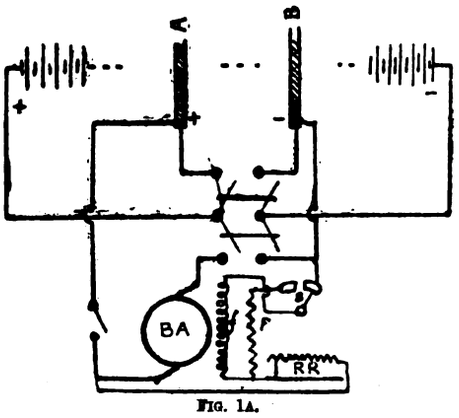

FIG. 1A.

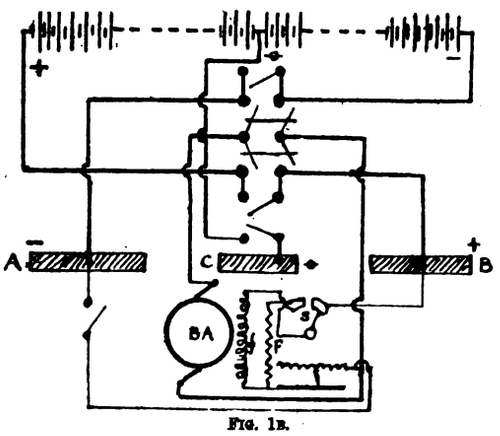

FIG. 1B.

Regulating cells are not shown. A, B, and C, arc-lighting 'bus bars; B A, booster armatures; *f*, booster field; F, shunt discharge coil; S, Shunt switch; R R, regulating resistance.

of a single cell when fully charged is 2·5, and the lowest to which it should be allowed to fall is 1·9. On this account, in a lighting station the battery is often divided into two parts, the main battery consisting of a number of cells which when fully charged will give a voltage equal to that of the 'bus bars, and in addition to these a number of regulating cells are provided sufficient to make the whole number in the battery equal to the figure obtained by dividing the 'bus-bar voltage by 1·9, this number being required in order that the total voltage of the battery when fully discharged will not fall below that of the 'bus bars. When the whole battery is fully charged its voltage will be considerably above that of the 'bus bars, and, therefore, to charge it a higher voltage than this is required. There are two methods of charging a battery: one is to disconnect it entirely from the 'bus bars and connect it across charging terminals at a higher voltage, while in the second case it is connected to the charging terminals and a less number to the 'bus bars, the regulating cells being cut out as they become charged and as the battery voltage rises. The higher voltage between the charging terminals is obtained either by a separate generator or by a booster. The connections in the latter case are given in Fig. 1, from which it will be seen that the charging current passes through the booster armature, where it is raised to the required voltage, the field being connected in series with an adjustable resistance across the 'bus bars. The diagram A shows a simple two-wire system, while B gives a three-wire system. It will also be noticed on reference to B (Fig. 1) that either half of the battery can be charged separately or both together. The method of connecting up the booster when the battery is arranged so that it can be connected to the 'bus bars and be charged at the same time is similar to that shown in Fig. 1, the difference only being in the battery connections and switches. In both

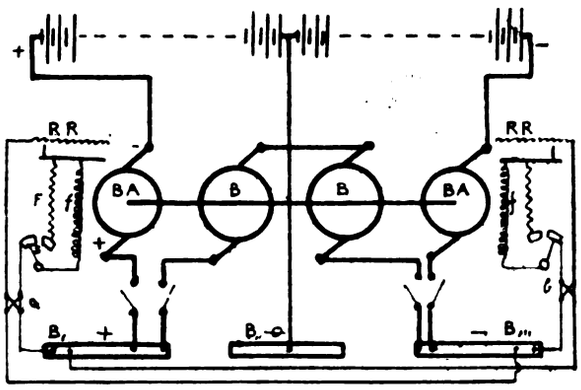

FIG. 2.—B A, booster armatures; B, balancers; B_I, B_{II}, and B_{III}, 'bus bars; S, field switches; *f*, booster fields; F, field discharge coils; R R, regulating switches.

these methods heavy leads and regulating switches are necessary, capable of carrying the maximum charging or discharging current, and these will cost a considerable sum, for in good practice one lead is used for every two regulating cells, so that the difference in potential between any two adjacent contacts on the regulating switches will not be much over four volts. Efforts have been made to reduce the cost of the regulating leads by fixing the regulating switches in or near the battery-room and connecting them mechanically to hand-wheels on the switchboard, but such an arrangement has many objections and cannot be considered satisfactory. Boosters have been designed not only to take the place of the regulating cells, but also to raise the

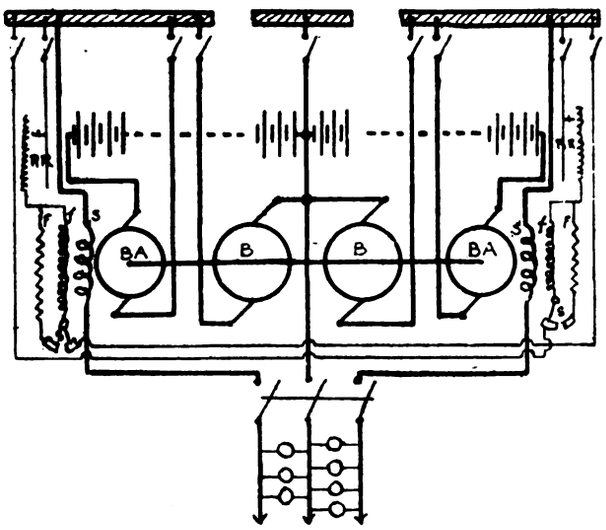

FIG. 3.—B A, booster armatures; B, balancer; B_I, B_{II}, and B_{III}, 'bus bars; S, series field coils; *f*, shunt field coils; F, field discharge resistances; R R, shunt regulating resistances; *s*, field switches.

voltage of the 'bus bars sufficiently to charge the batteries when required. This arrangement in connection with a three-wire system is shown in Fig. 2; two boosters are used and are driven by the balancer. The fields of these boosters are hand regulated and connected to the lighting 'bus bars; the current in them can be reversed by the switches marked *a b* when the battery requires to be charged. Boosters of this kind require continual attention if the load varies at all in order to keep the voltage constant, but in spite of this they are preferred by many to the automatic booster shown in Fig. 3.

This automatic booster is almost entirely independent of

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attention, but, like most so-called automatic machines, it cannot be depended on too much. Its field magnets are fitted with an additional coil, through which all or part of the main current leaving the station passes. This coil is connected in such a way that it works in opposition to the shunt coil, and so assists and retards the discharge of the battery according to the load. The current going through either coils can be adjusted by the resistances shown in the diagram. In traction work the usefulness of the automatic booster is more evident, for by its adoption the generating sets are run at a constant and economical load, the battery taking up the irregularities characteristic of such work.

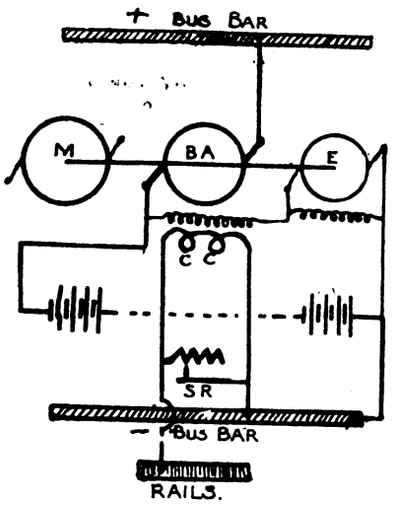

FIG. 4.—M, motor; B A, booster armature; E, exciter; C C, compounding coil to increase line volts as the load increases; S R, shunting resistance.

Fig. 4 gives the connections of the Highfield automatic reversible booster for use in conjunction with a battery for tramways. This booster consists of three machines—a motor, a boosting generator, and an exciter—all directly connected. The exciter is for exciting the magnets of the boosting generator. Its armature leads are coupled, one to the battery negative terminal and the other to the magnet coils of the boosting generator, the other terminal of the magnet coils going to the positive battery terminal. In this way the current in the magnet coils depends on the difference in potential between the exciter and the battery terminals, and should these be equal the booster will give no pressure; but as soon as one rises above the other, the booster will generate in proportion

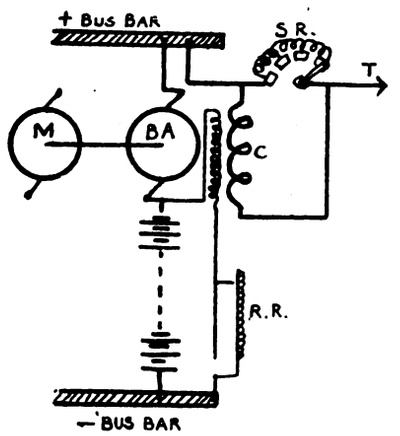

FIG. 5.—M, motor; B A, booster armature; R R, shunt regulator; C, series field coil; S R, shunting resistance; T, Feeder to trolley wires.

to the difference between them and in the direction to charge the battery if it is the lower and *vice versâ*. The booster thus follows the variations of the battery, maintaining a constant load on the generators and a constant pressure on the line. The other connections can be easily understood by referring to Fig. 4. Another type of booster for the same use as the one just described is shown in Fig. 5. It is the Chelmsford reversible booster, and is similar in some respects to those in Fig. 3, its action being as follows: When the external load is equal to the normal full load of the engines the battery will neither be charged nor discharged, as the series coils of the booster through which some or all of the main current flows (as desired) will then just neutralise the magnetising effect of the shunt coils, but when the load becomes greater the series coils overcome the shunt coils, causing the battery to discharge and assist the engines. When the external load falls below the normal full load of the engines, the reverse action takes place, the shunt wind overpowering the excitation due to the series coils, reversing the polarity of

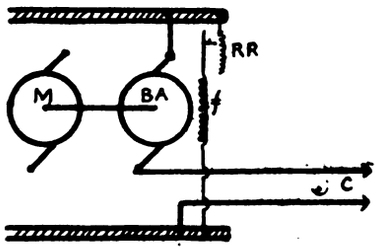

FIG. 6A.

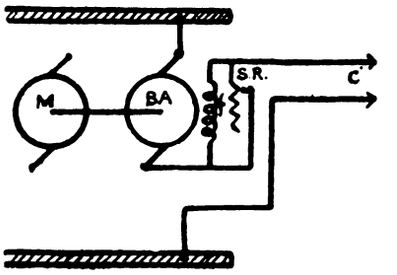

FIG. 6B.

M, motors; B A, booster armatures; *f*, field coils; R R, regulating shunt resistance; S R, shunting resistance; C, Feeders.

the booster and causing the battery to be charged. The point at which the reversal takes place can be varied by altering the resistance, shunting the current from the series coils, or by altering the resistance in circuit with the shunt coils, or both.

In supplying a district some distance from the generating station, another function of the booster is met with. To prevent a considerable fall of potential, the cables

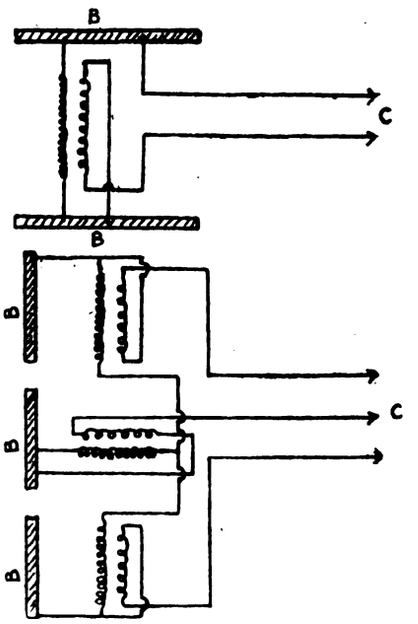

FIG. 7.—B, 'bus bars; C, feeders.

installed must be of large cross-sectional area, and consequently the outlay is excessive. To reduce this expense smaller cables are used, and to compensate for the greater drop the voltage at the station end is raised by means of a booster, the details of which are given in Fig. 6. The field is excited off the main 'bus bars, its strength being regulated by a rheostat to give the desired voltage at the booster terminals Another and preferable method of exciting the field is to connect it in series with the feeders and armature, in which case it is almost entirely automatic, the volts generated by the booster varying with the current

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in the feeder, as do also the volts lost in the feeder. To afford additional regulation the field is shunted by an adjustable resistance (see Fig. 6B). A single-phase and a three-phase alternating-current booster for use in power transmission schemes are shown in Fig. 7, by which they can be easily understood. Their construction is similar to a static transformer having no moving parts and requiring little attention. The primary coils are connected across the high-tension 'bus bars while the secondaries are put in series with the feeder to be boosted.

In a tramway system where the rails form the return conductor, the Board of Trade enacts that the greatest fall in potential on the rails shall not at any time be over seven volts. In any extensive scheme the rails are not sufficiently good conductors to keep within this limit, and to do so cables are run to distant points of the lines, and being connected in parallel with the rails improve the con-

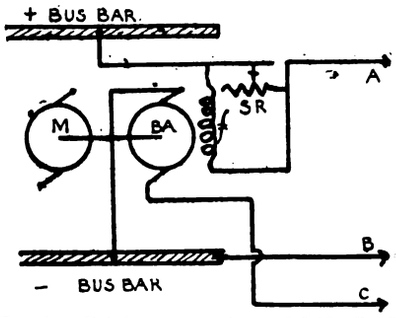

FIG. 8.—M, motor; B A, booster armature; *f*, field coil; S R, shunting resistance; A, feeder to trolley wire; B, to rails; C, booster feeder.

ductivity of the return circuit. These cables are an expensive item, as owing to the good conducting powers of the rails themselves they must be of large sectional area in order to make any appreciable improvement in the return circuit. To reduce this expense, Mr. Parshall designed a booster which is connected as in Fig. 8. The positive pole of this machine is connected to the negative 'bus bar, and the negative pole to a point about two-thirds of the distance from the generating station to the end of the line by means of a special cable. The field coils are connected in series with the positive line feeder going to the district to which the booster feeder is connected, and is thus excited by the current that supplies the cars on that line. In this way the voltage generated by the booster is automatically caused to vary with the load on the particular section to which it is connected. The action of this negative

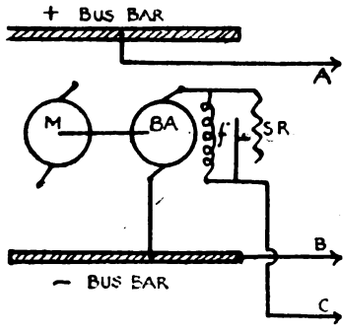

FIG. 9.—M, motor; B A, booster armature; *f*, field coil; S R, shunting resistance; A, feeder to trolley wire; B, to rails; C, booster feeder.

booster, as it is termed, is to reduce the potential at the station end of the booster cable below that of the rails at the station, and thereby drawing, as it were, back more current by that cable than would otherwise return by it, thus reducing the current returning by the rails. Its effect is such that the current returning by the cable is $\frac{e+AR}{r+R}$, whereas if no booster is used it would be $\frac{AR}{r+R}$, where A = total current in the return circuit of the section; e = voltage of booster; r = resistance of the booster cable and armature; R = resistance of rails.

In installing a booster the voltage it should generate can be found from these formulæ; thus $e = C(R+r) - AR$, C being the current to be returned by the cable. An additional shunt coil is sometimes added to the field magnets to give a greater range of voltage. Another method of connecting the negative booster is as in Fig. 9. In this case it is a simple series generator, which is in most cases to be preferred, as with it the current returned by the cable is proportional to the potential at the end of the cable connected to the rails, and it is not always possible to have a positive feeder in which the current varies with the fall in potential on the rails of a section.

THE DESIGN OF EXTRA HIGH TENSION SWITCHGEARS.

BY W. E. WARRILOW.

The most natural outcome of the development of the electrical industry is undoubtedly the concentration of large power sources into common centres, whence energy for both power and lighting purposes is radiated to supply areas many miles distant. One of the chief reasons for this course is to be found in the fact that the spots where natural power is available are generally remote from populated districts, and it has been necessary to adopt means for the transmission of power over long distances in order to establish a supply at all; further, the economies possible in high-pressure generation and transmission, with low-pressure distribution, have done much to lessen the opportunities the smaller undertakings have had of paying their way, and in view of these circumstances the laying down of extra high pressure schemes has resulted as a matter of course.

However, interwoven with this development have been the difficulties which always assail innovations of any description, and as we may discern in the evolution of the individual the evolution of the race, so it is possible to trace in the history of the earliest stations, and the larger ones now springing into prominence, parallel obstacles which have cropped up. In the first case, the chief enemy to deal with was the man in the street, who knew nothing of problems in electrical engineering, and considered that every effort was being made to impose on his ignorance of such matters. It is common knowledge how his prejudices have been broken down, and, as a result, attention can be drawn to so many successful undertakings in daily operation for the supply of light and power. In the second instance, the struggle has assumed quite a different aspect, the ground of contention being raised to much higher levels—in fact, to nothing short of the camp of the electrical engineers itself. Not only was there considerable passage of arms as to the economy, or even the feasibility, of such undertakings, but also the relative merits of single *v.* polyphase currents occasioned great strife among electricians, and many alarming statements were given vent to, in the full belief that they could not be otherwise than correct. The wheels of progress have, nevertheless, rolled over this rough ground, and now that the worst of the preliminaries are over and extra high-pressure work is becoming crystallised into definite forms, there is reason to doubt the credence given to the alarming views then expressed.

The problems directly associated with the production, transmission, and distribution of high-potential alternating currents have proved of a very fascinating character, chiefly because they are connected with phenomena hitherto confined, on a smaller scale, to the laboratory, and also because it has been unnecessary to turn much attention to the design of the plant itself, the principles underlying this having been long since understood and established in practice. Insulation troubles at either alternator or transformer have proved no mean task to encounter and overcome, but success has attended most of these labours and definite standards are now in common use. Power-station equipment at almost any voltage can be entertained and ultimately put to work, and the electrical world, much less the man in the street, has almost forgotten that its lights or trains are dependent on some such station many miles distant. Still, in spite of this marked advance, the work in hand is largely reliant on mere experiment, and as long as the human element has to be considered as part of a scheme, the safety of operators must rank high in the criticism of all apparatus needing attention at times when

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danger is most imminent. It is on the design of the controlling apparatus—the switchgear—that a scrutinising eye must be cast, as this section of the plant performa the most important function among all others in the station. It is needless to point out that when the energy corresponding to thousands of horse-power, and in its most intangible form at that, is concentrated into the space of a few square feet, the consequences of breakdown are so disastrous as to threaten the electrical and commercial life of the undertaking on their occurrence. It is interesting to note that whereas the design of generators and their prime movers is practically standardised, much diversity of opinion is to be seen in the controlling gear by the many varieties of apparatus constructed for use on switchboards. Continued experience with certain types, however, is indicating defects

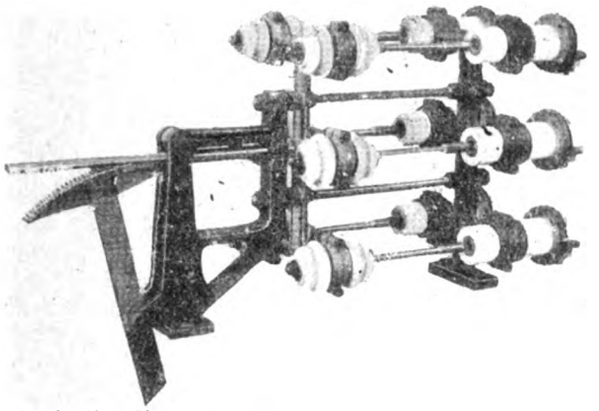

FIG. 1.—Three-Phase Switch, pressures to 10,000 volts (Oerlikon Co.).

in their design, and they are being "weeded out" to make room for more efficient goods, to the advantage of all concerned. In fact, there is hope that few more years will elapse before the principles underlying switchgear design will have become firmly grounded, and the control of high-pressure currents be conducted with absolute safety to attendants and perfect freedom from fire or interruption risks.

The coincidences in the evolution of the extra high pressure station and that of the pioneer undertakings mentioned above are especially noticeable in the design of the controlling gear, and it is highly probable that the outcome of each will be the same. In view of the high potentials dealt with, it has been thought necessary to spread out the gear to ensure isolation in case of fire, and many stations are equipped on these lines, the switchgear occupying a great portion of one of the station walls. Subsequent experience has illustrated that, in spite of the voltage, concentration within certain limits is possible and safe, so that the economies in wall space which are thus obtainable should ultimately cause preference to be given to this type of board. In the field of medium pressures the cellular type of gear seems to be more generally employed than any other, in this country at any rate, and its claim to this position can be directly based on its compactness and safety. It has replaced many boards of other makes which have been voted dangerous and have taken up more room, but it has only done so after the most exhaustive experiment and subsequent to continued manifestation of superiority. It may be said to represent the result of evolution in switchgears for the control of such pressures, and it will be interesting to note the consequences of its introduction into extra high potential work.

At the present time the gears for dealing with these voltages are varied in design and assembly of parts, though they are easily classed under two heads: (1) gears with backs; (2) gears without backs, the boards for distance control being also included. The examples described hereafter may be taken as representative of either of these designs, and they will serve to illustrate the developments which have resulted from but a few years' experience. It will also be noticed that considerable difference of opinion exists among manufacturers as to the best methods of assembling the gears, as well as in the design of the apparatus making up the various panels. Although the oil break fuse and switch have come into extended use on gears controlling medium pressures, and have proved their superiority over the air break, this latter type of switch is to be found among the designs put forward

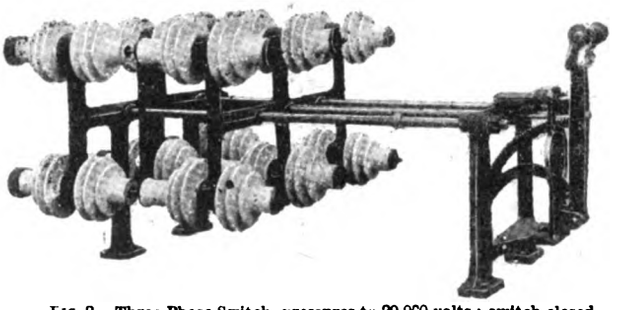

FIG. 2.—Three-Phase Switch, pressures to 20,000 volts; switch closed (Oerlikon Co.).

for dealing with extra high pressures, and quite a number of stations are running with apparatus of this description, though subsequent experience has illustrated that the oil break for either fuse or switch answers the purpose best.

The Oerlikon Company, Zurich, have had considerable experience in switchgear design, and favour the air break switch for pressures up to 20,000 volts, even at this potential finding no difficulty in breaking the circuit. Fig. 1 illustrates a switch of this type for three-phase working up to 10,000 volts, the photo showing the device in skeleton form complete for mounting in the most convenient position on or near the switch panels. It comprises a combination of simple castings carrying porcelain insulators in which the conducting portions of the switch are cemented. The back set of contacts are fixed to a frame provided with holders which clip the porcelain tubes, and the whole is bolted to the frame of the gear or the wall. Two guides are fixed to this back holder, and they serve the double purpose of acting as slides for the moving contacts of the switch and supporting the rack and sector gear which is connected to the operating lever on the face of the board. The sliding contacts are carried in porcelains in the same way as the fixed set, and two prongs per phase are fitted, which provide a double break, the terminals of the switch being screwed to the fixed contacts on the back frame. These latter comprise metal tubes embedded in porcelain, the whole, with terminal, being clipped to the carrier. The sliding contacts with spring plugs are arranged to enter the tubes, closing the circuit through the prongs on the moving carrier. No quick break is provided, but the arc is

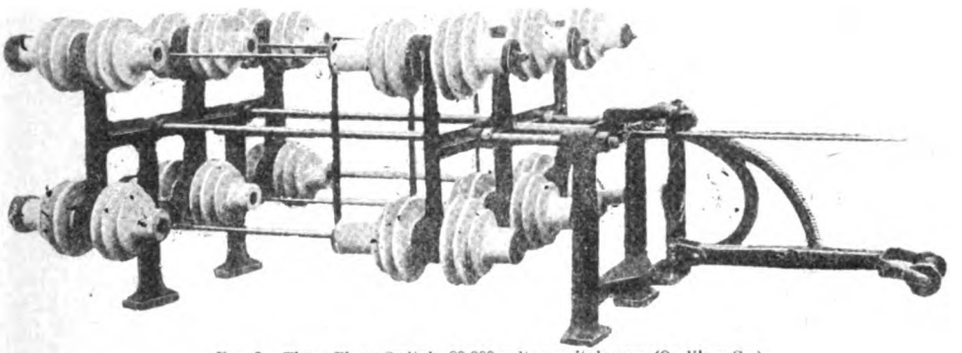

FIG. 3.—Three-Phase Switch, 20,000 volts; switch open (Oerlikon Co.).

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ruptured in the tube as soon as the contacts are separated, the space in the tube not allowing the entrance of sufficient air to maintain the arc. Fig. 2 shows the same design of switch in the closed position suitable for pressures up to 20,000 volts, the operating handle being also included. The same switch open is illustrated by Fig. 3, and the larger leakage surface of the insulators can be clearly seen in this particular design. In all these types the actual switch can be placed in any position as long as space will permit of its being linked up to the front of the board for operating purposes.

(To be continued.)

THE PRESENT POSITION OF THE THEORY OF ELECTROLYSIS.*

BY W. C. DAMPIER WHETHAM, F.R.S., MEMBER.

When, early in the nineteenth century, the attention of physicists and chemists was directed to the newly-discovered phenomena of electrolysis, an explanation had immediately to be found for the striking fact that the products of decomposition appeared at the electrodes only, while the body of the solution was unaltered. It was seen that a continual passage of the opposite constituents of the electrolyte in opposite directions through the liquid must be going on, and the chain hypothesis of Grotthus was long accepted as a true picture of the means by which that passage occurred.

About 1830 Faraday by accurate quantitative measurement threw new light on the subject, and proved that a definite electric transfer always accompanied a given amount of chemical decomposition. The process of electrolysis now appeared as a kind of convection—a stream of positively electrified cations drifting in one direction, and a stream of negatively electrified anions drifting in the other, under the influence of the E.M.F.

The next step was made in 1853 by Hittorf, who directed attention to the unequal dilution of the solution round the two electrodes, and showed that it could be explained either by the existence of complex ions, by means of which unaltered salt or solvent was dragged to one or other electrode, or by an unequal velocity of movement of the opposite ions. If in any given case we assume or can prove that no complex ions exist, we can calculate the ratio between the velocities of the cation and the anion, for this ratio will be the same as that between the amounts of salt lost by the solution from the neighbourhoods of the anode and the cathode.

In order to determine the absolute velocities with which the two ions move under a given force, it was necessary to discover another relation between those velocities. This was done by Kohlrausch, who pointed out that, on the convective idea of electrolysis, the total electric transfer per second through the solution, or the current, must be equal to the product of the number of ions, the charge on each of them, and the velocity with which they move relatively to each other—that is, the sum of their opposite absolute velocities. Now Kohlrausch had already described a satisfactory method of measuring the electric resistance of electrolytes by the use of alternating currents and a telephone, and had shown that when the reverse E.M.F.'s at the electrodes were eliminated the conduction of the current conformed to Ohm's law. The current through the solution would therefore be equal to the product of the conductivity and the potential gradient, and thus a relation was deduced between the molecular conductivity and the sum of the opposite ionic velocities under unit potential gradient, quantities which are known as the ionic mobilities. Combining these results with Hittorf's migration numbers, the absolute values of the ionic mobilities were obtained. Kohlrausch calculated many such mobilities, and showed that, in general, they increased with the dilution of the solution. When several salts containing a common ion, as, for instance, the chlorides of the three metals—potassium, sodium, and lithium—were examined, it was found that the values of the mobilities of the common ion chlorine, which differed in the three salts at moderate concentrations, approached each other as the dilution increased, and became identical at a dilution of about 100 litres per gramme equivalent of dissolved salt. To such a monovalent ion as chlorine, then, can be assigned a definite specific ionic mobility, which at great dilution is independent of the nature of the other ion present.

The first direct experimental confirmation of Kohlrausch's theory was given by Lodge, who measured the velocity with which hydrogen ions travelled along a tube filled with a jelly solution of a salt which contained an indicator, showing the presence of acid by a change of colour. Further experiments were made by the present writer, who traced the movement of the boundary between two solutions which were themselves of different colours. When the colour difference is due to the cations the colour boundary travels with the current; when it is due to the anions it moves against the current. This method has lately been improved and extended by Orme, Masson, and Steel. The general results confirm Kohlrausch's theory; the observed velocities agree with those calculated, and a very close coincidence is found throughout a considerable range of concentration for salts of monovalent ions. For divalent salts, slight discrepancies appear at higher concentrations, indicating the existence of complex ions, in this confirming the results of other lines of research.

The result of the investigations we have described clearly establishes the convective view of electrolysis; opposite streams of ions certainly pass through the solution, with the velocities indicated by Kohlrausch's theory, carrying their electric charges with them. To allow this migration a certain freedom of movement is necessary; how this freedom is secured is another question.

There is evidence to show that the migratory freedom is not produced as an effect of the electric forces, but exists whether or not such forces act. When the reverse polarisation at the electrodes is eliminated by the use of alternating currents or otherwise, it is well known that the conduction of electricity through solutions conforms to Ohm's law. The current is directly proportional to the E.M.F., and any force, however small, will consequently produce a corresponding current. In the body of the liquid, then, there can be no appreciable reverse E.M.F.'s, and no chemical or other reversible work is done when a current passes, all such work being located at the electrodes. Thus it follows that the current does no work in giving the ions the independence required for their electrolytic functions; the part played by the E.M.F. is merely directive, and the only work expended by it goes in moving the ions, which already possess the necessary freedom, against the frictional forces of the viscous medium.

So far our argument shows that under all conditions the ions of a conducting solution possess the freedom which allows their passage through the liquid under the action of an E.M.F., but we have not considered the essential nature of this migratory freedom. Two alternatives seem to present themselves. Either the ions may migrate independently of each other, in accordance with the dissociation hypothesis, or else they may work their way through the solution by taking advantage of the successive formation and decomposition of molecular aggregates, or of collisions between the dissolved molecules, and the consequent possibility of ionic interchanges, in some such manner as is pictured in Grotthus's chain.

Let us assume for the moment the latter hypothesis, and trace the consequences. The solute molecules are scattered throughout a large volume of solvent, and, on this view, the ions work their way along from molecule to molecule of the solute, at the instants of collision between those molecules. Their velocities must therefore depend in some way on the frequency of collision, and this frequency, we learn from the kinetic theory, varies as the square of the concentration of the dissolved molecules. The ionic mobilities, then, will increase with the concentration, probably approximately as its square, while the conductivity, which, on the convective idea, is proportional to the product of the mobility, and the concentration will vary more or less proportionally to the cube of the concentration. These consequences of the hypothesis are contrary to observation, which shows that in general the ionic mobilities only vary slowly with dilution, usually slightly falling as the concentration increases, while the conductivity of a dilute

* Paper read before the Faraday Society, June 30, 1903.

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solution is directly proportional to the first power of the concentration instead of to its cube, and increases more slowly than the concentration as the solution becomes stronger.

The view which refers the ionic mobilities to molecular interchanges is thus clearly untenable, and we are driven to examine further the hypothesis of ionic dissociation. Here may be emphasised the point that the dissociation indicated by the electrical properties of solutions is merely a dissociation of the ions from each other, and does not require the supposition that they are free from all chemical combination; forces would certainly exist between the ions and the solvent, and there seems no reason to assume that chemical union between them cannot occur. Molecular complexes with an ion for a nucleus may exist, definite compounds may be formed, or some kind of double decomposition result in the production of new molecules in which an ion retains its electric charge. About these various possibilities the electrical evidence has nothing to say, an effective migratory independence from each other is all that the ions need to produce the observed phenomena.

The dissociation theory, reached by the arguments outlined above, is supported, and was indeed originally suggested, by other relations. The possibility of assigning specific ionic mobilities, which are independent of the other ion present, is strong evidence for mutual ionic independence. The additive nature of the properties of electrolytes—their colours, for example—though perhaps too much stress has sometimes been laid on it, still tells the same tale. These and other similar arguments are familiar to all readers of text-books on the subject, and need not here be considered in detail. Evidence less well known is given by the power possessed by electrolytes of coagulating certain collodial solutions, such as those of the sulphides of arsenic and antimony. It has been found by Schulze, by Linder and Picton, and by Hardy, that this coagulative power stands in a remarkable relation to the valency of the reacting electrolyte, the relative effects for salts with monovalent, divalent, and trivalent ions being represented by the ratios l : 30 or 40 : 1,000 or 1,600. Such results are explicable on the view that the modification of conditions which results in coagulation is produced by the action on a colloid particle of a certain minimum electric charge. An equal charge is brought up by the conjunction of two triads, three diads, or six monads, and, by the principles of the kinetic theory, this relation leads to the values for the ratios of the coagulative powers of $l : x : x^2$. Putting x equal to 30 or 40, we get, within the limits of experimental error, an exact concordance with the observed results. This explanation has lately been supported by an experiment of Hardy, who finds that the less penetrating rays from radium, which consist of positively charged particles comparable in size with the hydrogen atom, are likewise able to induce coagulation in solutions of proteid.

Thus, taken together, the electrical properties of aqueous solutions yield an overwhelming amount of evidence in favour of the migratory independence from each other of the ions of the dissolved substances. The same conclusion has been reached by an entirely different method of research.

The theory of osmotics rests on a thermodynamic basis, from which we may approach it in two ways. We may accept the pressure-solubility relations of gases, and deduce the results by a thermodynamic cycle in a cylinder with semi-permeable diaphragms, in the original manner of van't Hoff, which has been followed by Lord Rayleigh, or we may with Willard Gibbs, von Helmholtz, and Larmor treat the subject from the fundamental ideas of the molecular theory. By the latter method we must regard the solute as distributed throughout the solvent as a number of discrete particles, each of which may effect, either by way of chemical combination or physical influence, a certain minute volume of the solvent lying round it. The nature of this influence is unknown, but, whatever it may be, as soon as the solution becomes so dilute that, except for an inappreciable fraction of the time, these spheres of influence do not in general intersect each other, any further addition of solvent will only increase the separation of these spheres of action. It cannot change the internal condition of one of them—that is, it cannot affect the interaction between the solute particles and their surrounding solvent. The change of available energy produced by the entry of solvent must then simply be that due to the dilution of the solute particles, and cannot depend on any interaction between solute and solvent. Now, the osmotic pressure which a solution will exert against a solvent is measured by the rate of change of the available energy of the system when solvent is allowed to enter the solution reversibly through a semi-permeable membrane. The osmotic pressure, then, must, from what we have said above, be independent of the nature of the solvent, and will, therefore, have the same value if no solvent be present. Thus, in cases where this is possible—that is, for volatile solutes—it follows that the osmotic pressure must be equal to the gaseous pressure corresponding to the same concentration. In this way we establish theoretically the gaseous laws for the osmotic pressure of volatile solutes, and, since volatility is probably only a matter of degree, it seems reasonable to extend this result to non-volatile bodies. Whether this extension be regarded as theoretically valid or not, there is abundant experimental evidence that it is practically justified, since the osmotic pressure of such substances as cane sugar is well known to have the gaseous value.

The direct measurement of osmotic pressure is a matter of considerable difficulty, but there exists a theoretical connection between that pressure and certain other properties of the solution, such as the lowering of its vapour pressure and the depression of its freezing point below the corresponding values for the pure solvent. Observations on the boiling or freezing points of solutions, then, enable the osmotic pressures to be calculated. As is well known, direct osmotic determinations, as well as the results of experiments on these correlated properties, yield abnormally great values in the cases of aqueous solutions of electrolytes. It was van't Hoff's investigation of this phenomenon that originally suggested the idea of ionic dissociation to Planck and Arrhenius. Since the thermodynamic theory shows that the osmotic pressure of dilute systems depends only on the number and not on the nature of the dissolved particles, or on the nature of the solvent, when the osmotic properties have abnormally great values for dilute solutions, it must follow that the number of dissolved particles is greater than that calculated from the chemical formula weight—that is, that dissociation must have occurred. It does not necessarily follow that the dissociation is that with which we have to deal when examining the electrical properties; whether it is or is not is a matter for further enquiry. Complicated molecules, dissolved in non-aqueous solvents at any rate seem sometimes to undergo dissociation into parts which are not electrical ions, for Kahlenberg has lately found that solutions of diphenylamine in methyl cyanide show abnormally low molecular weights and yet are non-conductors of electricity. On the other hand, it is difficult to see how more than one kind of dissociation is possible in such a molecule as potassium chloride, which we have already seen is dissociated into electric ions when dissolved in water.

In cases where the dissociation indicated by the osmotic pressure is found to be electrical in its nature, two separate relations have usually been held as necessary consequences of the dissociation theory. How far such suppositions are justified we will proceed to discuss.

The equivalent conductivity of a solution of a simple salt such as potassium chloride increases with dilution and finally becomes constant. There seems reason to believe that the salt is then completely dissociated into its ions, which, in this case, are shown by the chemical and electrical properties to be two in number. If the osmotic phenomena are examined at dilutions corresponding to complete electrolytic dissociation, we ought to find indications here also that the molecule of potassium chloride behaves as though it were separated into two parts—the osmotic pressure and the freezing point depression should possess double their normal values.

The only satisfactory measurements at the extreme dilutions necessary are those described by Mr. E. H. Griffiths to the British Association in 1901. The freezing

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points of a solution of cane sugar, as measured by the most accurate methods of platinum thermometry, were such that the molecular depression maintained a value of 1·858 from concentrations of 0·0005 to 0·02 normal. Taking 79·4 as the best value for the latent heat of fusion of water, the result, calculated thermodynamically from the gaseous value of the osmotic pressure, is 1·857. A solution of potassium chloride gave results which increased as the concentration diminished, finally reaching a value of 3·720 at a concentration of 0·0003 grm. equivalents per litre. Twice 1·857 is 3·714, agreeing within very small limits of experimental error with the observed result.

For no other electrolytes are such accurate cryoscopic data yet available. The observations of Loomis, which are put forward by Raoult in his recent work as in themselves trustworthy and in accordance with the best of the other known results, were carried only to concentration of 0·01 normal. At this concentration were found value for various binary electrolytes which approach the theoretical result within a few per cent. Substances which, like barium chloride or sulphuric acid, are shown by their electrical behaviour to produce three ions, gave a molecular depression of freezing point some 10 per cent. below the figure for complete dissociation, while salts with two divalent ions, such as magnesium sulphate, fail to reach 3·714 by about 30 per cent. In all these cases the discrepancies are in the direction suggested by the electrical conductivities, which, especially for the last class of salts, indicate that the dissociation is very far from complete at the concentration used in the cryoscopic experiments.

On the whole, then, the evidence is clearly in favour of the relation we are examining, in those cases which have been adequately examined at sufficiently great dilutions.

It has usually been considered that the dissociation theory required a further relation between the electrical and the osmotic measurements. At higher concentrations the equivalent conductivity diminishes, and this is held to denote incomplete ionisation. The actual value of the equivalent conductivity, divided by its value at extreme dilution, is commonly taken as measuring the fractional coefficient of ionisation, which can obviously be also calculated from osmotic data on the assumption that each dissolved particle still causes the effect it would produce at infinite dilution. Many discrepancies between the values given by these two lines of research have been discovered, and it is necessary to examine how far the theory really suggests any coincidence.

The electrical value of the coefficient of dissociation assumes that no complex ions are present, and that the ionic viscosity of the solution is the same as that which the solvent offers to the passage of the ions at infinite dilution. It is probable that small errors are introduced by these assumptions, but on the other side much larger ones are possible. The deduction by the principles of thermodynamics of the gaseous value for the osmotic pressure is only valid for dilute systems—systems, that is to say, between the parts of which there are no appreciable forces. It is true for a gas at atmospheric pressure; it is true for a non-electrolyte at moderate dilution; but, as Dr. Larmor pointed out to the writer, we must not assume that inter-ionic forces will vanish at corresponding concentration.

In the light of our present knowledge it is natural to represent a non-dissociated molecule as an electrical bipolar system. The forces between the widely separated molecules of the dissolved substance will be analogous to the translational forces between two small magnets at a distance from each other large compared with the length of either of them. Such forces vary inversely as the fourth power of the distance, and therefore become insensible as soon as that distance exceeds a very small value. Inter-molecular effects, then, will vanish for the solute at moderate dilutions, and the osmotic properties conform to the gaseous laws.

On the other hand, representing an electrolyte in solution as chiefly composed of dissociated ions, we see at once that the forces between those ions are those between isolated particles, charged with opposite kinds of electricity. Such forces vary inversely as the square of the distance, and therefore remain effective at distances whereat the bipolar solute molecules have quite ceased to exert any mutual influence. Inter-ionic forces will thus produce disturbing effects even at very great dilution. The fact that the theoretical value for the freezing point has been reached in the case of potassium chloride shows that here, at any rate, they vanish at a dilution which, though very great, is still experimentally attainable. It does not follow, however, that they remain insensible as the concentration rises, and the ionisation, determined electrically, ceases to be complete.

Experiments on the comparison of the electrical and the osmotic values of the coefficient of ionisation are now seen to have little use from the point of view of the controversialist seeking arguments for or against the ionic dissociation theory. Such comparisons, however, are of interest, inasmuch as they give data which may enable a more complete theory than we yet possess to take account of the inter-ionic forces which seem to disturb the course of the phenomena except at extreme dilution. Taking as an example solutions of potassium chloride, we may compare the ionisations deduced from electrical measurements by the writer at 0deg. C. with that indicated by the combined cryoscopic experiments of Griffiths, Raoult, Loomis, and H. C. Jones. The coincidence with theory of Griffiths's result shows that the two values agree at extreme dilution, but the cryoscopic curve falls below the electrical one at concentrations of about one-hundredth normal and upwards, reaching a maximum discrepancy (0·84 compared with 0·88) at one-fifth normal, and approaching the higher curve again at greater concentrations. It is possible that the two curves, if prolonged, would cross each other at some considerable concentration. Such chance coincidences probably explain some of the agreements which have been observed between the two lines of research in moderately strong solutions of many salts. More accurate determinations of freezing points are needed before such comparisons as these can be taken as a satisfactory basis for theoretical generalisations. Collections of present data have been made by MacGregor and by Kahlenburg, and further discussion can be found in the writer's book on the "Theory of Solution."

The modern theory of the galvanic cell, based on that of the concentration cell, involves both electric and thermodynamic considerations. By imagining an isothermal and reversible cycle, carried out by the passage of one electric unit through the cell and the reversal of all the chemical and concentration changes by other means, the electric work, and thus the E.M.F., can be calculated. The original treatment of the subject, due to von Helmholtz, effected the reversal by an imagined process of evaporation and condensation of vapour, but it is now more usual to suppose that the reversal is brought about by producing the necessary changes of concentration by osmotic means. In one or other of these ways, by assuming the gaseous laws, the work done in the second part of the cycle can be calculated, and this is equal to that given out in the first part. It is evident that such a theory, based on the principles of thermodynamics alone, furnishes no evidence one way or the other about any definite electrolytic or ionic hypothesis, any more than the thermodynamic theory of osmotic pressure can enable us to decide whether that pressure is produced by chemical affinity or by the bombardment of the membrane by the dissolved molecules. In each case we may either rest content with the correlation of the subject given by thermodynamics, or we may enquire further whether any known picture of the physical nature of the phenomena will give us a satisfactory explanation.

Now, one kind of concentration cell may be regarded in a simple manner from the point of view of the dissociation theory. It is a cell in which the total potential difference is that due to the contact of two solutions of the same substance at different concentrations. Let us imagine a strong solution of hydrochloric acid placed in a vertical cylinder, and a volume of water placed above it. The dissociated ions of the acid will both diffuse upward, but the more mobile hydrogen will travel faster than the chlorine. Separation thus occurs, and the water (or dilute solution) is found to take a positive potential relatively to the strong solution. Soon, however, the electrostatic forces between the ions become so great that further

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separation is impossible, and the opposite ions then diffuse at equal rates. From Kohlrausch's experiments we know the velocity with which any ion moves under the action of a given force, and from the knowledge of the osmotic pressure gradient we can calculate the forces at work. Thus the actual velocities of diffusion can be obtained and the diffusion constant deduced. It is found to agree in a remarkable manner with the observed diffusivity. Equating the velocities of the two ions we get the condition for no further separation, and obtain an expression for the difference of potential between the two solutions in the form

$$\frac{R\,T}{q}\frac{v-u}{v+u}\log\frac{c_2}{c_1},$$

where R is the gas constant for one gramme-molecule and of its electric charge, T the absolute temperature, c_1 and c_2 the concentrations, and u and v the coefficients of ionic mobility. Such an expression agrees with that deduced thermodynamically for similar cells, and Nernst, by suitable experimental arrangements, has confirmed it directly. Thus the phenomena of concentration cells may be satisfactorily explained by the hypothesis of independent ionic diffusion.

The chemical reactions of electrolytes, rapid and easily produced, are in marked contrast with those of organic bodies, which are usually attacked slowly and with difficulty. In the original presentment of the dissociation theory Arrhenius pointed out the close numerical connection which exists between the electrical ionisation of aqueous solutions and the coefficients of chemical activity of the dissolved substances.

There is no such definite theoretical deduction of this relation as of that between the conductivity and osmotic effects; the connection of electrical ionisation with chemical activity is a matter of observation, and the conclusion that in the rapid chemical actions characteristic of electrolytes it is the ions which alone are active, rests on the evidence of this connection alone. The numerical relations given by Arrhenius, and the many deductions from this hypothesis which have been verified for aqueous solutions, have led to the idea that a similar explanation of the nature of all rapid chemical action might be given, whatever the solvent and whatever the conditions. There seems, however, no valid theoretical reason which necessitates such an extension, and it is possible that in other solvents, and for gaseous or fused systems, rapid chemical change may be brought about by non-electrical double decomposition. This conclusion is supported by an observation of Kahlenberg on the instantaneous production of a precipitate of copper chloride when hydrochloric acid is passed into a non-conducting solution of copper oleate in benzene. It is evident that such a result indicates that in the particular solvent used rapid chemical action may occur which is not correlated with appreciable electrolytic ionisation, but it does not in the least affect the electrical and osmotic evidence we have adduced above in favour of the theory of the ionic dissociation of the aqueous solutions of electrolytes. Nevertheless, it serves to caution us against extending the deductions of theory which apply to simple aqueous solutions to cases which have not been subjected to an adequate theoretical and experimental examination.

The recognition of the intimate connection between chemical and electrical phenomena led Ostwald to apply the mass law of chemical action to the effect of dilution on the equilibrium between the undissociated molecules and the ions formed from them in an electrolytic solution. As is well known, this application met with perfect success in the case of weak acids and other slightly conducting solutions, but completely failed to explain the effects of dilution on strong acids and other good conductors. This discrepancy has been considered one of the greatest objections to the dissociation theory. The difficulty, which formerly appeared to the writer a very great one, is probably to be explained by that difference in the law of the variation of the force with the distance which we have already pointed out must exist between solutions containing non-dissociated bipolar molecules, and those containing dissociated electrified ions. The inter-molecular forces, varying inversely as the fourth power of the distance, rapidly become insensible with dilution, while those between the ions, depending on the square of the distance, are effective at much higher concentrations. Now, the theory of the mass law rests on a thermodynamic basis, and in its deduction the assumption is made that the matter considered is in the dilute state. The work done in forming a small quantity of one of the products of the reaction at a standard pressure, and bringing it to the existing pressure, may then be written in the form $a + R\,T \log b\,c$, where a and b are constants, R the gas constant for one gramme-molecule, T the absolute temperature, and C the concentration. Similar expressions give the work done for other reagents or products, reckoned positive when they are formed and negative when they disappear. When equilibrium is reached, the change of available energy arising from a further slight transformation must vanish; thus the value of $n_1 (a_1 + R\,T \log b_1 c_1) + n_2 (a_2 + R\,T \log b_2 c_2) + \ldots$ must be zero, and we see that $C_1^{n1} C_2^{n2} \ldots$ may be put equal to K, a function of the temperature alone. This result is the mass law, and if we apply it to a solution in which one gramme-molecule of electrolyte is dissolved in a volume, V, a faction, α, being ionised, we obtain the equation

$$\left(\frac{1-\alpha}{V}\right)^{-1}\left(\frac{\alpha}{V}\right)^{2} = \frac{\alpha^2}{V(1-\alpha)} = K,$$

Ostwald's dilution law. Its deduction clearly involves the assumption that the gas laws hold good, and that consequently no inter-molecular forces or other similar actions are appreciable. We must not, therefore, look for conformity with the dilution law in solutions where many dissociated ions are present.

Summing up our enquiry as far as we have yet pursued it, we may say that the phenomena of electrolysis and the osmotic properties of electrolytes clearly indicate that the conduction of a current through an aqueous solution consists in the convection of charged ions through the liquid, the ions being dissociated from each other while they are electrolytically active.

We must now raise the much wider question, and ask whether this mode of conduction is a universal accompaniment of electrolysis, or whether it is confined to the case of solutions in water. Since the development of the dissociation hypothesis as applied to liquid electrolytes a vast increase has occurred in our knowledge of the discharge of electricity through gases. This process has been satisfactorily explained as a convective electrolytic action, the ions being in some cases dissociated molecules, in other cases isolated corpuscles, which may represent the ultimate units of negative electricity, perhaps even the common constituents, aggregates of which make up the different chemical atoms. Such results not only support the idea of a similar dissociation as the cause of the conductivity of solutions, but give a presumption in favour of the general applicability of such theories. When, however, we examine how far such a presumption is justified, further considerations are seen to be involved. Had the phenomena of gaseous conduction been first in the field, we could not, without experimental evidence, have extended a dissociation hypothesis, framed to explain them, to the much more complicated systems which are formed by electrolytic solutions. It is only on the knowledge summarised in the laws of Faraday, Ohm, and Kohlrausch that the particular phenomena which have led us to the dissociation theory require such an explanation, and at present it is only for solutions in water and a few other liquids that we possess sufficient evidence for those laws, and for the other relations to which we have referred, to enable us to draw valid conclusions. Without definite experimental evidence in each case we cannot legitimately extend these conclusions, and when, as in fused salts, the conditions are entirely different, we shall presently see that an alternative explanation is possible. Nevertheless, for all *solutions* which conduct electricity, the presumption in favour of similarity of explanation is very great, and for several solvents, at any rate, experiments show that the general process of conduction is similar to that which we have studied in aqueous solutions.

When we go further, however, and try to trace in non-aqueous media the ionisation of solutes as measured electrically and osmotically, we are met by want of numerical data, largely owing to increased difficulty of experiment. With some solvents—as, for instance, the alcohols—freezing-

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point work is impossible, and in no case do measurements of osmotic properties appear to have been made at dilutions great enough to enable us to fairly treat the systems as thermodynamically dilute. On the electrical side some data are available, but the examples of acetic acid and ammonia show that, even in water solutions, complete ionisation cannot always be experimentally attained, and, without definite evidence, it is not safe to conclude that in another solvent it can ever be reached. We have already seen that only when the dissociation is complete can a just comparison be made between the numbers of ions given by a molecule as determined electrically and as determined osmotically. Thus it is necessary to push the dilution so far that the equivalent conductivity reaches a definite limiting value before making such comparisons. Limiting values have been obtained for salts of the alkali metals dissolved in methyl and ethyl alcohols, in acetone, and in pyridine, but in all these cases no osmotic data have been determined at dilutions great enough to secure complete ionisation or to justify the gaseous laws as applied to the osmotic phenomena. Experiments at higher concentrations are of little value, for not only do the disturbing causes already noted in the case of aqueous solutions act here also, but it is known that one of them, the influence of complex ions, is much more common and much more important. It is probable, too, that association of the non-ionied solute molecules may occur, Kahlenburg, for instance, having discovered cases in which the boiling or freezing points of conduction solutions indicate that the number of such molecules is less than the chemical formula would lead one to expect. It is evident that the existence of such association does not in the least prevent the conduction of the current by the movement of charged ions dissociated from each other. Such observations as those referred to have been brought forward as evidence against the whole basis of the theory of ionic dissociation, but the relations on which they bear are, as we have seen, merely consequences of the theory under ideal conditions of very restricted nature, and are not, as seems to be commonly supposed, the very foundation on which the theory rests.

Faraday found that many fused salts were electrolytes, with conductivities of the same order as those of aqueous solutions, and since his time it has been confirmed that in such cases the electro-chemical equivalents have the usual values. How far are the principles of the dissociation theory applicable to fused electrolytes? No osmotic data are available, and it is difficult to see how such data could be obtained. Let us examine the matter from the electrical side. The products of decomposition appear at the electrodes only, and Faraday's laws hold good; hence the process must be convective, but we have no knowledge of the ionic velocities, and no means of estimating the amount of ionisation. When closely scrutinised, the conditions are seen to be essentially different from those which led to the adoption of the belief in considerable and permanent dissociation for aqueous solutions. We do not know that the conductivity is proportional to the number of ions present, but even if such a relation were established, the consequences deduced from it in the case of solutions would not necessarily follow. The process, as we said, must be convective, and freedom of migration of the ions is necessary, but, unlike a solution, a fused salt consists of a collection of molecules all of the same kind, and the argument from the frequency of collision between dissolved molecules, isolated from each other by comparatively vast spaces of solvent, ceases to be valid. In a fused salt the electrolytic molecules are crowded together, and, even if dissociated ions are present, the interaction of one of them with one of the surrounding electrolytic molecules, which replace the neutral molecules of the solvent of a solution, would make possible an effective interchange, and enable an electric transfer to take place Thus the frequency of interchange for any one ion would not increase with the ionic concentration as in the case of a solution, and the conductivity might be proportional to the number of ions without permanent ionic dissociation. The conditions are entirely different to those which hold in a solution, where the solvent molecules are of different kind to those of the electrolyte, and cannot take a direct part in the electrolytic process. We may now go further, and say that it is possible that conduction in a fused salt may be due to a mere possibility of interchange between the electrified parts of the molecules, without any permanent and definite dissociation. Some process in the nature of Grotthus's chain may, in this case, secure the migratory freedom necessary for electrolytic conduction. Whether this is so, or whether, as in solutions, the current is carried by ions dissociated from each other, their number being a function of the temperature, remains a question for future investigation.

TRANSMISSION AND DISTRIBUTION BY SINGLE-PHASE ALTERNATING CURRENT.*

BY E. W. MONKHOUSE, M.A., M.I.C.E.

The question of electrification of railways has been, and is, receiving much attention and consideration from the directors of railways and their advisers, and the question of cheap power is receiving the attention of numerous other people. The problems which have to be solved are: the cheap generation of electrical energy; the transmission thereof; and the utilisation thereof at the end of or along the line. The necessity for transmission of power over long distances arises from the fact that it is often inconvenient or inadvisable, from the point of view of economical generation of energy, to have generating stations near the points at which energy is being used. If the distance is great, it is not possible to transmit at low pressures, as, if this were done, the amount of copper which it would be necessary to use in the transmission line would be prohibitive. Where it is not necessary, owing to circumstances, to generate and transmit at more than about 1,500 volts, the electrical energy can be generated by continuous-current machines, but above this pressure continuous-current machines give trouble, and it becomes necessary to employ machines which generate alternating current.

It is a well-known fact that for use in lamps there is nothing to choose between continuous and alternating current provided the frequency of the latter is high enough, so that the question is narrowed down to one of transmission and use in motors. The transmission of electrical energy over long distances for power purposes is being successfully accomplished at the present time by means of alternating currents, but these are usually polyphase. The alternating current so transmitted is generally converted into continuous current either by means of polyphase motors driving continuous-current dynamos, or by means of rotary converters, before it is used by the consumer. The numerous conversions which the original source of power has to go through in such a case all serve to lower the efficiency of the system, and it is, therefore, very desirable that the number of conversions should be cut down to a minimum. This means that we must, as long as we are compelled to use alternating current for transmission, have motors which are capable of working satisfactorily with it, and motors which will work with current at as high a voltage as possible, so that transformers are not necessary, and the copper in the transmission lines may be kept down to a minimum. An ideal system would be one in which there were no transformations of voltage between the dynamo and the motor. This means that, for very long-distance transmission, both dynamos and motors would have to be wound for very high voltages.

The generation of electrical energy at high voltage (10,000), and the transmission at the same voltage, is being effectively carried out by the London Electric Supply Corporation; and that it is possible to use high voltage in motors is shown by the fact that in 1899 a stationary motor working at 10,000 volts was in use at the General Electric Company's works at Schenectady, U.S.A., driving the machinery of a portion of the shops, and appeared to be running satisfactorily; and also that lately the Valtellina Railway in Italy has been constructed, and on this the voltage at the motors is 3,000.

* Paper read before the Engineering Conference of the Institution of Civil Engineers.

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The raising of the voltage of transmission and the voltage at the motors points to the necessity for having all connections and apparatus as simple as possible; and the use of single-phase alternating currents in place of polyphase would tend to this end, as all switches, instruments, etc., are reduced to a minimum. On a single-phase alternating system the switchboards at the generating and sub-stations are much simpler and less costly pieces of apparatus than on polyphase systems, for only single-pole switches and fuses are required in place of triple-pole; the instruments are much fewer, and the connections are of the simplest character. The transformers also are simpler. It follows, as a matter of course, that the cost of up-keep is much less, and also that the chances of breakdown owing to failure of apparatus are considerably reduced.

The desirability of employing a single-phase system rather than polyphase for transmission of energy from the generating station to the sub-stations is therefore apparent, but this is greatly emphasised when the question of the line from which current for traction purposes has to be collected is considered. All writers on the subject of electrical working of long distance heavy railways are agreed that, owing to the fact that the line voltage could only be comparatively low if continuous currents were used, the conductors for carrying the large currents necessary for working the trains would be of a prohibitive size, unless sub-stations for feeding current into them were placed at very short intervals along the line, and this, of course, would involve not only a large capital outlay, but also a large staff of men, and consequently heavy running expenses, and also that the collection of such large currents would be a matter of great difficulty, and that, therefore, the currents used must be high-tension alternating. This being the case, we have the choice of using single-phase or polyphase currents, and it will be at once apparent that on the score of simplicity the single-phase current is the much more desirable; for, assuming that the rails are used as one conductor, as is the case on the Valtellina Railway, it is only necessary to have one conductor in addition to these, and consequently one collecting device, instead of two conductors and two collecting devices, as is necessary with a polyphase system. Having only one conductor makes junction work extremely simple, whereas with two conductors this is extremely complicated; and as, for reasons already given, high voltages are necessary, complications are to be avoided. Moreover, the whole of the collecting and controlling gear is much simpler.

The difficulties hitherto experienced in starting alternating-current motors under load, and in getting such motors to deal satisfactorily with great and sudden changes of load, would appear to be the principal reasons for adopting polyphase alternating currents for motor work as against single-phase. The single-phase motor of the present day, however, can be started under load, and will deal satisfactorily with very sudden and great variations in the load.

The question of speed regulation is one which affects polyphase and single-phase motors alike, and in a paper read before the institution Messrs. Mordey and Jenkin gave descriptions of methods that had been proposed for dealing with this. All the methods proposed involved the use of some sort of rotary transformer for transforming alternating current into continuous current, and then using it in the motors, and this involved the provision of sub-stations by the side of the line, or the carrying of much machinery besides the motors on each train.

Mr. Lamme, in a paper read before the American Institution of Electrical Engineers, gives a description of the Washington, Baltimore, and Annapolis Railway, which is to be a single-phase overhead alternating-current system, in which the motors are to be worked by the single-phase alternating current at 3,000 volts. The speed control is to be effected by an induction regulator, thus avoiding the use of resistances which absorb power.

The advantages of transmission of power by single-phase alternating current are so apparent that it only remains for a suitable motor to be produced which will give as good results both as to regulation and efficiency as are given by the best continuous current motors, to ensure the system being used for long-distance power transmission in the future.

DISCUSSION.

The **Chairman** said the subject dealt with by Mr. Monkhouse was extremely interesting and important. The author had said that it remained only for a suitable motor to be produced which would give as good results both as to regulation and efficiency as were given by the best continuous-current motors. That was really the difficulty, and that was why the single-phase motor had not been pushed from the beginning, and anybody who could give them any information as to how the difficulty could be overcome would confer a great favour on the electrical world. The thing, of course, was that the single-phase alternating current was difficult to start. They wanted starting devices to get it into synchronism with the generator, and that did away again with the simplicity of the system which Mr. Monkhouse had spoken of. Once the thing was running it done all that could possibly be desired. But before it could be got to run complications and starting devices had to be introduced, which did away with all the advantages it possessed beforehand. There was no doubt that single-phase motors were nowadays better than they used to be; still, their use was restricted.

Mr. H. R. J. Burstall said the London Electric Supply Company had been taking a good deal of pains lately to obtain single-phase motors, and they had had at Deptford for the last few months a single-phase motor on trial. They had tried throwing a load on and off, and they had also switched off the main current for quite an appreciable time, the switch being broken for half a second. It picked up and ran perfectly well. One firm he knew of had been doing their utmost to use the single-phase motors, and he thought with success He thoroughly agreed with Mr. Monkhouse about the question of the simplicity of the single-phase alternating current compared with the polyphase. When one compared the extremely simple switch gearing which could be used with the single phase with the necessarily complicated polyphase switch gearing, the cost was very much less, and the gearing could be so arranged as to be perfectly safe in every way. The author had confined his remarks mostly to the question of railways, that being one of the most important questions at the present time. But a great deal of work had been done during the last year or two in the way of adapting the single-phase current for ordinary work, and his own opinion was that within the next few years they would see a great deal more work done in that direction if makers would only take a little trouble to see what could be done with the single-phase motor instead of running after what was more or less the fashion now—the polyphase alternating machine.

Mr. A. H. Preece knew a large factory where they had some single-phase motors varying in size, and they had absolutely no trouble or bother. He had recently installed, for condensing purposes, two motor circulating pumps for lifting water from the Thames into a station which was about 300 yards off the river. So far as he recollected, the horse-power of them was about 30 h.p. to 35 h.p. They gave absolutely no trouble, starting and stopping as required, and did not affect in any way the public supply. He knew of two theatres where the system of continuous current was adopted. One had a 25-kw. motor-generator which had a single-phase motor, and that, again, worked perfectly. He thought it only required a little more push and go on the part of the single-phase makers to create a very large business in London.

Dr. Hopkinson doubted really whether the advantages were quite so apparent as Mr. Monkhouse suggested in his paper. He mentioned that there was, of course, an obvious advantage in having two conductors instead of three. That, probably, was the only advantage that could be put forward, and against that, of course, there was a larger amount of copper required for single-phase distribution than there was for the three-phase distribution. He quite agreed with what had been said as to the satisfactory running of a single-phase motor. That fact had been well established in many cases, but he did think that the use of a larger amcunt of copper was a serious disadvantage.

Mr. Broadbent said there was no doubt that the alternating current was coming to the front, and that the continuous current would take a back place in the future. Mr. Monkhouse had referred to the Valtellina Railway, but the motors used on that railway were not alternating-current motors of the kind one was accustomed to think of. Reference had been made in the paper to the speed control being affected by the conductor regulator. One would like to know a little more about that method of regulation.

Mr. Monkhouse having replied, a vote of thanks was passed.

ROBERTSON ELECTRIC LAMP WORKS.

Last Friday the directors of the General Electric Company, Limited, and of the Incandescent Electric Lamp Company, Limited, entertained a large company of ladies and gentlemen on the occasion of the opening of the extension to the "Robertson" Electric Lamp Works. Personally, we found ourselves and another child or two who take notes taken care of at Blackfriars Bridge, installed in a comfortable 22-h.p' motorcar, supplied with a regalia—not a "dos amicos ranchtsi fueros mueros," but a brand almost too good for outside consumption—and whisked along the Embankment in defiance of time-taking "Roberts." Arrived at the Robertson Works in Hammersmith, we found a very large gathering of

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ladies and gentlemen, arrayed in all their Ascot finery, listening to an excellent programme by the Blue Hungarian Band and discussing ice creams, which once in a way proved seasonable even in London's midsummer.

Mr. C. Wilson, the general manager of the works, then led the way through the old works and through the extensions, which together make a handsome pile of formidable dimensions. We are informed that 10 miles of flooring was used within the building. The inspection commenced with the "stinks" department, where the magic process of converting solid cotton-wool successively into liquid, solid, thick, soft, thin, hard, and pliable matter, evinced great interest. Up and down stairs we went then for miles, seeing 550 men and girls busy glassblowing, adjusting, testing, and packing lamps without number. The annual output of the works figures over 3,000,000 lamps, and there were the busy bees absorbed in all manner of delicate operations, some spinning at threads 1/2500in. in thickness. We never saw such a lot of girls together keeping so quiet in all our lives. A new process, special to Robertson's, by means of which the old and wearisome process of closing up the terminals with plaster of Paris is superseded by the application of a quickly-setting solution, seemed specially interesting and valuable. Instead of having to wait for two days, the lamps are ready sealed up in almost as many minutes. After descending an unusually wide outer staircase made of iron steps of an easy grade, and which reaches from top to bottom, we regained the spacious hall aforementioned. Here a most perfect system was laid on for charging the cells of inner man and woman, the latter especially being charmed with an endless variety of delicious confectionery.

Mr. WILSON, in introducing the Mayor of Hammersmith, Mr. Alton Phillips, read a telegram from Mr. Hirst, the managing director of the General Electric Company, whose unavoidable absence through illness was much regretted.

It being the King's birthday, the MAYOR asked the company to sing "God Save the King," which was done most enthusiastically. The Mayor then referred to the company, stating that they were the largest consumers of the Corporation's current, spend a large amount in wages in the district, while the Corporation were their customers for the excellent lamps made at the works. He proposed "Success to the Company," which was drunk in bumpers of champagne, which suddenly sprung up from nobody knew where.

Sir RICHARD HAWTRY then proposed a vote of thanks to the Mayor, and the builder, Mr. T. CHAMBERLAIN, gave some details of the building.

Mr. G. BYNG, chairman of the General Electric Company, was next sung a "Jolly Good Fellow," and his speech was taken as read. It reads as follows: "I look upon this large attendance of ladies and gentlemen as an encouragement to British industries. There are a good many old friends amongst you who have known me and the scope of our enterprises for a great many years, but there are a great many also to whom some introduction of myself and our undertakings would at the present moment be appropriate, and, at the outset, I wish to ask your kind indulgence, if, throughout my speech, I refer a great deal to myself. Those who know me will readily understand that this is not done from any selfish motives, but mainly to draw from my own experience such lessons as cannot be found if I were to confine myself to generalities. We manufacture almost every kind of electrical apparatus and machinery. At Birmingham we have our large works for dynamo, motor, carbon, steel tubing, and electric light fitting. At Manchester we have our works for telephone, telegraph, bell, arc lamp, switchboard, and electric light accessories. In the aggregate these works form the largest electrical undertaking in the country, and I, who am at the head of this enterprise, employ now more than 5,000 workpeople. The following is a short history of the "Robertson" Electric Lamp Works: The late Mr. Fraser, our technical manager, Mr. Robertson, and myself, were the founders in 1893—10 years ago. The success of the works was slow at the beginning, but later on extension after extension became necessary, and the larger the works became the better and cheaper could we produce our lamps. We commenced in the old building which you see here; then we bought the adjoining land, covering about an acre and a half; subsequently we built the fireproof building, then extension No. 1, and now the present extension No. 2. We started here practically a new industry, and we ourselves taught the workpeople you see here, and not only those we now employ, but many more who have drifted elsewhere. On the head of introducing a new industry into the country we may claim public credit. It is well known that on the system of free competition under which we have to work the starting of a new industry is almost an impossibility. If we are an exception, the reason lies mainly in the fact that we have two good men as managers—Mr. Robertson and Mr. Wilson—who have produced an electric lamp far superior to the lamps made by our foreign competitors. This has enabled us to obtain the goodwill and support of the British and Colonial electrical trade, amongst whom the "Robertson" lamp has become a household word, and the demand for the "Robertson" lamp has thereby not only increased, but we have been able to obtain a price not based upon competition alone, but on the merit of the article itself. I do not mind confessing that it fills me with pride to stand in this position to-day, that of the founder of an enterprise, not only successful, but one that has done good to the country at large; but, proud as I am of this achievement, yet another feeling than pride fills me to-day, and this feeling is one of anxiety. I feel anxious for the safety of the child that I have reared. To-morrow, circumstances may arise over which I have not the slightest control, which may pull down this whole edifice, and bring the work and worry of years to nought. Do you think that it is a comfortable position to be in? Now, in order to explain this, I come to the subject which is uppermost in the minds of most of us at the present moment. I refer to the question of preferential tariffs which has been raised by Mr. Chamberlain. The matter is one which concerns manufacturers vitally, and upon which those who are employers of labour should be consulted, as they are the best able to speak from actual daily experience. Would you plant a valuable tree in an exposed position, where it can grow only in fair weather, but would perish by any wind that may come along? No, you would not. Look at this factory; as I have said, it is successful in fair weather; to-morrow it may be attacked, and in a year or two you may see it empty and deserted. I will explain. I have told you that we have been successful because we can make better goods than our foreign competitors. But there is another reason. Manufacturers of incandescent lamps on the Continent have up till now quarelled amongst themselves, and their power of competition in this country has been somewhat restricted, but they are beginning to combine. I can show you documentary evidence that a movement is on foot to combine all the German, Austrian, and Dutch electric lamp factories, and what is their main object? It is first and foremost to kill the British industry of lamp-making and to capture the English market and that of our Colonies. And how will they do it? Not by any special invention or other meritorious achievement—no, first of all they will increase their price in their home market, thus becoming more powerful financially. This will mean increased output, and this open and undefended market is the place to get rid of that output. I say this may happen in a few years' time—it may happen actually to-morrow. I am entirely powerless, helpless. The success of my enterprise, the investment of hundreds of thousands of pounds, the wages of my employés, the bread of my workmen depends, upon the action and is at the mercy of the foreign manufacturers. This is a dangerous position, one that cries for immediate relief. It is the duty of the State to provide policemen against burglars—it is the duty of the State to safeguard our industries against foreign attacks. We are in the midst of a fierce commercial war, and we are unarmed against the weapons of the whole world. This is how our present fiscal policy affects the master. How does it influence his workmen and their wages? Here, again, I, an employer of labour, am entitled to be heard throughout the country. I hold that you should listen rather to the experience of a man who pays in wages alone over £6,000 per week than rely upon the opinions of men who never pay wages but to their butler, coachman, or cook. Four principal factors determine the rates of wages of manufacturing workpeople. Firstly, skill; secondly, competition; thirdly, profits of the master; fourthly, combination. With regard to the skill of a workman, in the factory wherein you are at present, the rates of wages vary from 8s. to £3. 10s. per week. A girl who wraps up the parcels and is unskilled is paid 8s., but if she acquires the knowledge of glassblowing or air exhausting she can command wages from two to four times as high. The same applies to the men; the ratio of their wages ranges in accordance with their skill. Who teaches the workmen? The master. What gives them the chance of becoming skilful? The enterprise of the master. But I say emphatically the system obtaining at present in our country, the uncertainty as to the security of capital invested, and the want of the home market wherein to sell, makes it impossible for the master to be enterprising. I look forward with much concern to the future. If this system continues but a few years longer, the skill of an ordinary workmen, as well as the inventive capacity of a higher-class workman, will be of necessity of a much lower standard than the skill of workpeople of other nations, and of necessity, too, it will tend to reduce their wages. As to competition, take facts as occurring in this very factory. Here are those workpeople—glassblowers. Look into their wages book. Two years ago their earnings averaged £3 a week. To-day they earn about 45s. a week. Six months ago our manager, Mr. Wilson, had to tell these men, "You have earned these high wages because we did not feel foreign competition. It is getting more formidable. We cannot sell at the old prices owing to foreign competition. You must either consent to have your wages reduced or go." The English workman is exposed to the competition of the labour market of the whole world and he cannot retaliate. Owing to circumstances which I could explain, he has not felt as yet the full force of this competition. I

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hope he never will—the result would startle even Sir Henry Campbell-Bannerman. The profits of the master are obvious. If the master earns good profits, he can pay good wages; if the profits are small, wages must go down. If there are no profits, there will be no wages. Those politicians who affirm that the workman pays no share of the income tax (or direct taxation) may usefully ponder over this (apparently) schoolboy political economy. With respect to combination, I am a believer in the usefulness of trade unions. I look upon them as a safety valve. We masters are human, and not perfect. Trade unions keep us in order. But trade unions are powerless against foreign competition. This is so obvious that I cannot understand at all the present attitude of those at the head of trade unions; they ought to be the first and foremost in the country to cry out to relieve them of that competition over which they at present have not the slightest control. All these four factors are influenced by free trade, and in each one of them the outcome must ultimately be reduced wages. Give our workmen that protection which every other workman on the face of the globe possesses, and his wages must go up. Mr. Chamberlain is right, and I emphatically endorse his contention. Do away with the self-inflicted incubus of one-sided free trade and wages will rise. I say more: give me and my workmen our legitimate share in our home and Colonial markets, then not only will wages rise, but at the same time cost of production will go down. This statement of mine may sound a paradox to many who are anxious to continue the policy of doing nothing, but again I must claim to know more about what determines cost of production than people who never have produced sixpennyworth in their lives. I know well that many other considerations have to be reckoned with in this great question, but everyone of them, without exception, must be secondary to this consideration: Will it harm or will it benefit the power of production of our people. In conclusion, may I be so bold as to warn you against the assertions of men who have no practical experience. I am certain that you will not find the true solution of what our country wants at this present critical juncture in the Blue-books of the House of Commons or in the musty volumes of Adam Smith, Stuart Mill, or Ricardo—not even in the speeches of Cobden and Bright. No; the truth you will find here, only here, among the engineers who work our machinery, among the chemists that ponder in our laboratories, among the clerks that reckon out the cost of production in our counting-houses."

Afterwards a fire was started in the yard, a man at once made a frantic rush at an alarm to let the people inside know, and in a twinkling all the hands had come out to look at it. Some were in such a hurry that they would not wait, and had to be carried down pick-a-back by the firemen. The company's brigade of firemen rapidly laid a hoseway and had the fire out in no time. Joking apart, the display was very creditable, indeed, and showed two things—first, that the building can be emptied almost instantly, and second, that the men are well trained for an emergency which we trust will not arise.

LONDON TRAFFIC ENQUIRY.

Mr. E. Harper, statistical officer of the London County Council, was the witness before the Royal Commission on London Locomotion at their sitting last Friday. The verbal information he had to offer was supplemented by a huge mass of figures dealing with the growth of population in Greater London in the nineteenth century, overcrowding, passenger traffic in London, omnibus routes and services, railways in London, overcrowded trains, etc., all of which will, no doubt, prove of the greatest value to the Commissioners in their deliberations, but are lacking somewhat in interest to those outside the Commission. The figures he gave as to the growth of the population, etc., were directed to show that the tendency for business men to reside outside the City was swelling, and that while the increase in the day population of the City was ever growing, the night population was decreasing rapidly, thus indicating the need for improved railway facilities. He also showed that 1½ million of males over 10 years of age in Greater London were engaged in labour, and were entitled to have transport facilities provided for them. The witness touched on the importance of opening up further districts to the working-class population by means of cheap transit. It was necessary to offer some inducement to workmen to live further out, and he showed that rents in the central area did not represent the true commercial standard, and the differences between the rest of the county were insufficient to cover a workman's travelling expenses and the extra cost of meals. Dealing with decentralisation as a means of relieving the present congestion, he pointed out that local centres of business consisted mainly of shops, and the large operations of commerce must continue to be transacted in the central area. Some relief, especially to the working-class population, might be obtained by the transfer of manufactories to the country.

The Chairman: Would you be prepared to go so far as to say that workmen should be carried backward and forward by locomotion without any profit?—I would be prepared to go at least as far as that, because I have the precedent of Parliament, which has gone so far as to grant a remission of a certain portion of the passenger duty to railway companies, and part of a sort of parliamentary bargain that they should run these cheap trains which might not pay.

Mr. Gibb: Why do you suggest that the reduction should come off the carriage and not off the rent?—I should be equally pleased to see it come off both. I am not prepared to say definitely that the loss should fall on the back of the railways or on any particular back, but the interest of the community as a whole will render it imperative that cheap means of transit should be provided.

If so, why should not the community as a whole pay for it?—Clearly that should be so, and the principle to some extent is embodied in the Cheap Trains Act. The maximum workman's fare should be 2d. for 20 miles.

In answer to further questions, the witness said he did not look upon the transfer of factories to the country as any real solution of the traffic problem. The witness was next examined as to locomotion in connection with railways, describing the methods and results of the railway companies in London and Greater London, referring, among other things, to the questions of fares and season tickets, mileage, and speed, and submitting a table showing the approximate speeds per hour on the "Tube" and other underground railways.

The Commission adjourned.

DISTRICT RAILWAY.

OPENING OF THE LINE TO SOUTH HARROW.

A small section of the electric line of the District Railway—from Ealing Common to Park Royal—was opened on Tuesday, the 23rd ult., on the occasion of the Royal Show. It had been intended to open at that time the whole of the new line, a distance of over six miles, from Mill Hill Park to South Harrow. A landslip caused by the recent heavy rains, however, prevented this, and the opening was then postponed for a fortnight. The very fine weather which set in during show week and the work rendered possible by it enabled the company to anticipate this date by a full week, and the line was opened without singsong last Sunday for passenger and parcel traffic along the whole distance. In the morning and evening half-hourly trains are run, and there is an hourly service during the day. The fares are cheap; 1s. 1d. is charged for a third-class return from South Harrow to any part of the City, and there are cheap season tickets. Second-class ticket-holders travel first on the electric line, where only first and third class carriages are provided. These are of the corridor type, airy and comfortable, and similar to those in use on the Central London Railway. The gauge is the ordinary 4ft. 8½in. There are two contact rails, a positive on the side and a negative in the centre of the track. The trains are intended to be composed of seven carriages each, the cars at each end and that in the middle carrying motors. On this short line there are only four-car trains used, the cars at each end carrying each two 175-h.p. geared motors. Accommodation for parcels is made on these cars. The temporary generating station is situated at Alperton, on the Grand Junction Canal, and the plant there installed is identical with that which was used at Earl's Court for the experiments between that station and High-street, Kensington, two years ago.

The principal generating station at Chelsea is making progress, 450 men being employed there at present, and it is expected that within three months this number will exceed 1,000. The new line runs through a beautiful and rising district, beginning at Mill Hill Park and proceeding thence, *via* Ealing Common, North Ealing, Park Royal, Perivale-Alperton, Sudbury Town, Sudbury Hill, to South Harrow. It was built for experimental purposes, and during the last two months a large number of tests have been carried out in order to arrive at a basis for the principal lines as far as current consumption and heating of motors are concerned. In one day as many as 165 miles were run, with a stoppage of 22 seconds at every 2,500ft., and the valuable data thus obtained will be utilised in the general scheme. We are indebted to Mr. J. R Chapman, the engineer, and Mr. Soar, the traffic manager, for the above details, the latter laying particular stress on the fact that this new line gives now a direct connection between the South and North of London by means of the junctions at Victoria, Charing Cross, Brompton, Ealing, Moorgate-street, etc.

SOUTHPORT CORPORATION TRAMWAYS.

The accounts of the tramways undertaking for the year ended March 31 last shows that the total capital expenditure on that date amounted to £116,888, or, as reduced by sinking fund, £110,612. The traffic revenue was £16,179; total revenue, £16,387; working expenses, £11,231; interest on capital, £3,493; sinking fund, £2,884; net balance profit, £1,222; car miles run, 418,324; passengers carried, 3,535,434; percentage of working expenses to receipts, 67 per cent.; average revenue per car mile, 9·401d.; and average working expenses per car mile, 6·44d. In his report on the year's working, Mr. T. J. Kendrew, the tramways manager, says the whole of the lines, cars, and electrical equipments have been kept in first-class condition, and a deal of extra work has had to be gone through at the depôt, as the department have repainted nine double-decked cars, revarnished 11 cars, rewheeled 16 cars, and overhauled 20 cars. Ten of the double-decked cars have been fitted with the British Electric Car Company's patent destination boxes, which contain 12 names of destination, and have been found very useful in cases where it was required to transfer a car from one section to another. Twelve cars have been equipped with Angier's patent brake adjuster, which is proving very satisfactory. There has been only one case of a wire falling in the street, and this was due to a splicing ear breaking, and on no occasion have any of the trolley wires broken. The list of delays due to breakdown of the overhead equipment is very small, owing to the careful examination which has been regularly carried out.

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THE FARADAY SOCIETY.

Time brings about many changes and knowledge increases so that the study of a branch of a subject now occupies a lifetime, when a century ago what was known of the whole subject could be mastered in a short time. For some years too little attention has been paid by learned societies to that branch of physics yclept electro-chemistry, not because they did not appreciate its importance, but because they had not room for it. Thanks to the activity of a few energetic spirits during the past winter, a new society has been inaugurated to deal specially with electro-chemical questions. It has aptly been called the Faraday Society, because Faraday found empiricism and left exactitude. On Tuesday last a first meeting, well attended, was held at the Chemical Society's rooms. Midsummer is not a usual time for such meetings, but probably a desire was felt to get into harness, and to show the kind of work it was proposed the society should do. The council are wise in their generation, for success depends upon the amount of patronage, and too many people are inclined to wait before joining a new society. *Bis dat qui cito dat* is as true now as when first uttered, and every member joining in the earlier months is more valuable than ten of those who join when success is assured. The only question to be asked in this case was if such a society was required, and there could be but one answer—an emphatic yes! The opinion was generally favourable, and the promoters of the new society found many friends who possessed knowledge, energy, and ability, hence have been able to inaugurate the work of the society with a series of papers which set a high standard to the proceedings. There were no less than four papers prepared for the meeting, but in future, if real discussion is to be evoked, this number will no doubt be reduced. It is impossible to adequately discuss four papers on different topics in one evening. We have been told *ad nauseam* that this country lags in the race intellectually, commercially, and technically, but on the whole the statements to this effect have little foundation in fact, emanating as they do from sources where talent is at a discount, and the prizes go to the free and forcible writers It is interesting to find even in chemical research, where we are said to be woefully behind other nations, that the current number of the Chemical Society's *Journal* contains some eighteen original communications, filling over two hundred and twenty-five pages of the *Journal*, with about two hundred and fifty pages of abstracts, so that if our chemists do not know what is going on in the world from month to month, it is not the fault of the society. The new society will not be so purely academic as the parent, but will have a leaning towards the practical, and will, indeed, be truly scientific. We in this agree with Mr. Swinburne, who said: "All engineering — electrical, chemical, or otherwise—is purely a question of cost; there are many people who think that science is not science unless it is merely useless information," rather than with a well-known professor and experimentalist, who once told us that the scientific man, the investigator, should be content with the accumulating of facts, being certain that sooner or later the practical head would come along and use those facts. We prefer the man who has a definite object in view, and this object the utilisation of results for the use of mankind. Use depends upon cost, hence cost is an important item in the investigation. One other point. The formation of a new society is the formation of a new educational centre, and while the public mind is so oblivious to facts and to the truth as to accept such a dictum as that uttered by Mr. Asquith on Wednesday, and by scores of

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others on previous occasions, to the effect that "there was one point in which Germany could boast a vast superiority, that was in her system of secondary and technical education," such statement we emphatically deny. It arises through complete ignorance of facts and through the laziness of people who accept what someone else says without proper investigation. Look round our great industries. Where do we owe anything to Germany? Is it in shipbuilding, or iron or steel manufacture, or cotton or woollen manufacture, or where? Echo answers, where? Much has been made of German enterprise relating to analine dyes. That was merely finance, nothing else. Look where you will, the result is the same. The spouters speak truths that are half truths, and, therefore, bigger lies than real lies, and more difficult to disprove. They compare an old ironworks in England with a new works in America, and draw conclusions disadvantageous to us. Why do they not compare the new with the new? Why not draw conclusions from factories under similar conditions, and not when the conditions are divergent? But we have left the Faraday Society, and have but a few more words. Its start is excellent, and we trust its career will be eminently successful. It needs support now, and all those interested in the work should give that support at once.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

LAMP TEST.

SIR,—We desire to bring to your notice a description of co-operative lamp test that we are now carrying out.

The scheme of the tests is as follows: 40 lamps, all of 16 c.p. and 200 volts pressure, have been purchased on our behalf by an independent party. There are 10 makers represented, and four lamps by each maker. The candle-power and efficiency are being measured at start and after 100, 400, 700, and 1,000 hours burning. The figures for the whole of the lamps will be embodied in our report as well as tables of averages. This report will take the form of a small book, and will be copyright. A single copy of this report will be forwarded to all subscribers of 2½ guineas, and no copies will be sold cheaper than this. The report is intended for private circulation only, and must not be copied or used for advertising purposes.

We believe that these results will be of considerable value, as the lamps are all subjected to identical conditions as to pressure variations, and are tested against the same standards. The lamps being tested are the following: Ediswan, Gabriel, Robertson, Maxim, Goossens - Pope, Sunbeam, Premier, B.T.H., Stearn, Cryselco. We regret that we are unable to test a larger number of lamps of each make, but the funds subscribed do not allow of this. We shall be glad to hear from you as to whether you would care to subscribe 2½ guineas for a copy of the report. We should be greatly obliged if you would kindly mention these tests in your next issue. The lamps have now been burning over 900 hours, and the tests should now be completed within a few days.—Yours, etc., for and on behalf of Westminster Electrical Testing Laboratories,

LANCELOT W. WILD, Chief Electrician.

FORTHCOMING EVENTS.

Sanitary Institute.—Congress and exhibition, Bradford, July 7-11.

Municipal Electrical Association.—July 15 to 18, annual convention, Sunderland. July 17, Middlesbrough Corporation luncheon.

Iron and Steel Institute.—Summer meeting, Barrow-in-Furness, September 1-4.

Municipal and County Engineers.—Meetings: Widnes, July 18; Aberdeen, August 20, 21, and 22; Hastings, September 11 and 12; York, probably in October.

Municipal Tramways Association.—Annual conference, July 8, 9, and 10, at Glasgow.

QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any questions should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

597. Describe the electrical equipment of an electric automobile, with special reference to the motor, or motors, and wiring.—D. R.

598. In order to test high-tension cables, it is necessary to have ready means of varying the pressure to suit the test specified. Can this be done best by adding to or reducing the number of transformers in series, or what is the best way?—G. M. B.

ANSWERS.

Question No. 589.—A shunt-wound 500-volt four-pole motor drives the circulating pump of a surface condenser, and as this motor is semi-enclosed, the two bottom sets of brushes are difficult to get at for cleaning purposes, etc. It is now proposed to use two sets of brushes only instead of four. What alterations must be made to the armature in present use? and if an entire new armature is necessary, show exactly how it must be wound.

Answer to No. 589 (*awarded* 10*s.*).—There are methods of cross-connections by which the number of brush sets may be reduced, but these have, to the writer's knowledge, only been applied to ring armatures. Mordey's method of cross-connecting, used by him in the "Victoria" dynamo, consists in connecting the opposite commutator segments together. But considering the fact that the present armature is of the multiple-circuit type, and the peculiar features appertaining to this type of winding, it would probably be the best to put in a new armature, unless the constants adopted in designing are very conservative. In Fig. 1 is shown a diagram of a typical multiple-circuit

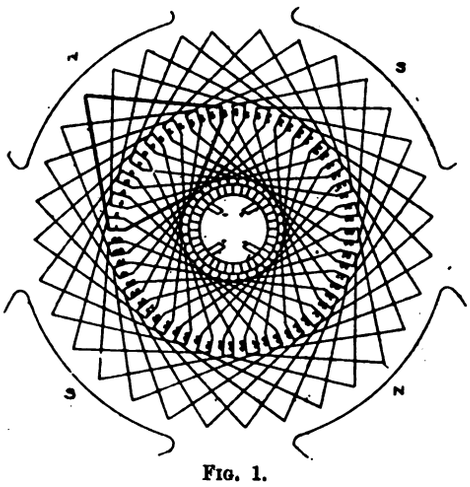

FIG. 1.

FIG. 1A.

winding. The armature, in this case, has four circuits, each conductor carrying only one-fourth of the current input to the brushes. Consider the effect of taking away the lower two brushes. Now, one section of the armature will be carrying three-fourths of the total current, and the remaining three sections one-fourth. If R be the resistance of one-fourth of the armature, and C be the current input at the brushes, then we have the "heat" loss with four brushes as

$$4\left(\frac{C}{4}\right)^2 R = \frac{C^2 R}{4},$$

and with two brushes

$$\left\{R \times \left(\frac{3}{4}C\right)^2 + 3R \times \left(\frac{C}{4}\right)^2\right\} = \frac{3C^2 R}{4}.$$

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Hence we see that the "heat" loss has increased in the ratio of 1 : 3—*i.e.*, the rise in temperature of the armature will have also increased in the ratio of 1 : 3. At the commutator the losses will increase in the ratio of 1 : 2, and the radiating surface being the same in each case, the rise in temperature will increase in the ratio of 1 : 2. No account has been taken of the sparking constants, and the "reactance voltage"* of the coils undergoing commutation for the case with two brushes will be practically four times that when four brushes are employed. Hence we see that not only are the heat losses increased and likewise the efficiency decreased, but the reactance voltage has been raised to a rather dangerous amount, and that sparking will result unless the other constants of the machine are very conservative.

All difficulties, however, can be got over by using a new armature. The winding in this case would be of the two-circuit type, a typical form being shown in Fig. 2. For

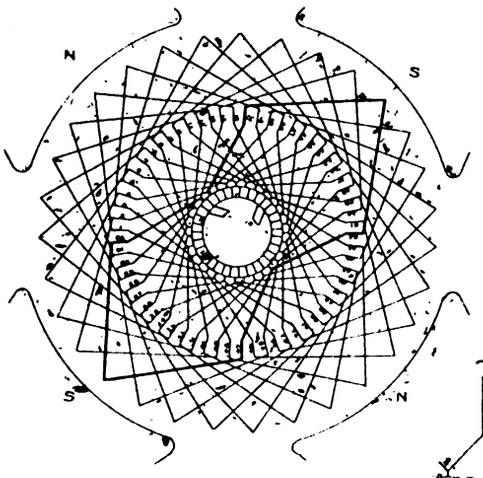

FIG. 2.

FIG. 2A.

the sake of clearness the coils are shown of one turn each, but in actual practice they consist generally of two, six, or ten turns, being arranged as in Fig. 2A, Fig. 1A showing the form of coil for multiple-circuit windings. On comparing Figs. 1 and 2 it will be noticed that in starting from one segment to the next a quarter of the winding has to be passed over in Fig. 1, but in Fig. 2 a complete "round" of the armature has to be passed over. It will be convenient to state here the formula for E.M.F.—viz., $E = \frac{4\,T\,M\,N}{10^8}$; where E is the E.M.F. generated in the armature; N, the number of magnetic cycles per second $\left(= \frac{\text{revolutions per minute} \times \text{poles}}{60 \times 2}\right)$; T, the number of turns in series between the brushes; and M, the magnetic flux linked with each of the T turns. The value of T will be equal to the total turns on the armature divided by the number of paths through the armature. Hence we see that, other things being the same, for the same E.M.F. only half the turns will be required for a two-circuit that are required for a multiple-circuit winding. It must also be noted that the conductors in a two-circuit winding have to carry double the current that they would with a multiple-circuit winding. The most important point, however, is the formula for winding. All two-circuit windings for four-pole motors require an *odd* number of commutator segments, and the number of the latter should always be prime to the number of poles. Thus, in the winding shown in Fig. 2, the number of commutator segments is 31. The general formula for two-circuit windings is

$$c = n\,y \pm 2\,m,$$

where c = number of face conductors;
n = number of poles;
m = number of windings (whether single, double, or triple);
y = average pitch.

* See "Electric Generators," by Parshall and Hobart," p. 175; also an article on "Electric Motors," by Mr. H. M. Hobart, in "Traction and Transmission," vol. iv., p. 141.

It should be noted that for two-circuit windings the pitch, y, is always *forward*, and not alternately forward and backward as in multiple-circuit windings. In all motors with two-circuit windings the armature has a single winding, two-circuit double windings being seldom used. Hence m will be unity, and the formula for a four-pole machine becomes

$$c = 4\,y \pm 2.$$

It should be pointed out that if the winding is to be singly re-entrant—*i.e.*, of the ordinary type used in motors—y must be *odd*. In the diagram shown in Fig. 2, y is chosen as 15 and c as 62. If a new armature with a two-circuit winding is put in place of the present one, and the former proportioned so that the reactance voltage of the coils undergoing commutation is low, no sparking troubles will result. Two-circuit windings have a distinct advantage over multiple-circuit windings, in that equal voltages are induced in each half of the winding, even if the armature is eccentric with regard to the field (due to wear of bearings, etc.). This, however, is not the case with multiple-circuit windings, as in this case any eccentricity of the armature causes unequal E.M.F.'s to be induced in the different portions of the winding, which set up cross currents and sparking.

The following tables may be of use in applying two-circuit windings. Table I. gives, for the case of plain two-circuit single windings, the number of conductors which are possible per slot for motors with from four to eight poles.

TABLE I.

Number of poles.	Possible number of conductors or groups of conductors per slot, for symmetrical windings.											
4	1	...	2	...	—	...	6	...	10	...	14	—
6	1	...	2	...	4	...	—	...	10	...	14	16
8	1	...	2	...	—	...	6	...	10	...	14	—

In Table II. are given data of two armatures for two four-pole, 220-volt, 35-h.p. motors, one of which is a multiple-circuit and the other a two-circuit winding.

TABLE II.

Style of winding	35-h.p. 220-volt motor, 950 r.p.m. Multiple circuit single		35-h.p. 220-volt motor, 600 r.p.m. Two circuit single
Number of slots	71	.....	71
Conductors per slot	8	.....	6
Turns in series between brushes	71	.....	106·5
Total number of conductors	568	.....	426
Number of commutator segments	142	.....	213
Reactance voltage (volts)	2·7	.....	1·75
Number of brush sets	4	.....	2

—A. D.

Answer to No. 589 (*awarded* 10*s.*).—If, as is most usual in small 500-volt motors, the armature is a series-coupled,

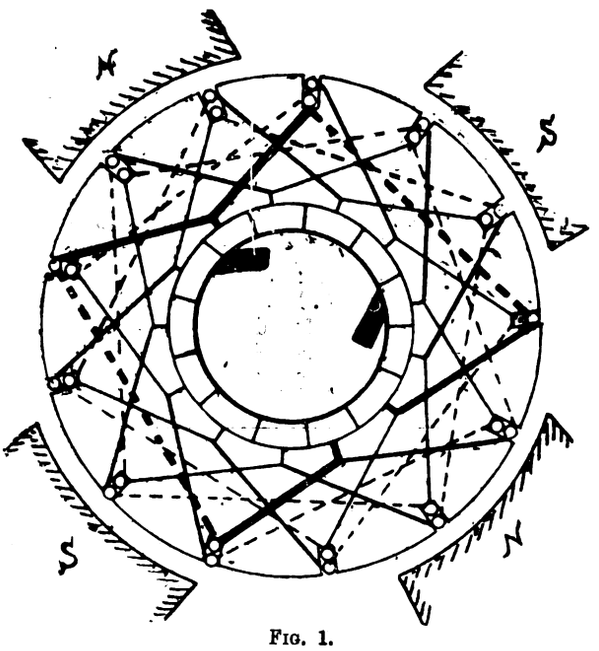

FIG. 1.

wave-wound one, the motor will run equally well with two or four sets of brushes, provided only that the commutator

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is large enough for the whole current to enter at one set of brushes without overheating—*i.e.*, with a current density not exceeding, say, 50 or 60 amperes per square inch of brush contact, assuming that carbon brushes are in use. If, however, the armature is a parallel-coupled, lap-wound one, it will be necessary either to cross connect every commutator plate to the plate of equal potential diametrically

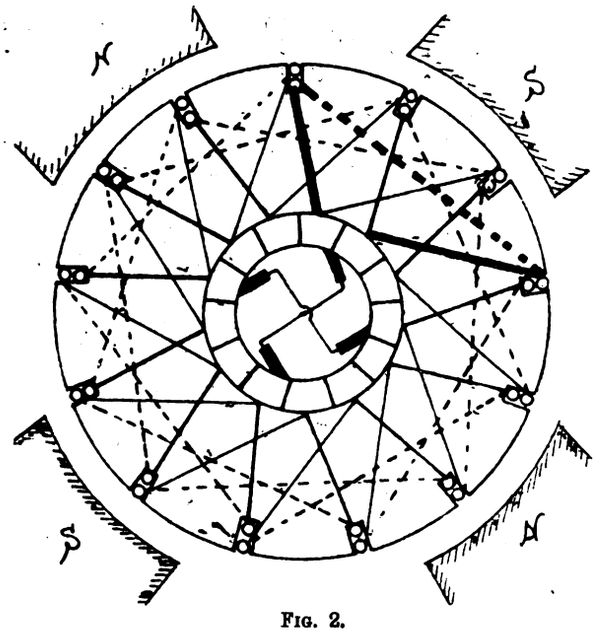

FIG. 2.

opposite to it, or else entirely to rewind it, making it into a series-coupled one. The latter alternative is preferable, as the cross-connections sometimes allow wasteful currents to circulate in the windings.

The motor mentioned has presumably a modern slotted-drum armature, and if so it will be a simple matter to determine by inspection whether it is series or parallel

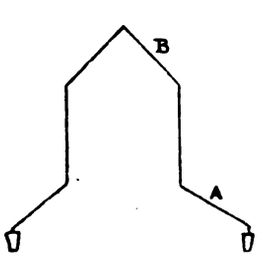

FIG. 3.

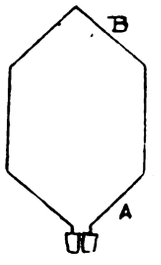

FIG. 4.

coupled. Fig. 1 shows the connections of a series-coupled armature, and Fig. 2 those of a parallel-coupled one, the dotted lines representing connections at the back and the full lines front connections. Figs. 3 and 4 show the shapes of the single coils used for series and parallel windings respectively. It will be noticed that whilst in the case of a series coil (Fig. 3) the end connection, A, at the commutator end slopes in the *same* direction

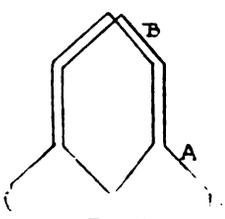

FIG. 5.

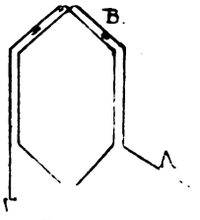

FIG. 6.

as the connection, B, at the other end, in the case of a parallel armature (Fig. 4) the slopes at the two ends are oppositely directed. If a series coil has more than one turn, as would probably be the case in this machine, only the starting connection and finishing connection of each coil will have the characteristic slope, whilst the intermediate turns will slope as in a parallel-coupled armature (see Fig. 5, which represents such a series coil). In such a case only the external connection to the commutator must be considered. Occasionally only one of the connections is sloped, the other being brought straight out to the commutator (Fig. 6), but even in this case the slope of the ends, A and B, will serve to determine the winding as before.

If from any cause the connections cannot be traced out, the point can be decided by measuring the armature resistance (not including the brush contact resistance), first with all four sets of brushes down, and then with only two neighbouring sets down on the commutator. If it is a series armature, the resistances will be alike in both cases, whilst if it is parallel coupled, the resistance will be three times as great with two sets of brushes as with four sets.

If the armature proves to be a parallel-coupled one, the cross-connections between diametrically opposite commu-

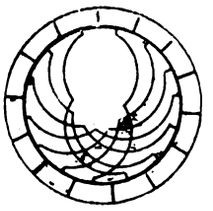

FIG. 7.

tator plates mentioned above, can be carried out (as shown in Fig. 7) by means of a series of connectors arranged in two layers. These connections will probably be best carried out at the back of the commutator, and for this purpose the whole of the commutator connections will have to be temporarily unsoldered. If, instead of cross-connecting, it is decided to entirely rewind the armature, it may be necessary to provide a new commutator, having one segment less than the present one, in order to ensure that (number of segments × 2) + 2 shall be exactly divisible by the number of poles, which is a necessary condition for series-coupled armatures. If this has to be done, there will be a slight want of symmetry in the winding—two of the slots having rather fewer conductors than the rest—but this will have no harmful effect. The actual total number of conductors must be as nearly as possible half the present number (consistent with the above change in number of commutator segments), and the area of the wire used must be double that of the present wire. The winding can then be carried out as in Fig. 1, making each coil span approximately a quarter of the periphery.—Q.

[Other answers to this question in next issue.—ED. *E. E.*]

Question No. 590.—Describe fully the best way to make an aluminium rectifier for rectifying alternate current into unidirectional current, same to be suitable for working on 110-volt circuit at 50 cycles and carry one ampere. Explain how to form the aluminium plate.

Best Answer to No. 590 (*awarded* 10*s.*).—The idea of an aluminium rectifier is due to Mukelman, and its latest development to Pollak. The original observation of Mukelman was first made known in 1883 by means of *Wiedemann's Annalen*. He observed that a "formed" plate of aluminium—*i.e.*, one covered with an insulating or dielectric crust of aluminia and other compounds of aluminium—stopped the positive current, but not the other, and this, when interposed between an alternate-current generator and the wiring, secured a continuous current in the latter. The electrolyte used in the first experiment was acid (sulphuric), and the apparatus would not work with voltages above 20. With an electrolyte of potash alum 140 volts were reached, and Pollak has now reached 200, although on a very small scale.

In the latest form of apparatus Pollak uses a slightly acid solution of potassium phosphate as an electrolyte. The aluminium plates are formed by first macerating them for some time in a solution of caustic soda. The crust remains unaltered in air for an indefinite time, but gradually disintegrates in water or in aqueous solution. Hence, for the continued life of the rectifier it is necessary that the electrolyte should be run off the plates whenever the apparatus is not in use. Another important point is that the temperature, which rises during the operation of the battery, must not be allowed to reach 40deg C. above that temperature, the current is allowed to pass both ways to a large extent. The necessary regulation of temperatur e

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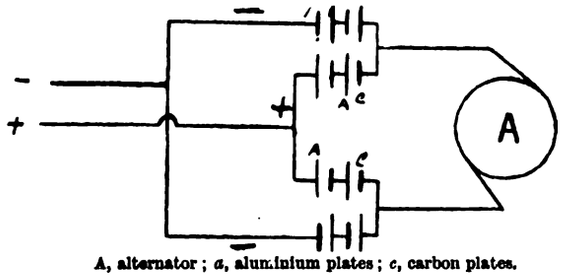
can, of course, be effected by water jacketing the cell, but a much better and simpler plan is to use a cell in which the column of electrolyte is several times as high as the aluminium plates, then radiation and convection do all the cooling that is necessary. Such a cell can be used for four hours on end without overheating. The life of a formed aluminium plate, if overheating does not take place, is from 500 to 800 hours. Then the crust begins to crumble, chiefly on account of the action of the hydrogen bubbles. The apparatus must, of course, be quadrupled as shown in the



A, alternator; *a*, aluminium plates; *c*, carbon plates.

diagram, if both phases of the alternate current are to be made use of, so as to have the polarity of the aluminium plates reversed synchronously with the direction of the dynamo current. The smallest cell that could be made would pass one ampere, but as carbon and aluminium sheets are so cheap there is no object in making the cells too small. By inserting a variable resistance in the alternating circuit, any current desired could be obtained as long as the rise in temperature of the rectifier did not exceed 30deg. to 40deg. C. If a single cell only is used, one cannot be certain that the rectified current is truly unidirectional, as a single cell does not always keep out the positive half of the alternating current.—C. A. B.

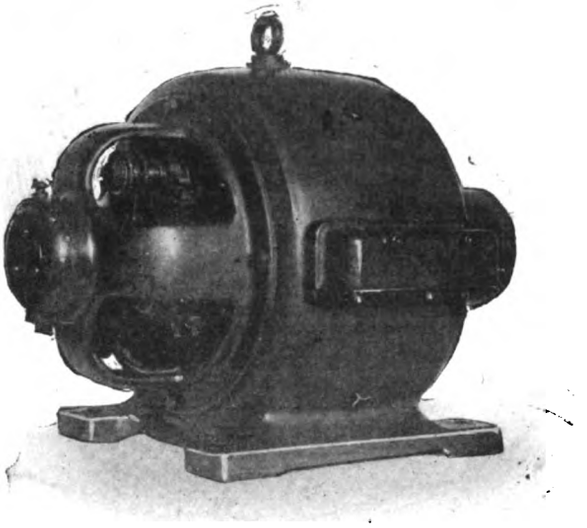
Answer to No. 590 (*awarded* 5*s.*).—The applicability of an aluminium electrode to the rectifying of an alternating current results from the remarkable fact that when employed as the anode it interposes an enormous resistance into the circuit, though behaving normally when a cathode. The very fact of this metal not being rapidly acted upon by dilute sulphuric acid is in itself peculiar, since it is rapidly dissolved by hydrochloric acid and many salt solutions, moreover, even by pure water. Though the abnormal behaviour of aluminium was noted so long ago as 1854, when Wheatstone was determining its place in the voltaic series, it was not till 1897 that Pollak and Grätz independently proposed its employment, in conjunction with a carbon cathode, for rectification. Of recent years, though by no means very efficient, this application has been brought into much prominence. The cause appears to be that the anode becomes coated with a layer of hydroxide, $Al(OH)_3$, through which the ions Al and SO_4 are unable to diffuse. This view of the matter has, indeed, been proved by the work of Taylor and Inglis, who constituted an anode of platinum coated with the hydroxide, which had the same property.

To construct a rectifying cell it is only necessary to immerse a piece of sheet aluminium—for one ampere about 4in. by 6in.—and a carbon or other plate or rod in dilute sulphuric acid. The positive of the rectified circuit is connected to the carbon, the negative and the aluminium to the alternating mains. It must not be assumed, however, that the current will be entirely rectified at the frequency mentioned, for, as shown by Wilson, transformation is not complete at a higher frequency than 15. There will be only a preponderating current in one direction, and this becomes less and less excessive as the frequency is raised. The action may nevertheless be made more effective if several such cells are placed in series.—Z.[2]

TRADE NOTICES AND NOVELTIES.

Continuous-Current Motors.

The latest type of motors of the Electrical Company, Limited, has been designed to meet the growing demand for machines occupying small space and of light weight, and possessing a large overload capacity. The chief characteristic of this type is that the brushes are fixed independently of the load. The machines are of the protected (semi-enclosed or enclosed) type, and are shunt or series wound, but larger machines can also be compound-wound. The machines are so rated that at the end of a continuous run of six hours at full load the temperature of no part of the machine will exceed 80deg. F. above the surrounding atmosphere in the semi-enclosed tope, or 90deg. F. in the fully enclosed type. The machines from E.G. 5 to E.G. 100 are designed to stand an overload of 25 per cent. for one hour, the larger machines 25 per cent. for two hours, without undue heating or sparking at the brushes. The two smallest types, E.G. 5 and E.G. 10, are two-pole machines; the larger types, E.G. 20 to E.G. 650, are of the four-pole type. The field magnets are accurately bored and designed to ensure a perfect magnetic balance of the armature. The poles are constructed of laminated wrought iron, firmly attached to the cast-iron frame. The bearings are carried on brackets, which are bolted on to the frame. These brackets are so designed that the motor can be fixed either on floor, wall, or ceiling. The bearings are provided with self-oiling rings and means for drawing off the oil. The openings in the bearing brackets are closed by covers, fitted with felt gaskets. These covers are provided with small handles, so that they can be easily removed for inspection of brushes. The field coils are former-wound, wrapped in insulating cloth, dipped in insulating varnish, and thoroughly baked, so as to be absolutely impervious to moisture. They are arranged on the poles so as to be well ventilated by the revolving armature, and thoroughly protected against mechanical injury.



Electrical Company's Continuous-Current Motor, latest type E.G.

The armature is of the slotted drum type, the core being built up of laminated iron firmly secured to the shaft. Ventilating channels parallel to the shaft are provided. The armatures of the larger machines are also provided with space between the laminations to ensure a more efficient ventilation. The armature coils are former-wound, impervious to moisture, and furnished with thoroughly damp-proof insulation. The commutator is built up of hard-drawn copper bars of high conductivity, insulated from one another and the sleeve with mica. The brush-gear is designed for carbon brushes, each brush having a separate spring to take up the wear automatically. The tension of the springs is adjustable, so that a constant pressure on the commutator is obtained, even when the brushes are worn down. The screw fixing the position of the brush-gear in the smaller sizes is intentionally placed in an inaccessible position, so that the brushes cannot be moved. The terminals are outside the motor, and are protected by a metal hood. Separate terminals are provided for armature and field windings. The insulation has been made a special feature of this type. We are informed that it has proved thoroughly reliable under the most adverse conditions, and that, in order to put it to the severest test, the firm erected some months ago an open type motor on the roof of their premises, and have left it exposed night and day in all conditions of weather since its erection.

Patent Filters.

Messrs. Bell Bros., 41, Corporation-street, Manchester, and Calder Ironworks, Ravensthorpe, Yorks, have just issued an illustrated pamphlet descriptive of the Bell patent process for purifying and softening all classes of river, well, or other waters for bleaching, dyeing, wool-scouring, milling, paper-making, cotton spinders, silk manufacturers, laundries, wire works, hydraulic works, boilers, and other purposes; also for water supplies of cities, towns, etc., and for purifying sewage and factory effluents, also for purifying black soda lye in soda-recovery plants, and the purifying of sugar, etc. We are informed that over 25,000,000 gallons of water are purified by

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this system per day, and refer our readers to the booklet for details of the process.

Safety Wiring.

The illustration herewith shows a display of the Simplex Steel Conduit Company's fireproof system of conduits and fittings for safety electric wiring. It consists of two cases arranged on stands, made up of the conduit and fittings of the company's manufacture, with roof to each and boards at the back on which are mounted the various fittings and accessories, showing their application. The front is left free for a framework of tubes on which lamps are connected up by means of ceiling-rose boxes, pendant boxes, lampholder fittings, etc. On the horizontal tubes are shown a number of porcelain connection fittings having the inspection covers removed so that the wires may be seen connected to the terminals on the porcelain interiors. This arrangement illustrates how with a complete system of this kind the whole of an installation may be readily tested and inspected throughout by the removal of an inspection cover. The tubes and fittings are shown enamelled and galvanised for screwed or socketed junctions and are of a first-class finish, all the fittings being subjected to a sand-blasting process before leaving the works, and the tubes have a smooth bore throughout, so that no abrasion of the wires can take place when erecting. In the cases and on the panels at the back are shown the more important of the fittings, as bends, tees, junction, draw-in and branching boxes, also saddles, crampets, and clips for erecting, together with plugs for fixing to the walls of a building.

Safety Electric Wiring.

PERSONAL.

We offer our hearty congratulations to Mr. John Gavey, engineer-in-chief to the Post Office, on his appointment to the Companionship of the Bath. Although Mr. Gavey is an eminently worthy representative of electrical engineering, we should have liked to have seen the names of a few more members of the profession figuring in the list of birthday honours this year. As it is, he stands alone in his well-merited honour, and we are sure that he has the best wishes of all who are acquainted with the excellent work he has done in the past 30 years in connection with the Post Office telegraphs.

Mr. Leonard Andrews, joint managing director with Mr. C. J. Cowan of the Key Engineering Company, returned last week from a six weeks' trip to the United States. We are informed that the primary object of Mr. Andrews's visit was to assist the Stanley Manufacturing Company in the development of his United States patents, which were acquired by that company last year, and that he has also succeeded in transacting a considerable amount of other business, both in introducing English engineering specialities in the American market and in the obtaining and handling of several American novelties, which will shortly be put on the English market by the Key Company. Mr. Andrews is resigning his appointment of consulting engineer to the Hastings Corporation, so that he will be able to devote his entire attention to the management of the Key Company in the Manchester and Northern district. Mr. Cowan will look after the company in the London and southern district.

Mr. C. Jones has been appointed chief electrical engineer to the Metropolitan Railway.

Mr. H. Waring, of Mexborough, has been appointed resident electrical engineer at Todmorden at a salary of £250 a year.

In our issue of May 29 we pointed out that Mr. A. M. Thompson, M.I.C.E., M.I.E.E., had taken charge of the electrical and telegraph work of the London and North-Western Railway Company. He has also been appointed electrical engineer to the company from July 1 in succession to Mr. J. W. Fletcher, who retired from the service on that date. His office will be at Crewe.

The Electric Lighting Committee of the Edinburgh Town Council recommend the salary of the resident electrical engineer to £850.

APPOINTMENTS VACANT.

Tramway Manager, Corporation of Walsall, £200 a year, July 11.

Working Foreman Platelayer, East Ham Tramways, £3 per week.

Mains Foreman, W. E. Milns, Electricity Works, Grantham, £2 per week.

Electrical Engineer, Aldershot Urban District Council, £200 per annum, July 8.

Assistant Electrical Engineer, Corporation of Torquay, £156 per annum, July 20.

Assistant Electrical Engineer, Llandudno Urban District Council, £100 per annum, July 11.

Electric Lighting Engineer, Municipal Corporation of Port Elizabeth, Messrs. Davis and Soper, £600 per annum, July 9.

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LEGAL INTELLIGENCE.

HULL TELEPHONES.

Mr. Justice Buckley, in the Chancery Division of the High Court, gave judgment on Saturday in the case of the National Telephone Company *v.* the Mayor, etc., of Kingston-upon-Hull, which raised the question whether under the Telegraph Act of 1899 the Telephone Company were entitled to a renewal of their license to maintain and use a telephone system in the city and county of Hull.

His Lordship read a written judgment dealing *in extenso* with the various Acts of Parliament bearing on the case from the Telegraph Act of 1863 down to 1899. He said the result of the various Acts was that the Postmaster-General had a monopoly, with the right to grant licenses of the telephonic and telegraph systems, subject, however, to the obligation to obtain the consent of the district authority where an underground system was contemplated. The Telephone Company had laid down systems under license from the Postmaster-General, and had sold to the Post Office their trunk lines, retaining the local areas, amongst which was Kingston-upon-Hull. By an agreement between the company and the Corporation, dated November, 1897, the company were licensed to exercise all the powers of the Postmaster-General, with a proviso, however, that where the system was to be underground further consent of the Corporation should be obtained. In 1899 the Corporation obtained an Act authorising them to lay down a telephone system in their area, but the Act contained a proviso that where there was already a system under license from the Postmaster-General that license should be continued for the period of the license granted to the Corporation. The Corporation of Kingston-upon-Hull were alarmed, as he thought unnecessarily, at a clause it was proposed to introduce in the Bill, and they gave the company notice, as they were entitled to do, to determine the agreement, and on Aug. 3 they passed a resolution to determine six months from that date. The Act was passed on Aug. 9, 1899, but the Corporation did not obtain their license until February, 1900, long after the expiration of the notice. He held that the resolution determining the agreement was validly passed. The company's system only existed on sufferance. They could therefore not claim the benefit of the Act, and he must dismiss the action with costs. His Lordship expressed a hope, however, that some arrangement would be come to which would avoid idle waste of money in taking up the company's system and laying down a new one.

COMPANIES' MEETINGS AND REPORTS.

BRITISH ALUMINIUM.

The report states that the profit for the year ended Dec. 31, 1902, is £20,770. This is insufficient to meet the debenture stock interest, depreciation on plant, etc., and charges on stocks of metal by £3,392, and the debit balance has therefore been increased by this sum to £22,357. In accordance with the arrangements made with the debenture holders last autumn, payment of interest due on Nov. 1, 1902, and May 1, 1903, was postponed, and deferred warrants have been issued to the stockholders for the amounts accrued due to them. The £10,000 authorised to be raised in priority to the debenture stock was borrowed in January last, and £2,000 has since been repaid. The sales of aluminium continue to increase so satisfactorily that the Board has deemed it necessary to take steps to extend the water-power installation at Foyers by the erection of two more dynamos, and to increase the capacity of output of the several works of the Company. These extensions will involve considerable expenditure, which the Board hopes to provide without making any fresh issue of capital or increasing the debenture debt. Relations with the other aluminium producers continue to be of a friendly character. The original understanding with them was modified last January to the future advantage of the Company. A considerable reduction in the cost of the manufacture of carbide has been effected, which justifies the Company continuing this branch of the business.

J. G. WHITE AND CO.

Presiding over the ordinary general meeting of the shareholders in this Company, held at the offices, College-hill, E.C., Lord Arthur Butler said the profit and loss account for the half-year ended Feb. 28 last showed a balance of profit of £14,628, which compared favourably with former results. After bringing forward the balance from the last report—namely, £11,469—the total to the credit of profit and loss was £26,097. Generally speaking, he thought the accounts showed a distinct advance in the position of the Company as compared with former years. The capital had hitherto proved sufficient for the Company's construction business, but recently several favourable propositions had been under consideration, in which the question of financial assistance was an important factor, and the directors find it advisable, in order to extend the scope of business, to propose a further increase in the capital of the Company. The Company had recently tendered for the complete construction of the Derby Corporation tramways, and he was glad to be able to say that the committee of the Council had recommended its acceptance. With regard to the proposed method of declaring dividends, he should explain that the result of the half-year's trading quite justified the declaration of a 10 per cent. dividend on both classes of shares; but if this plan were adopted without explanation, shareholders would, no doubt, look for a continuance of dividends at the same rate, and this the directors considered, when coupled with the necessity for providing a reserve fund, might be placing too heavy a burden on the resources of a young company. For this reason it was proposed to adopt the policy of declaring a dividend at a rate which the directors considered, from the business outlook, the Company would be able to maintain for the ensuing year, and a special dividend based entirely on the results of the trading in the past half-year. He moved "that the directors' report and statement of accounts, as at Feb. 28, 1903, be and are hereby received and adopted."

Mr. A. N. Connett seconded the motion, which was then put and carried unanimously.

The **Chairman** next moved: "That dividends be sanctioned and declared as follows: (*a*) a dividend, free of tax, at the rate of 8 per cent. per annum on the 6 per cent. cumulative preference shares for the half-year to Feb. 28, 1903, absorbing £3,258. 13s. 4d.; (*b*) a dividend, free of tax, at the rate of 8 per cent. per annum on the ordinary shares, for the half-year to Feb. 28, 1903, absorbing £2,000; (*c*) a special dividend, free of tax, at the rate of 2 per cent. per annum on the preference and ordinary shares for the half-year to Feb. 28, 1903, absorbing £1,314. 13s. 4d."

Mr. W. C. Burton seconded the motion, which was unanimously agreed to.

The sum of £5,000 was allocated to reserve fund, and £14,525 2s. 3d. was carried forward to the next account.

ELECTRIC CONSTRUCTION.

The annual report of the directors to May 31 last states that the net profit for the year is £20,736. 19s. 9d., and, adding the balance brought from last year, £3,504. 6s. 1d., the amount available for distribution is £24,241. 5s. 10d., which the directors recommend should be appropriated as follows: dividend at the rate of 7 per cent. per annum on the preference shares (to be paid on July 31 next), £4,394. 12s.; dividend at the rate of 6 per cent. on the ordinary shares (one-half to be paid on July 31 next, and one-half on Jan. 30, 1904), £13,452; general reserve fund, £2,000; balance carried forward to next account, £4,394. 13s. 10d.—total, £24,241. 5s. 10d. The general reserve fund will then amount to £34,000. The buildings and plant have, as formerly, been thoroughly maintained out of revenue, and £5,000 has been credited to depreciation account, which now amounts to £48,000. The past year has developed increased competition among both home and foreign manufacturers of electrical machinery, with the consequent reduction in prices, but the Company has successfully maintained its position, and the net result of the business is approximately the same as last year. The directors have, therefore, much pleasure in recognising the ability and skill of the management and men by recommending the distribution among them of the usual bonus. The new financial year opens with a larger volume of orders in hand than at the same time last year, including contracts for two important installations of electrical plant, one for his Majesty's Government in Gibraltar and the other for the Corporation of Wellington, New Zealand. The traffic and net revenue of the Madras electric tramways continue to grow satisfactorily, and according to the present prospects the improvement will be more than maintained in the current year.

ABSTRACT OF PROFIT AND LOSS ACCOUNT.

Expenditure.	£	s.	d.
Interest on loans and debetures, paid and accrued ...	12,620	4	4
General charges ...	19,070	17	5
Maintenance of plant and buildings, £3,735. 11s. 2d.; depreciation account (amount appropriated), £5,000	8,735	11	2
Net profit carried to balance-sheet ...	20,736	19	9
	£61,163	12	8
Income.			
Gross profit on manufacturing and contracting...	48,233	7	5
Rents, pupils' premiums, and sundry profits...	3,293	5	0
Profit on running Madras electric tramways ...	5,837	1	0
Dividends on shares of other companies...	3,768	4	3
Transfer fee	31	15	0
	£61,163	12	8

ABSTRACT OF BALANCE-SHEET.

Capital and Liabilities.	£	s.	d.
Capital authorised ...	400,000	0	0
Capital issued ...	286,980	0	0
Debentures issued ...	246,800	0	0
Loans (secured by deposit of shares in other companies) ...	60,000	0	0
Creditors ...	36,453	19	3
Bills payable ...	6,882	5	4
Depreciation account—amount at credit per last account, £43,000; credited from profits for year ended May 31, 1903, £5,000 ...	48,000	0	0
General reserve fund ...	32,000	0	0
Profit and loss account ...	24,241	5	10
	£741,357	10	5
Assets.	£	s.	d.
Properties, patents, and goodwill ...	385,388	1	1
Shares of other companies... ...	81,303	10	6
Sundry debtors (after providing for bad debts)...	103,767	11	5
Madras electric tramways ...	87,673	6	9
Works and contracts in progress (cost) ...	23,131	4	4
Finished goods and materials on hand (cost or under)	32,192	13	10
Bills receivable ...	2,059	16	11
Investment—£10,000 consols ...	9,100	0	0
Cash at bankers and in hand...	16,741	5	7
	£741,357	10	5

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RAND CENTRAL ELECTRIC WORKS.

On Friday the annual meeting of the shareholders was held at Winchester House, Sir C. Rivers Wilson presiding.

The **Chairman** expressed the hope that the shareholders would view the report in the light of the circumstances which had prevailed during the period under review. The military guard in charge of their works was not withdrawn till June, and it would readily be understood that the influence of the war affected the Company's operations during the whole of 1902. Dealing with the accounts, he pointed out that the balance of their claim against the Imperial Government in respect of damage to the plant done by the Boers amounted to £2,729. The Company's works were attacked in consequence of the assistance which they were able to render to the military authorities, so that he thought they had good grounds for their application for compensation. Before the outbreak of hostilities they had contracts with mines using 980 stamps. Only 225 of these were working at the commencement of the year under review, and the number gradually increased until it reached 530 at Dec. 31 last. So soon, however, as the mines were able to use the full power contracted for, and other contracts which were under consideration had been concluded, the Company's plant would be taxed to its utmost capacity. The Board had come to the conclusion that the time had arrived to provide additional plant, and with that object had ordered a fifth engine. It was expected that the cost would be £30,000, but arrangements had been made to find the money without calling on the general body of shareholders. The prospects of the Company were decidedly good. New fields were being opened up in the direction of their works, and that fact alone pointed to the probability of their having to meet a demand for a considerably larger amount of power. He concluded by moving the adoption of the report.

Mr. G. Zwilgmeyer seconded, and the motion was adopted unanimously.

ELECTRIC AND GENERAL INVESTMENT.

The report of the directors for the year ended May 31 last states that the profit and loss account shows a gross profit on the transactions of the year of £19,424. 10s. 5d. After deducting all general charges and the interim dividends already paid on the preference and ordinary shares, and providing for the proportion of the final dividend accrued on the preference shares to May 31, 1903, there remains a net balance of £8,996. 19s. 7d., to which the directors propose to add, by transfer from "provision for contingencies," £1,003. 0s. 5d., making a total of £10,000. The directors recommend that this amount be distributed as follows: ordinary shares—to the payment of a dividend of 5s. per share for the year ended May 31, 1903, of which 2s. per share was paid *ad interim* in December, 1902, leaving 3s. per share to be paid on July 8, 1903, £3,000; to the payment of a bonus of 2s. per share for the year ended May 31, 1903, £2,000; to the payment of a dividend of £50 per share for year ended May 31, 1903, on founders' shares, £5,000—total, £10,000. The trustees for the ordinary shares reserve fund propose to distribute to the holders of such shares a sum of 6d. per share, making, with the above-mentioned dividend and bonus, a total present distribution of 5s. 6d. per share, or 7s. 6d. for the year on each ordinary share. The trustees for the founders' shares reserve fund propose to distribute to the holders of such shares a sum of £5 per share, making, with the above-mentioned dividend, a total distribution of £55 on each founders' share for the year. The above-mentioned payments will be subject to the deduction of income tax.

ELECTRICAL POWER STORAGE.

In their report on the year ending May 31 last the directors state that the profit for the year, including the balance of £854. 14s. 9d. brought forward, is £11,983. 17s. 10d. Out of this sum the directors have carried £5,000 to the reserve fund and £1,000 to the contingent fund. They recommend the payment of a dividend of 6 per cent. on the ordinary share capital, which will absorb a further £5,389. 13s. 7d., and leave £594. 4s. 3d. to be carried forward. The buildings, plant, tools, etc., have been maintained in thorough repair and condition at a cost of £3,502. 9s. 8d., which sum has been provided out of revenue. The directors have again to record an increase in the business, the output having exceeded that of any previous year. Every type of cells has been represented in the increase, power, lighting, automobile, and launch cells having all been in larger demand. In consequence of the numerous orders received, especially for the Company's largest types of cells, it has been found necessary to increase the forming space at the works. A new floor has, therefore, been added to the main shop at Millwall to enable the Company to keep pace with the orders received. During the year the Company has installed batteries in many of the largest central stations in the kingdom, and the number of repeat orders received affords most satisfactory evidence of the efficiency and value of the Company's manufactures.

DUDLEY, STOURBRIDGE, AND DISTRICT ELECTRIC TRACTION.

The report of the directors for the year ended Dec. 31, 1902, states that the gross receipts for the year amounted to £41,828. 8s. 2d., and the expenditure to £30,463. 1s. 2d., including £2,000 placed to depreciation and renewals account, interest on debentures from date of issue, cost of repairs and maintenance, and all other expenditure properly chargeable against revenue, leaving a net profit of £11,365. 7s. After deducting the dividend on the preference shares accrued to Dec. 31, 1902, and adding the balance of £600. 0s. 4d. brought forward from the last account, there remains an amount available for distribution of £6,965. 7s. 4d. This the directors recommend should be applied as follows: to be placed to the reserve (sinking fund), £2,100; to the payment of a dividend at the rate of 4½ per cent. per annum on the ordinary shares, £4,500; to be carried forward to the next account, £365. 7s. 4d. During the past year £60,000 4½ per cent. debenture stock has been issued. The expenditure chargeable to capital account during the year amounted to £46,114. 0s. 6d., making the total amount expended to date on electric traction £284,514. 14s. 2d. The extension through Stourbridge to Lye was opened on Nov. 1 last. In order to cope with the increasing traffic, eight additional cars of large carrying capacity have been purchased. A Bill is being promoted in the present session of Parliament to confirm the agreements made with the various local authorities for the extension of the tenure, and to authorise the local authorities of the districts served by the Company to grant leases to the Company of the lines within their area, after they have purchased same, and for other general purposes.

NEW GENERAL TRACTION.

The report of the directors for the year ended March 23 last, to be presented at the meeting on the 2nd prox., shows gross profits for the year £11,585, after charging the sum of £5,714 for general expenses, salaries, directors' fees, interest on loans and legal expenses. After deducting £9,064, being 5 per cent. interest on the Company's outstanding mortgage debentures up to March 23 last, there remained a balance of £2,521. To that balance has to be added the sum of £11,662 brought forward from last year, making a total amount of £14,183 standing to credit of profit and loss account. The directors recommend that this should be carried forward. The disappointing results of the past year are attributed to the prolonged delay in completing the tramways belonging to the Philadelphia, Morton, and Swarthmore Street Railways Company, of which this Company holds the securities, and the bad weather during the spring and summer of 1902, which seriously affected the earnings of all the company's English tramways. In last year's report it was mentioned that the completion of the Philadelphia system was dependent upon a decision of the Supreme Court then awaited from day to day. That decision was not given until Oct. 13 last, and the judgments of the Lower Court and of the Court of Appeal were thereby reversed. As a result the Company could not make the short connection with the terminus in Darby as originally planned. Upon the occasion of Mr. Hopkins's recent stay in Philadelphia measures were taken to overcome the difficulties which had thus arisen. New rights of way into Darby have recently been acquired, and the laying of the track is now proceeding satisfactorily.

BRITISH ELECTRIC TRACTION.

The report of the directors for the year ended March 31, 1903, states that the profits, including £27,438. 7s. brought forward from last year, amount to £266,399. 18s. 10d. This does not take into account the premiums, amounting to £90,337. 4s., received in respect of new share and debenture capital, and which have been carried direct to reserve. After deducting the proportion of general expenses chargeable to revenue, and also the expenses incurred in connection with schemes not proceeded with and written off, contributions to superannuation fund, and interest on debenture stock, there remains a net profit of £208,161. 14s. 11d., which the directors propose should be applied as follows: reduction of licenses and testing of new systems account, £2,500; reduction of furniture account, £551. 13s. 7d.; dividend at the rate of 6 per cent. per annum on the preference shares for the year ended March 31, 1903, including the dividend paid to Feb. 15, 1903, and proportion of dividend payable Aug. 15, 1903, accrued to date, £74,760. 9s. 7d.; dividend at the rate of 10 per cent. per annum on the ordinary shares for the half-year ended March 31, 1903, making with the interim dividend at the rate of 6 per cent. per annum paid for the half-year ended Sept. 30, 1902, a total distribution of 8 per cent. for the year, £105,437. 0s. 9d.; carried forward to next account, £24,912. 11s. The reduction of the dividend on the ordinary shares by 1 per cent. for the year is mainly due to a larger amount of new capital having been raised during the past year which has not yet become productive of profit, though ranking for dividend. Capital account: In June, 1902, 20,000 ordinary shares were allotted to the shareholders at par in accordance with the proposal approved by the shareholders, and contained in the last annual report of the directors. In November last an issue was made of 75,000 preference shares at the price of £12 per share; 37,500 shares of this issue were underwritten for a commission of 10s. per share, and 37,500 shares were allotted. A further 3,213 ordinary shares and 11,447 preference shares have also been issued as fully paid up to the holders of 32,130 ordinary shares, and 68,682 preference shares of the Brush Electrical Engineering Company, Limited, in exchange for their shares in the Brush Company. There have been issued as fully paid-up 8,853 ordinary shares and 7,490 preferenee shares in exchange for shares in the Electrical Power Distribution Company. The absorption by the Company of the Electrical Power Distribution Company has been completed, and the latter company is now in course of liquidation. There has also been issued £212,912 5 per cent. perpetual debenture stock, and £35,754. 5s. 8d. has been received on account of further stock to be issued. The total premiums received in respect of these issues, after deducting the expenses, amount to £90,337. 4s., and the whole of this amount has been added to reserve, which at the date of the accounts stood at £550,042. 8s. 10d. The subscribed share and debenture capital at March 31, 1903, was £1,320,660 in ordinary shares of £10 each, £1,564,370 in 6 per cent. cumulative preference shares of £10 each, £1,023,818 in 5 per cent. perpetual debenture stock—total, £3,908,848. Contracts and undertakings: The balance under this head, after deducting the cost of undertakings transferred, and after writing off expenses incurred in respect of schemes not proceeded with, but including a proportion of general expenses, is £214,048. 0s. 8d., made up as follows: expenditure on works and undertakings for account of other companies, £36,827. 8s. 5d.

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expenditure on works and undertakings owned or leased by British Electric Traction Company and for general stores £116,744. 2s., less reserved £4,000, leaving £112,744. 2s.; and expenditure in connection with schemes in course of development, and on Acts of Parliament, light railway orders, and other rights and powers secured or in course of promotion, £64,468. 10s. 3d. Investments: The total amount of investments, after deducting cost of securities sold, stands at £3,569,658. 5s. 8d. Borrowing powers: The directors intend to ask the shareholders to increase the borrowing powers of the directors upon debentures or debenture stock up to an amount equal to the subscribed capital of the Company. This will enable the directors to raise upon second debenture stock ranking subsequent in point of charge an amount equal to the 5 per cent. perpetual debenture stock now authorised. The directors are of opinion that the security of the first debenture holders will be improved thereby, and that the ordinary shareholders should benefit by a decrease in the average cost of the capital of the Company. Directors: the Right Hon. Lord Rathmore has resigned his seat at the Board. The directors who retire this year are Sir Charles Rivers Wilson, G.C.M.G., C.B., and Mr. John S. Raworth, and both are eligible for re-election.

ABSTRACT OF BALANCE-SHEET.

Liabilities.	£	s.	d.
Capital authorised—200,000 6 per cent. cumulative preference shares of £10 each, and 200,000 ordinary shares of £10 each	4,000,000	0	0
Capital issued—118,937 6 per cent. cumulative preference shares of £10 each, fully paid	1,189,370	0	0
37,500 6 per cent. cumulative preference shares of £10 each, upon which £6 per share has been paid up, £225,000; add instalments paid in advance, £24,224—total, £249,224; less instalments in arrear, £639	248,585	0	0
132,066 ordinary shares of £10 each, fully paid	1,320,660	0	0
Debenture stock—£969,830 5 per cent. perpetual debenture stock	969,830	0	0
£280,170 5 per cent. perpetual debenture stock—amount received to date, of which £53,988 has been allotted	89,742	5	8
Loans by bankers	200,000	0	0
Deposits by sundry associated companies	64,000	0	0
Reserve—Premiums on issues of shares and debenture stock, as at March 31, 1902	439,705	4	10
Ditto in respect of subsequent issues, less commissions, brokerage, and expenses	90,337	4	0
Amount transferred from profit and loss account, as at March 31, 1902	20,000	0	0
Sundry creditors	103,655	6	6
Profit and loss account: Preference share dividend—proportion of dividend due Aug. 15, 1903, accrued to date	9,693	13	2
Ordinary share dividend—proposed dividend at the rate of 10 per cent. per annum for the half-year ended March 31, 1903	66,033	0	0
Balance carried forward to next account	24,912	11	0
	£4,836,524	5	2

Assets.	£	s.	d.
By contracts and undertakings	214,040	0	8
Investments	3,569,658	5	8
Sundry debtors (including £816,351. 8s. 10d. due from other companies in respect of sale of undertakings and on construction and other works)	985,228	18	0
Goodwill account	1,000	0	0
Cost of licenses, and of testing and developing new systems of traction	3,793	12	9
Office furniture and fittings	4,965	2	2
Cash on current account and in hand	57,838	5	11
	£4,836,524	5	2

Dr. PROFIT AND LOSS ACCOUNT.	£	s.	d.
General expenses	12,490	18	0
Superannuation fund (contributions)	582	3	8
Debenture stock interest to date	45,165	2	3
Balance carried down	208,161	14	11
	266,399	18	10
Cost of licenses, and of testing and developing new systems of traction—amount written off	2,500	0	0
Furniture and fittings—amount written off	551	13	7
Preference share dividend	65,066	16	5
Ordinary share dividend—interim dividend paid to Sept. 30, 1902	39,404	0	9
Proposed dividend at the rate of 10 per cent. per annum for the half-year ended March 31, 1903	66,033	0	0
Balance carried forward to next account	24,912	11	0
	£208,161	14	11

Cr.	£	s.	d.
Balance brought forward from March 31, 1902	27,438	7	0
Profits on working lines, sales of investments, rents, sale of undertakings and of parliamentary powers, and underwriting profits	238,961	11	10
	266,399	18	10
Balance brought down	208,161	14	11
	£208,161	14	11

NEW COMPANIES REGISTERED.

Universal Insulator, Limited (77,770).—Capital, £10,000. Object: to adopt an agreement with L. Grote and E. Perry to manufacture, buy, sell, let on hire, license, or royalty or otherwise deal in electric insulators and moulded articles of any kind, and to carry on the business of mechanical and electrical engineers and manufacturers, etc.

Henley's (South Africa) Telegraph Works Company, Limited (77,781).—Capital, £2,000. Objects: to carry on in South Africa or elsewhere the business of electricians, telegraph and telephone engineers and contractors, submarine, cable, telegraph, and telephone instrument manufacturers, wire drawers, galvanisers, wire rope makers, and engineers, producers of light, heat, or power by electricity, galvanism, or magnetism, etc., in South Africa or elsewhere. Registered office: 27, Martin's-lane, Cannon-street, E.C.

CONTRACTS FOR ELECTRICAL SUPPLIES.

West Ham.—The Corporation require tenders for cables, etc., by July 14.

Lisbon.—The Public Works Department require tenders for the public electric lighting of Macao. Tenders by Oct. 21.

Ipswich.—The Corporation invite tenders for the supply and delivery of electricity meters by July 14.

Poplar.—The Electricity Committee of the Council invite tenders for the supply of arc lamp carbons by July 8.

Hornsey.—The Urban District Council invite tenders for ventilating fans and wiring and fittings for electric light. Tenders by July 6.

St. Pancras.—The Borough Council invite tenders for the wiring and fitting of the Goldington-buildings, Great College-street. Tenders by noon on July 8.

St. Pancras.—The Borough Council invite tenders for supplying about 31 miles of lead-covered and armoured cable. Tenders by 12 noon on July 14.

St. Pancras.—The Borough Council invite tenders for supplying an electric jenny and grab to their King's-road power house, Camden Town, N.W., by July 14.

Cairo.—Tenders will be received at the Central Office, Sanitary Department, up to 11 a.m. on July 11, for the proposed electric light installation at Kasr-el-Aini.

Madrid.—The Post and Telegraph Department require tenders for the laying and supply of telegraph cable from Fernando Po to Cameroon. Tenders by July 10.

Hammersmith.—The Borough Council invite tenders for the supply of 40 alternating-current series arc lamps and accessories. Tenders by July 15. See advertisement.

West Ham.—The Borough Council invite tenders for the supply of high-tension paper-insulated cable for tramway feeders and of multicore telephone and pilot cables. Tenders by July 14.

Stepney.—The Electrical Committee of the Borough Council invite tenders for the supply of feed, suction, and other pipework, water-softening plant, and storage tanks. Tenders by July 21.

Ipswich.—The Corporation invite tenders for the supply and delivery of electricity meters. Particulars may be obtained at the office of Mr. Will Bantoft, town clerk, Town Hall, Ipswich. Tenders by 14th inst.

Barnstaple.—The Corporation invite tenders for wiring, lamps, fittings, switches, etc. Particulars may be obtained from Mr. W. H. Trentham, 39, Victoria-street, Westminster. Tenders by July 16. See advertisement.

Lisbon.—The Public Works Department require tenders for the construction of 1m. gauge light railways as follows: (1) Limatal, Vianna-Ponte de Barca; (2) Oberer Minho, Braga-Monçao; (3) Braga-Guimaraes. Tenders by Aug. 1.

London, N.W.—The St. Pancras Borough Council invite tenders for the supply of about 350,000 carbons. Particulars may be obtained upon application at the Electricity Department Offices, 57, Pratt-street, N.W. Tenders by 14th inst.

Aberdare.—The Urban District Council invite tenders for the installation of call bells between the central fire station and the residences of the firemen. Particulars may be obtained at the Surveyor's Office, Town Hall. Tenders by 11th inst.

Leicester.—The Tramways Committee invite tenders for the erection of the car-sheds, workshops, stores, etc. Particulars may be obtained at the office of Mr. E. George Mawbey, M.I.C.E., engineer, Town Hall, Leicester. Tenders by 10th inst.

London, W.—The Hammersmith Borough Council invite tenders for supply of 40 alternating-current series arc lamps and accessories. Particulars can be obtained from the engineer, Mr. G. G. Bell, Electricity Works, 57, Fulham Palace-road, W. Tenders by July 15.

Shanghai.—The French Colony propose to instal motor-propelled tramways. Tenders may be sent by Oct. 31, 1903, to Secrétariat de la Municipalité Française de Shanghai. Particulars may be obtained from l'Office National du Commerce Extérieur, Rue Feydeau, 3, Paris.

St. Pancras.—The Borough Council invite tenders for the supply of about 350,000 carbons of various lengths and diameters for 12 months. Specifications, etc., can be obtained at the Electricity

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Department Offices, No. 57, Pratt-street, N.W. Tenders by July 14 at noon.

London, N.W.—The St. Pancras Borough Council invite tenders for supplying about 31 miles of lead-covered and armoured cable. Particulars may be obtained upon application to the Chief Clerk, Electricity Department Offices, 57, Pratt-street, N.W. Tenders by July 14.

Bath.—The Corporation invite tenders for the supply and erection of a jet condensing plant, etc. Particulars may be obtained from the consulting engineers, Messrs. Kincaid, Waller, Manville, and Dawson, 29, Great George-street, Westminster. Tenders by July 17. See advertisement.

Derby.—The Electric Lighting Committee invite tenders for the supply of accumulators, balancers and reversible boosters, and switchboards. Particulars may be obtained from Mr. T. P. Wilmshurst, borough electrical engineer, Full-street, Derby. Tenders by July 13. See advertisement.

London, E.—The Electricity Committee of the Poplar Borough Council invite tenders for the supply of arc lamp carbons. Particulars may be obtained at the offices of the Borough Electrical Engineer, Electricity Works, Glaucus-street, Bromley-by-Bow, E. Tenders by 8th inst.

Bradford.—The Corporation invite tenders for works required in the erection of a new electricity station at Sunbridge-road destructor works. Particulars may be obtained on application to Mr. F. E. P. Edwards, A.R.I.B.A., city architect, Whitaker-buildings, Brewery-street. Tenders by 7th inst.

London, N.W.—The St. Pancras Borough Council invite tenders for supplying an electric jenny and grab to their King's-road power-house, Camden Town, N.W. Particulars may be obtained upon application to the Chief Clerk, Electricity Department Offices, 57, Pratt-street, N.W. Tenders by July 14.

Sleaford.—The Urban District Council invite tenders for supply and erection of water-tube boiler with piping, and 90-kw. steam generator and switchboard panel. Particulars may be obtained from Mr. R. G. Spencer Yates, A.M.I.E.E., engineer, Electricity Works, Sleaford. Tenders by 10th inst. See advertisement.

Launceston (Tasmania).—The Mayor and Aldermen invite tenders for the supply of 500 or more electric meters. Particulars may be obtained on application to Mr. William Corin, city electrical engineer, Launceston, Tasmania, or to Messrs. John Terry and Co., 7, Great Winchester-street, London, E.C. Tenders by Sept. 28.

Heston and Isleworth.—The Urban District Council invite tenders for the supply of steam-engines, dynamos, boosters, etc., storage batteries, cables, and arc lamps and glow lamps. Particulars may be obtained from the Council's engineers, Messrs. J. and J. S. Enright, 47, Victoria-street, S.W. Tenders by 23rd inst. See advertisement.

Leek.—The Urban District Council invite tenders for the supply and erection of switchboard and connections, balancing transformer and motor-generators, storage batteries, and travelling crane. The specifications, plans, etc., can be obtained from Messrs. Burstall and Monkhouse, 14, Old Queen-street, Westminster, S.W. Tenders by 12 noon on July 9.

Weymouth and Melcombe Regis.—The Corporation invite tenders for the supply, delivery, and erection of the following in connection with the electric lighting of the town: Lancashire boilers, engines and dynamos, overhead travelling crane, switchboard and battery boosters, storage battery, arc lamps and arc lamp posts, pipework, feed pumps, economiser, ejector condensers, etc., distributing mains and feeders, by July 19.

RESULTS OF TENDERS.

West Ham.—The Town Council have accepted the tender of Walker Bros., Limited, for the construction of corrugated iron tramcar sheds, at £1,099.

Rotherham.—The Town Council have accepted the tender of R. Taylor and Sons, Marsden, at £1,280, for two boilers in connection with the electric light.

Maidenhead.—The Town Council have accepted the tender of Mr. W. B. Theaker for the extension of the central-station buildings in Braywick-road, at £874.

Barnsley.—The Electricity Committee recommend that the tender of Messrs. Ferranti and Co. for the extensions of the switchgear at the electricity works, at £375, be accepted.

Derby.—The Tramways Committee have recommended for acceptance the tender of J. G. White and Co., at £87,627. 10s., for the construction of the permanent way and the provision of electrical equipment and cars.

Derby.—The Electric Lighting Committee have, subject to the approval of the Council, accepted the tender of Messrs. Radford and Greaves, at £449. 10s., for building the boiler foundations, etc., at the electricity works.

London, E.—The Stepney Borough Council have accepted the tender of J. Richmond and Co., 30, Kirby-street, Hatton-garden, E.C., for a suspended electric goods lift in the large store at the Wentworth-street depôt, at £220.

Ilford.—The Urban District Council have accepted the tender of W. Newbold and Co., Pearl-buildings, London Bridge, S.E., at £384. 5s., for the supply of machinery and tools in connection with their electric tramways.

Islington.—The Electric Lighting Committee recommend that the seal of the Council be affixed to a contract with the Electrical Construction Company for the supply of thirty-seven 30-kw. transformers at £2,966. 10s. 6d.

Leicester.—The Tramways Committee recommend that the contract for the supply of cars be divided between Messrs. Dick, Kerr, and Co., Preston, and the Brush Company, Loughborough.

Croydon.—The Town Council have accepted the following tenders: British Insulated and Helsby Cables, Ltd., at £1,039. 1s. 3d., for high-tension cables; Messrs. E. Goossens, Pope, and Co., for 3,741 incandescent electric lamps.

Colchester.—The Council have accepted the following tenders: Henley Telegraph Works Company, Limited, cable, £1,635; Klein Engineering Company, water cooler and tray, £713; Davey, Paxman, and Co., condenser pipework, £116, and exhaust range, £225.

Engine Contracts.—We are informed that Messrs. W. H. Allen, Son, and Co., Bedford, have recently received the following orders: one 80-b.h.p. engine for Messrs. Pilkington Bros.; two 365-b.h.p. engines and two 150-b.h.p. engines for Londonderry; four 300-b.h.p. engines for Gibraltar dockyard; four 400-b.h.p. engines for Messrs. John Taylor and Sons for the Kola power station; and one 500-b.h.p. and one 270-b.h.p. engine for Rotherham.

Superheated Steam.—Messrs. Easton and Co., Limited, report that the Providence Engineering Works of Providence, Rhode Island, U.S.A., who hold a license under the Schmidt highly superheated steam patents for America, have within the last few weeks secured orders for complete steam engine plants as follows: one engine of 700 h.p., two engines aggregating together 1,800 h.p., and another of 1200 h.p., the order comprising in each case, in addition to the engines, Schmidt superheaters and receiver heaters.

London, E.—The Stepney Borough Council have received the following tenders for completing the electric light installation at the public library, Commercial-road East, Limehouse, E.:—

Barlow Bros., 237, Shaftesbury-avenue, W.C. (accepted)	£42	10	0
J. C. Christie, Mansell-street, E.	68	15	0
F. E. Emerson and Sons, Burdett-road, E.	52	0	0
Strode and Co., 48, Osnaburgh-street, N.W.	98	0	0
Tamplin and Makovski, Redhill	75	0	0
Ward Bros., 28A, Basinghall-street, E.C. (informal)	51	17	0

Maidenhead.—The Corporation have received the following tenders for extensions to the central station buildings:

W. E. Theaker, Maidenhead (accepted)	£874	0	0
Peerless, Dennis and Co., Eastbourne	1,242	0	0
Thompsett and Co., Farnham	1,221	0	0
W. J. Bloxham, Banbury	1,174	0	0
H. Flint, High Wycombe	1,127	12	6
C. W. Cox and Sons, Maidenhead	1,110	0	0
A. J. Colborne, Swindon	1,099	19	6
F. W. Edwards, Maidenhead	1,080	0	0
F. Bissley, Maidenhead	1,020	0	0

BUSINESS NOTES.

TRACTION.

Aberdeen.—The Ferry Hill tramway has been opened for traffic.

Swindon.—The Town Council have obtained sanction for a tramway loan of £36,000.

Eastbourne.—The Town Council have decided to institute a service of motor omnibuses.

Liverpool.—The Tramways Committee are looking out for a site for new tramway offices.

Lowestoft.—The formal opening of the new electric tramways has been fixed for the 18th inst.

Southampton.—The old Portswood tramway route will be opened for traffic in two or three weeks' time.

Liverpool.—The Electricity Committee have decided to apply for powers to supply Upton and Bidston with electricity.

Hull.—The tramway clauses in the omnibus Bill promoted by the Corporation have been passed by a committee of the House of Commons.

Colchester.—It is proposed to apply for an extension of time for three months in which to commence the construction of the electric tramways.

Paisley.—Extensions at the Blackhall electricity station are to be made to meet the demand for current for the tramways when they are constructed.

Doncaster.—A motion in favour of the abandonment of the proposed Oxford-street route was defeated at the last meeting of the Town Council.

Middlesex.—On Thursday last week the amount to be expended on light railways in Middlesex was brought up to £1,000,000 by a further vote by the County Council.

Wick and Lybster Light Railway.—The Wick and Lybster Railway was inspected on Friday by Major Druitt, of the Board of Trade. The formal opening took place on Wednesday.

Cardiff.—This week the Clive-street route was opened for traffic. It is anticipated that the Royal assent will not be given to the Bill to confirm the new tramway provisional order before next August.

Barcelona.—The committee appointed by the British Electric Tramways Company of Barcelona to enquire into the provisionally adjusted strike of their employés has arrived at Barcelona from London.

Salford.—The Council have resolved to make application to the Board of Trade for sanction to borrow £3,931 for the electrical equipment of the Prestwich Urban District Council tramways in Bury Old-road.

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Gosport, Fareham, and Cosham Tramways.—The committee of the House of Lords presided over by Lord Hatherton has found the preamble of this Bill proved, particulars of which were given in our last issue.

Bradford.—The Drighlington section of the tramways system has been opened for traffic. The new line is nearly two miles in length, and the journey from the city to the Drighlington terminus is one of over 4½ miles.

Brighton.—A Select Committee of the House of Lords is enquiring into the provisions of the Corporation Tramways Bill, which asks for powers to extend the existing tramways in various directions. The enquiry will be resumed next week.

Dundee.—The agreement between the promoters of the proposed Dundee and Broughty Ferry tramways and the Broughty Ferry Town Council has now been signed. Arrangements have been made for pushing on the matter as rapidly as possible.

Rotherham.—The Tramways Committee recommend that the Board of Trade be asked to increase the speed limit to 12 miles an hour. The Tinsley section of the tramways is now completed and awaits inspection by the Board of Trade official.

Nelson.—The Electricity and Tramways Committee of the Corporation have further considered the question of the stages and fares on the Nelson and Barrowford tramways. The committee reaffirmed their previous decision with regard to the first ½d. stage.

Halifax.—The Hove Edge extension has been opened for traffic. The new line consists of a length of single track between Hipperholme and Hove Edge, and it is important as bringing the Halifax system within measurable distance of the centre of Brighouse.

Burnley.—The Accrington-road section of the tramways, the first of the branch routes, will be quite ready by the Burnley Fair holidays. The actual date of the visit of the inspector of the Board of Trade is not known, except that it will be between July 6 and 10.

West Bromwich.—The Highway Committee state that they have approved of 44 stopping places upon the electric tramways from the Handsworth boundary to Wednesbury and Dudley, which have been arranged with the South Staffordshire Tramway Company.

Bromley.—The British Electric Traction Company have given notice of their intention to apply to the Light Railway Commissioners for an order authorising the construction of light railways in the urban district of Bromley and the parishes of Farnborough and Chelsfield.

Baker-street and Waterloo Railway.—The Baker-street and Waterloo Railway (Extension of Time) Bill has been passed, as an unopposed measure, by Mr. Jeffreys, the deputy chairman of committees of the House of Commons. The Bill will be reported to the House for third reading.

Handsworth.—The District Council are still conferring with the Birmingham Corporation on the tramway question. It was stated at their last meeting that the Council were not tied to the British Electric Traction Company, otherwise they would not be open to confer with Birmingham.

Gloucester.—Tenders for the construction of the electric tramway system have been received, and will be presented to the next Council meeting. The work will probably be commenced six weeks after the signing of the contract, and the work will have to be finished in six months after it is initiated.

City and South London Railway Bill.—On Friday the Select Committee of the House of Lords of which Lord Belmore is the chairman concluded their enquiry into the provisions of this Bill, which were given in our last issue. The committee found the preamble proved, and the Bill will proceed.

Private Bills.—On Friday in the House of Lords the Baker-street and Waterloo Railway (Transfer) Bill was read a second time, and the Mid-Yorkshire Tramways Bill a third time. In the Commons the Harrow and Paddington Tramways Bill has been read a third time, and the Taff Vale Railway Bill a second time.

Reading.—Rapid progress is being made with the power-house which will supply current for running the tramways. Three of the four generating sets are delivered and the switchboard work is well in hand. The track itself is nearly completed and the last consignment of cars have been delivered by Messrs. Dick, Kerr, and Co.

Central London Railway.—This railway is now running a two minutes' service during the "rush" hours—that is, between 8 and 10 in the morning and 4 and 7 in the evening. Between Tottenham Court-road and Bond-street the company are experimenting with an automatic system of signalling, with a view to its adoption throughout the line.

Barrowford.—Two additional cars have arrived, making six in all, and when the tramway is completed it is proposed to run a seven-minutes' service, with five cars, during the week, and put the sixth on the lines during the week ends to facilitate a more frequent service. The new car-shed adjoining the present one is now almost completed.

Camberwell.—The Borough Council have approached the London County Council with a request for the construction of a tramway from the junction of the proposed line in Lordship-lane to the Crystal Palace, *via* Sydenham-hill. The Council have approved the underground conduit system for the tramways proposed to be constructed in the borough.

Hammersmith.—Subject to details being prepared, the Borough Council have decided to consent to the proposed tramway from Shepherd's Bush to the Marble Arch, and to make a contribution of one-third of the cost of the necessary street widenings not exceeding £9,260, provided that the tramway is extended either along Uxbridge-road to Bayswater or along Latymer-road.

Stepney.—The Borough Council have declared their intention of refusing to sanction the installation of the overhead trolley system in the streets under their control as proposed by the London County Council. On the other hand, they are ready to consent to the tramways which it is proposed to construct on the conduit system.

Llandudno and Colwyn Bay.—The order made by the Light Railway Commissioners extending the time for the completion of this railway has been confirmed by the Board of Trade, with the addition of the provision that the powers shall cease on Sept. 20 next unless the work is substantially commenced at that date. This date was fixed so that the district councils affected would (if the promoters failed to proceed) have sufficient time to prepare and lodge their own application for powers to construct electrical tramways.

Stretford.—A special meeting of the District Council has adopted a resolution authorising the necessary steps to be taken for an application to the Light Railway Commissioners for a provisional order under the Light Railways Act of 1896. This order, if granted, will authorise the Council to proceed with the construction of a light railway in the parishes of Stretford and Davyhulme, and will provide a through route between the Cock Hotel at Stretford and the proposed South Lancashire scheme. It will also afford a means of communication between Trafford Park and Stretford.

Dewsbury.—The work of connecting the Halifax-road and Heckmondwike trams is proceeding apace at Staincliffe. The track, which has been laid by Messrs Dick, Kerr, and Co., is now complete. It is hoped to run trial cars over the new line in about a week or 10 days, and the Board of Trade inspection will then follow immediately. An extension of the electric tramways in the Dewsbury district is being made by the construction of a line from the temporary terminus near Ravensthorpe (L. and Y.) railway station to the Fir Cottage estate at the Mirfield boundary.

Leeds.—The Leeds Tramways and Roundhay Park Committees have considered suggestions made by the general manager of the tramways (Mr. Hamilton) with the object of preventing the crushing which occurs at the Canal Gardens tram terminus at holiday times. The proposals are, in effect, the provision of sidings on the plot of ground opposite the Canal Gardens, so that, with the aid of queue gangways, passengers may quietly board their respective cars. The committees were impressed with the suggestions, which in due course will be carried out. It is proposed to considerably extend the ½d. fare system by way of experiment.

Gordon-Bennett Cup Race.—The Attorney-General, replying to Mr. Leamy in the House of Commons on Wednesday, said the Government had received no guarantee from the promoters of the Gordon-Bennett motor race in Ireland for the expenses of extra police over the sum of £1,000 which the Treasury was willing to contribute. Mr. Leamy: As the race comes off to-morrow, does the Government propose to levy any portion of the cost of the extra police on the county of Kildare? The Attorney-General: That matter is under consideration. As far as the race is concerned, all arrangements have been made, and 2,700 police will be there to assist.

Liverpool and Bootle.—Mr. E. C. Bellamy, general manager of the Liverpool tramways, gave evidence before the Select Committee of the House of Commons which is enquiring into the application of the Liverpool Corporation for the annexation of Bootle. He stated the difficulties which have arisen under the present arrangement in regard to the extension of the tramway system into the Bootle district, and showed the advantages that would accrue from the inclusion of Bootle within the city boundaries. He also referred to the scheme for the carriage of merchandise from the docks to South Lancashire towns, and outlined a scheme of tramways for Bootle.

Newport (Mon.).—The Caerleon-road section of the tramway system having been extended to the borough boundary, which is well over the hill beyond the Wesleyan Church at St. Julian's, was opened for passengers on Tuesday. The line, which constitutes the third artery for traffic to the suburbs, had been inspected by Major Druitt, on behalf of the Board of Trade, earlier in the day, and had been formally approved by him. There yet remain the Malpas-road and Stow-hill routes to be completed before the electrical traction of the borough is fully provided. Malpas-road is being provided with a double line, and will be shortly completed, but no start has yet been made with Stow-hill.

Additional Traffic Returns.—Angle-Argentine, £1,854 increase; Barcelona Ensanche y Gracia, £205 increase; Barcelona, £63 decrease; Brisbane, £93 decrease (month of May, £10,160, decrease £672); British Columbia Electric (month of March), gross earnings £10,352, net income £2,668; Buenos Ayres and Belgrano Electric, £814 increase (month of April, £12,995, increase £1,125); Calcutta, £350 increase; Cape Town (month of April), receipts £16,003, expenditure £8,313; Isle of Thanet Electric, £189 decrease; Mexico Electric (month of March), receipts £46,200, expenditure £26,400; Perth Electric, £43 increase; Port Elizabeth (month of April), receipts £4,292, expenditure, £2,281.

Elland.—At a meeting of the Urban District Council on Wednesday it was unanimously resolved to approach the Huddersfield Corporation and ask them to bring their tramcars to Elland Town Hall. Several of the members expressed dissatisfaction with the way in which Halifax had treated them in respect to tramways. It was pointed out that while on an average 3,000 passengers travel every week by rail between Elland and Halifax, only about 180 per week make the journey by train to Huddersfield. Although the latter is only four miles away by road, the railway fare is 8d. It was urged that if tramcars were run from Huddersfield much patronage would be diverted from Halifax to Huddersfield.

Bath.—It appears that there has been certain departures from the agreement entered into between the Bath Electric Tramways Company and the Somerset County Council. It was stated at the last meeting of the County Council that the county surveyor had done all in his

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power to keep the company to the terms of the order, but he had signally failed. The company had entered upon the road without sufficient notice, and the second point, which was more serious, was that they had contravened the terms of their order that they should not break up more than 100 yards of road in every quarter of a mile throughout their district. It was decided to defer the question of liability until a survey has been completed.

Middlesbrough.—The Imperial Tramways Company have written to the Corporation with reference to the proposed tramway extension. The company are desirous of getting the plans ready for deposit in Parliament, and it is therefore necessary to get the route fixed without delay. The Town Clerk stated at the last meeting of the Council that Mr. Clifton Robinson was of the opinion that the cost of the bridge it would be necessary to construct would be £30,000, one-third of which should be paid by the local authorities, one-third by the railway company, and one-third by the tramways company. It was decided to have something a little more definite from Mr. Clifton Robinson before the Council took any action.

Giant's Causeway Electric Tramway.—The Ballymoney Rural District Council have passed the following resolution: "That the Board of Trade be requested to cause an enquiry to be made into the management of the Giant's Causeway and Portrush Tramway, inasmuch as six lives have been lost and two individuals have been maimed for life since the trams were introduced. Public opinion in the neighbourhood feels strongly that the rules laid down by the Board of Trade have not been complied with, and this Council, in the interests of those whom they represent, hereby call upon the Board of Trade to make an enquiry into the matter; and, further, that a committee be appointed to get up the facts for the enquiry, with power to employ the Council's solicitors."

South Lancashire.—The Bill promoted by the South Lancashire Tramways Company, which has passed the House of Lords, was before a committee of the House of Commons presided over by Mr. Bond on Tuesday. The only opponents were the Corporation of St. Helens. In the end an arrangement was arrived at by which the company are to have such running powers over the lines of the Corporation (now leased to a company) as are necessary to conduct a through communication of passengers, passengers' luggage, and small parcels, and the company are not to enter into agreements with the company working the St. Helens lines except so far as is necessary to give effect to the running powers. Any dispute on the matter is to be referred to the Board of Trade. The Bill as amended will be reported to the House for third reading.

Sunderland.—The borough electrical engineer, Mr. J. F. C. Snell, has presented alternative plans to his committee, one showing a double track with the exception of Lawrence-street, which is too narrow to permit of a double line, and another showing a single track with turn-outs. The double track would cost £12,000 and the single £9,000, and the committee decided to adopt the single track, to be laid in such a way that if in future a double track were necessary it would be possible to lay it for the additional £3,000. It was decided to use the Thermit system of welding in the construction of this section, and matters are to be put in hand at once so that immediately the Council approve the work can be commenced. The Board of Trade are considering the application of the Corporation to increase the speed limit on the tramways.

Embankment Tramways.—It seems that the defeat in the House of Commons of the County Council's proposal to run a tramway along the Embankment was due to the failure—in his constituents' opinion—of one member to do his obvious duty. The Lambeth councillors are exceedingly wroth about the matter and have fixed on the local M.P., Mr. Horner, as the scapegoat. He it was, they say, who supplied the one vote by which the scheme was thrown out. Not satisfied with having by resolution expressed their "regret" at the hon. member's action, the Council at their last meeting agreed to another motion that Mr. Horner should be informed that the explanation offered by him—that he was awaiting the result of the Royal Commission on London Locomotion—"in no way modified" the view already taken of his conduct.

Flintshire.—The railway companies whose lines run through North Wales are threatened with formidable opposition. It is reported that a powerful syndicate will next session of Parliament apply for powers to construct and work a system of electric tramways over a circular route, which will pass through Sandy Croft, Queen's Ferry, Connah's Quay, Flint, Bagillt, Holywell, Northop, Mold, Buckley, Hawarden, and back to Connah's Quay. There are large industrial populations in most of the centres, and along the coast of the Dee large works are being erected, and some thousands will be employed. The line will also serve several towns and villages which are a considerable distance from a railway station, and the opening out of the new route, while probably a cause of anxiety to the railway companies whom it will affect, will be hailed with satisfaction by the inhabitants of the district

Wolverhampton.—A special meeting of the Town Council was held on Monday to deal with matters relating to the borough tramways. It was moved and seconded that the minutes and proceedings of the Council in committee with regard to the Lorain system of tramways be adopted. The Town Clerk said it would be in the interests of the town that there should be no discussion on the subject, as the Tramways Committee had been instructed to seek an interview with the Lorain Steel Company in order to arrive at an amicable settlement of the dispute between the company and the Corporation. After further discussion the motion was adopted by 30 votes to 14. It was further resolved that the corporate seal be affixed to a memorial to the Board of Trade applying for the prolongation of the periods limited by Section 18 of the Tramways Act, 1870, for the commencement and completion of the works authorised by the Wolverhampton Corporation Tramways Order, 1902.

New Issue.—The South Staffordshire Tramways Company, which has a capital of £150,000, divided into 15,000 £5 ordinary shares and 15,000 6 per cent. cumulative £5 preference shares, of which 10,000 ordinary shares have been issued, and are fully paid up, announces the issue at par of 10,000 preference shares. The company was registered on July 31, 1899, to acquire a lease from the South Staffordshire Tramways Company of tramways of an approximate length of 23 miles. The population of the districts served, according to the last census, is 363 289, as follows: Walsall, 76,440; Darlaston, 15,381; Wednesbury, 26,544; Tipton, 30,543; West Bromwich, 65,172; Coseley (including Sedgley), 38,169; Dudley, 48,809; Handsworth, 52,921. The minimum subscription is the whole amount now offered, which has been underwritten by the British Electric Traction Company, Limited.

Bournemouth.—A special meeting of the County Council of Dorset is to be held "To receive a petition lodged by the Branksome Urban District Council in the House of Commons against Clause 11 of the Bill (being one of the agreed clauses in consideration of which the County Council withdrew their opposition), and which provides that the Bournemouth Corporation shall not accept a lease of or enter into a contract or agreement with respect to the working, etc., of tramways within the county (except in the borough of Poole) unless they obtain the consent of the County Council, which consent, however, is not to be unreasonably withheld; to receive a joint report of the County Works and Parliamentary Committees recommending the sealing and supporting before the House of Commons Committee of a petition against alterations; and, upon the adoption of the report, to pass a resolution authorising the seal of the Council to be affixed to the petition in question."

Railway Electrification.—The Court of Referees has adjudicated on a petition of the Corporation of the City of London to be heard against the Bill of the South-Eastern and London, Chatham, and Dover Railway Company, one of the objects of which is to provide for the ultimate electrification of the company's line. Mr. Pollock, the City Remembrancer, appeared for the Corporation to show cause why they should be allowed a *locus standi*. He said that when the railway was electrified—it might be six years hence—electric traction, "which was now only in its infancy," might have developed so that large engines might be in use, also strong electric currents, which might cause great injury by electrolysis to service works for which the Corporation was responsible. Damage might be done to gas and water pipes and mains, and to other service works. Mr. Clode (who appeared for the promoters) opposed the *locus* of the City, said there were no pipes or wires in the neighbourhood of the railway which could suffer from electrolysis, therefore the case was difficult to meet. The *locus* was disallowed.

South London Tramways.—Without ceremony, the London County Council have opened a new section of the tramways which they are electrifying south of the Thames. This is the line from Camberwell-green which formerly extended *via* Kennington Church and Harleyford-road to Vauxhall Station. For the present the section between the Oval Station and Vauxhall cannot be opened, as the road widenings are not complete, but there is a double line on the conduit system from Camberwell-green to Kennington, and by means of the loop at this point the cars can join the main line in Kennington Park-road and run on to Blackfriars, Westminster, and Waterloo. On Wednesday morning there was a further extension of the Council's tramway system. A number of cars of the lighter type, intended for use over the cable section between Kennington-gate and Streatham-hill, were put on, and ran with but very few hitches. These cars will, it is understood, be used between Camberwell-green and Westminster, as well as over the cable route to which they have been adapted. They are smaller than the standard cars, and carry 56 instead of 66 passengers.

Deptford.—The General Purposes Committee have had under consideration a letter from the clerk of the London County Council referring to the suggested widening of Lewisham High-road, Loampit Vale, and Lee High-road, in connection with a proposal to construct a tramway from New Cross to Lee Green. The estimated total net cost of the street widenings contemplated by the scheme is £149,300. Of this amount the estimated net cost of acquiring the necessary property in Deptford is put at £6,500, whilst the cost of executing the necessary paving works in Deptford, excluding the cost of laying and paving the tramway track, is estimated at £2,200. The estimated cost of the Lewisham portion of the scheme is £128,800 for property and £11,800 for paving works, the total net cost of the scheme therefore being £149,300. The committee recommend that so far as concerned the portion of the route within the borough the Council give its consent to the construction of the tramway and agree to contribute one-third of the net cost, such contribution not to exceed the sum of £2,900, of the necessary street widenings and paving works.

Scarborough.—Mr. A. A G. Malet, Local Government Board inspector, conducted a local enquiry on Saturday into the application of the Corporation for sanction to borrow £3,500 in respect of the repaving of Westborough and Newborough, leading from the railway station to the market hall, and the aquarium top between the Valley Park and the south foreshore. The borough engineer (Mr. H. W. Smith) stated that the work of laying the electric tramways would commence on Oct. 1, and the private company who had the control of the undertaking would keep in repair from then the ground occupied by the system, together with 18in. on each side of the rails. The Corporation had finally decided, with a view to ascertaining the extent of the increase of traffic which would be brought about by the trams, that a less expensive scheme than at first fixed upon should be carried out—viz., the use of wooden setts for paving. On the aquarium top this was especially advisable, as it would deaden the noise of traffic at present penetrating into the underground theatre. The chairman of the Streets Committee and the chairman of the Streets Sub-Committee particularised the proceedings of those bodies in the matter, the former

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stating, in answer to the inspector, that the committee had not taken into consideration "wood-paving sore throat," which, Mr. Malet remarked, was becoming an evil of London streets. The inspector, after inspecting the thoroughfares in question, promised to report to his Board, who would intimate their decision in due course.

Pontypridd.—The consideration of the Pontypridd Tramways Bill by a Select Committee of the House of Commons presided over by Mr. Edward Bond was concluded on Monday. On the committee taking their seats the Chairman announced that the committee unanimously regarded the preamble as proved. Mr. Page, K.C., submitted a clause on behalf of the frontagers of Mill-street, whom he represented, providing that the proposed tramway should not be constructed unless and until the promoters should have satisfied the Board of Trade that the street was of sufficient width to allow of the working of the new tramways. The Chairman intimated that the committee could not introduce a proviso of that kind. Mr. Page next asked for a proviso stipulating that in working the tramway by this Act the Council or their lessees should not allow more than one tramcar or other vehicle used upon the tramway to be upon that portion of the tramway which would be situate between the junction of Mill-street and the proposed new street and Taff-street at any one time, and the Council or their lessees should for every breach of this enactment be liable to a penalty not exceeding £10. The Chairman said the committee thought it better to leave the protection of the inhabitants of Pontypridd to the joint action of the local authority and the Board of Trade. They thought that between the two authorities there would be sufficient protection. The clauses were then finally adjusted, and the Bill ordered to be reported for third meeting. A special meeting of the District Council has decided to apply to the Board of Trade for authority to give notice to the owners (the British Electric Traction Company) of the Pontypridd and Rhondda Valley horse tramways of their intention to purchase so much of the undertaking as is in the urban district.

London County Council.—Replying to a number of questions at Tuesday's meeting of the London County Council, Mr. J. W. Benn, chairman of the Highways Committee, referred to Lord Avebury's criticisms of the Council's tramway undertaking before the Industrial Freedom League, and said he was waiting for some responsible member of the Council to get up in the Council to say the things that Lord Avebury was saying to the league. He would then be happy to reply to him, or even to bring up a report upon the statements. Electric traction had not reduced the number of men employed to work the cars. The number of men employed under the old system was 547, and under the present 603. Horsekeepers, farriers, and workers in the granaries had been discharged, but many of them were found employment. Of the 154 men who had been discharged, 52 of the oldest servants had been re-engaged. It was not true that at the Penrose-street depôt they refused to engage a man over 35 years of age. The Improvements Committee submitted for approval a proposal for the execution of certain street widenings in South London in connection with a scheme for the construction of a new tramway from Camberwell-green to Lordship-lane. The thoroughfares proposed to be widened in certain parts are Denmark-hill, Champion-park, Grove-lane, Dog Kennel-hill, Grove-vale, and Lordship-lane. The gross cost of the improvement is estimated at £119,900, of which £78,900 represents the cost of acquiring property, and £41,000 the cost of the necessary paving and other works. The Camberwell Borough Council has consented to contribute one-third of the cost of the improvement within their district, but the Lambeth Borough Council has declined to adopt a similar course with regard to the portion of the improvement within their borough. It is accordingly proposed with regard to the improvements in Lambeth to charge one-half the cost to the improvement and the other half to the tramways account. The Finance Committee contend that the outlay in Lambeth could only be justified as tramway expenditure, and that the whole cost of the improvement should be charged to the tramways account.

Londonderry.—A report dealing with the tramway services was present at the last meeting of the Town Council, stating that in the report of Sir William Preece, adopted by the Council, it was stated that the additional cost of making arrangements to supply power to tramways, including the special feeder, did not exceed £1,000, and that the amount was included in his estimate. It would be of great service to the citizens if an extended system of tramway services at 1d. fares could be established in the city. Electric tramways would furnish considerable revenue for the power of which the Corporation had now a monopoly. Waterloo-place would make a convenient centre for the starting of the tramcars on the city side, and the Northern Counties Railway terminus would make a convenient centre for the starting of tramcars at Waterside. On the city side a line might be laid from Waterloo-place by the Strand-road, as far as Duncreggan-road, and from that point up Duncreggan-road, along Lone Moor-road to the junction with Lecky-road; one line returning to Waterloo-place by Lecky-road, Rossville-street, William-street, and another line returning to Waterloo-place by Bishop-street, Abercorn-road, John-street, Foyle-street, and Shipquay-place. There might also be from the Strand-road a line up Great James-street to the Brooke Park gate. From the Northern Counties Station trams could be run to the end of the bridge, round Spencer-road, along Clooney-terrace, and out Clooney-road as far as the city boundary extended, and back by Bond's-hill to the starting point. All these services could be managed, by means of places for passing, so that the cars could run in both directions. The citizens would be fairly well served with these lines within the borough, but the Council should, in the near future, endeavour to extend the tram services as far as Culmore, and Gallagh on the Donegal side of the river, and Enagh Lough and the Cross on the county Derry side. Such extensions of the tramway service, besides bringing traffic to the city, would enable the citizens to speedily reach the country, thus doing away to a large extent with the necessity for open spaces and park accommodation. It would have the further advantage of making the city spread and enabling the citizens to have their residences away from the centre of the traffic, while at the same time providing a speedy means of reaching their business. The question of whether a company should be allowed to take up the tramway services on terms to fixed by the Corporation or should the Corporation undertake the municipalisation of tramways should be discussed as soon as convenient, and it must be remembered that if Londonderry was to keep pace with the times, and if its property was not to be allowed to fall into decay, an extended tramway service at cheap fares was essential.

Birmingham.—At a meeting of the City Council to be held on July 7 a report will be presented by the Tramways Committee. The committee, in the first place, report concerning the steps to be taken by the Corporation to exercise its compulsory powers of purchase in respect of the tramway lines now owned by the City of Birmingham Tramway Company in Balsall Heath. The committee state that notice requiring the company to sell may be given within six months from July 12, and if not so given the power of purchase cannot be exercised for another seven years. The committee, therefore, recommend that the Council should pass the requisite resolutions under the Tramways Act, 1870, deciding to give notice to the company requiring them to sell to the Corporation so much of their respective undertakings under the said tramway orders as may be within the city, and that the committee should be instructed to take all such steps as they may consider requisite or desirable with respect to such notices, and to any arbitrations or other proceedings thereunder. The committee next report the correspondence which recently took place with the Aston Manor authorities, and also the proceedings successfully taken to defeat the application for compulsory running powers sought for in the Birmingham and District Tramways Bill. In this connection the committee placed on record the following passage from the speech on behalf of the Corporation of Mr. Balfour Browne: "I pledge myself to two things, and I will put in gentlemen from the Corporation of Birmingham who will pledge themselves, who will say that they are prepared, either at once or before the termination of the lease, to make all reasonable arrangements for the carriage of traffic where necessary into Birmingham without any change of car. I also ask them to pledge themselves to this—that they will, at the very earliest opportunity, as they intend to, equip those lines for electric traction, so that cars may be running continuously from the country round Birmingham into Birmingham and from Birmingham out into the country round." These pledges were confirmed by Mr. Alderman Beale and Mr. Alderman Cook in their evidence. The committee then report as follows regarding the appointment of a tramway manager: "In the opinion of your committee it is most desirable, having regard to the magnitude of the interests involved, to the arrangements which have to be made almost immediately for the working of the Aston tramways, and to the many questions constantly arising on which the advice of an experienced tramway manager is necessary, that such a person should be appointed forthwith. They find a difficulty, however, in asking the Council to fix the salary of such an appointment, as the persons possessing the requisite experience are few, and in all probability would not apply for the situation if advertised. Your committee are of opinion that the best way of securing the most efficient person would be for them to be authorised to make enquiries and, if they think requisite, to advertise for a manager, and to appoint the person they deem best qualified at such salary as they may, under all the circumstances, consider reasonable, having regard to the salaries paid for similar services in other large towns. The proximity of the autumn vacation and the desirability of avoiding delay obliges them to ask for this unusually wide discretion." No definite arrangement has yet been made for convening a conference of the Tramways Committee of the City Council and the representatives of the local authorities with the object of arriving at an agreement respecting the future working of the tramways in Birmingham and the outlying districts. It is believed, however, that the Tramways Committee will have an interview with the representatives of some of the neighbouring authorities next week.

LIGHTING AND GENERAL.

Aldridge.—The telephone exchange was opened on Monday.

Limerick.—The electric street-lighting was successfully inaugurated on Friday last.

Woolwich.—The Borough Council have fixed 4d. per unit as a general rate for the supply of current.

Gillingham.—The laying of a number of additional mains has been agreed to by the Urban District Council.

Lancaster.—The Town Council have obtained sanction to the borrowing of £225 for electric lighting purposes.

East Barnet Valley.—The Urban District Council have decided to obtain advice on the question of electric lighting for the district.

Mansfield.—The Electricity Committee have taken over the station as from June 24. The current was supplied gratis up to that date.

Wirksworth.—The district manager of the National Telephone Company has visited the town, and there is a prospect of a line being laid shortly.

Tonbridge.—The Guardians have asked the Tunbridge Wells Corporation to send an estimate of the possible supply of electric light to the workhouse.

Rotherham.—Another request is to be made to the National Telephone Company to provide better telephonic communication between Rotherham and Sheffield.

Slough.—The Urban District Council are in a quandary as to whether they may legally pay for goodwill in the event of purchasing their electric lighting order from the Slough and Datchet Electric Supply Company.

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Croydon.—The Council have approved a draft agreement with the London, Brighton, and South Coast Railway Company with reference to the passing of electric cables under the company's railway from Cornwall-road to Lower Church-street.

Northfleet.—The Board of Trade have decided to defer consideration of the question of revoking the Council's electric lighting order for one year from the 2nd inst. The Kent Electric Power Syndicate's engineer is to meet the Council on July 7.

Charing Cross and Strand Electricity Supply Corporation. Warrants for the dividend on the City undertaking 4½ per cent. preference shares, and for the interest on the 4 per cent. debenture stock of this Corporation, were posted on June 30.

Bedford.—A further loan of £6,960 has been obtained by the Corporation for the electric light works. Over £2,000 will be spent on a steam alternator, £1,556 for water-tube boiler, and the balance for extensions, cables, and house connections.

City of London Electric Lighting Co.—The following dividends on account have been declared: on the preference shares, Nos. 1 to 40,000, 6s. per share; on the ordinary shares, Nos. 40,001 to 110,595, 5s. per share. Warrants for the above interim dividends, less income tax, will be posted on July 14.

Whitehaven.—The Guardians have decided that both the infirmary and the workhouse be lighted with electricity instead of gas, and that an arrangement be made with the Corporation of Whitehaven to supply electricity at the rate of 6d. per unit, subject to the sanction of the Local Government Board.

Stockton.—The two electric motors which have been installed at a cost of £365 at the Corporation quay to drive the elevator hoists and other machinery in the transit shed and grain warehouse were formally started on Friday morning last by Councillor F. Raines, chairman of the Quay Committee.

Metropolitan Asylums Board.—The Managers have adopted a proposal from the County of Surrey Electrical Power Distribution Company to supply current to the Southern Hospital at the rate of 3d. per unit. It will be necessary to provide a small sub-station to contain the distributing apparatus.

Hammersmith.—The last report of the Electricity and Lighting Committee states that 13 additional consumers have been connected, representing a maximum of 298 8-c.p. lamps; that nine consumers have been disconnected; and that the total number of consumers now taking current from the mains is 1,268.

Malton.—The Urban District Council, after considering a letter and report from the Northern Counties Electric Supply Company, have decided to ask the Board of Trade to direct the company to carry out the terms of the order granted them within a reasonable time, or otherwise to revoke the order.

New Book.—Messrs. Whittaker and Co. will shortly publish "Whittaker's Electrical Engineers' Pocket-Book," edited by Kenelm Edgcumbe. The sections in this volume have been written by experts, and will contain information which will meet the requirements of the various branches of electrical engineering.

Huddersfield.—The borough electrical engineer's last report gives the following figures: number of consumers—June 1,785, May 1,768, increase 17; lamps connected—June 123,821, May 123,172, increase 648; units metered—May 125,275, corresponding period last year 69,709, increase 55,566, equals 79 per cent.

Halifax.—Major C. E. Norton has held an enquiry into the Corporation's application for sanction to borrow £20,000 for the extension of their electric light undertaking and £3,970 for street improvement. Mr. W. M. Rogerson, the electrical engineer, explained that the £20,000 required for his department was principally for mains.

Dublin.—In response to an appeal issued by Trinity College for assistance to build and equip laboratories and lecture rooms for physical science, electrical and technical engineering, botany, and zoology, Lord Iveagh proposes to provide a capital sum of £30,000 as soon as a sufficient amount has been raised to produce an annual outlay of £2,730 per annum.

Willesden Polytechnic Electrical Engineering Society.—On Thursday last the society visited the private electric lighting installation of Messrs. C. M. Martin and Co., Limited, at Stoke Newington. The arrangement of engines and dynamos and the special methods of switching proved of great interest to the members, and the visit proved in every way a most instructive one.

Coventry.—Mr. J. A. Jeckell, the manager of the Corporation electricity works, was congratulated at Tuesday's meeting of the City Council on the improved position of the undertaking. It was explained that the charge upon the rates this year was only £189, whereas it has usually amounted to about £1,700 per annum. The improved result had been brought about largely by economies effected at the works.

Wimbledon.—The financial statement of the electric light undertaking for the year ended March 31, 1903, shows that after providing for repayment of principal and interest, and putting £500 to reserve, there is a sum of £1,527 to be applied to the reduction of the rates. In the first year there was a loss of £250, in the second £1,040, and since then the balances have been on the right side—namely, £134 in 1901, £1,357 in 1902, and now £1,527 as stated.

Leeds.—The revenue of the electric department of the City Council for the financial year ending March 25 was £231,734, as compared with £178,422 in 1901-2, showing an increase of £53,312. To this increase light contributed £34,537 and power £18,775. The average price obtained per unit was 3·02d. in 1902-3, as compared with 3·56d. in 1901-2. The total expenses per unit (including interest and sinking fund) were 2·95d. per unit, as compared with 3·31d. in 1901-2.

Sale of Business.—Messrs. Moores, Farrell, and Co., Mynshulls House, Victoria-street, Manchester, have purchased the goodwill of the business of electrical engineers heretofore carried on by Messrs. Wilson and Orr at Ellesmere Electric Works, 46, Ellesmere-street, Cornbrook, Manchester. They have engaged Mr. Wilson to act as manager of the works, where they will manufacture switchboards, switches, fuse boards, watertight fittings, and general electrical accessories.

Aston.—The electrical generating station, which was commenced a little more than a year ago, is rapidly approaching completion. The total cost, with the expense of the cables, has been £65,000. The plant consists of two 500-kw. engines, one 250-kw. engine, and six boilers. The latter are fitted with mechanical stokers. Up to the present about 10 miles of cables have been laid for lighting purposes. The date of the formal opening of the generating station has not yet been fixed.

Stourport.—The Shropshire and Worcestershire Electric Power Company, who have acquired a site for a station in the district, intend to apply for a provisional order to supply electricity in the Council's district. They have informed the Urban District Council that they did not wish to be hostile to the Council, and if the Council wished to obtain an order themselves they would be willing to supply electricity in bulk to them. The matter is before the General Purposes Committee.

Headlights.—It is reported that the Canadian Pacific Railway has equipped 100 engines with a new type of electric headlight, and very shortly all passenger engines will be similarly equipped. The lamp, in addition to sending a powerful ray along the track in front of the engine, also projects a powerful vertical beam. The latter makes a very decided illumination in the sky, whereby it is possible to detect the presence of an engine, follow its path, and determine which way it is heading.

Swansea.—In an analysis of the second year's accounts, and already noted by us, Mr. Prussman (electrical engineer) states that the total cost per unit works out this year at 1·48d. as against 1·72d. last year, or a decrease this year of 0·24d. per unit. The works costs work out at 1·06d. per unit, as against 1·02d. per unit last year. All items in the works costs show a decrease except those of wages and materials on repairs, maintenance of buildings, plant, instruments, etc., and those of public lamps.

Stock Exchange Settlements.—The Stock Exchange Committee have ordered Primitiva Gas and Electric Lighting Company of Buenos Ayres, Limited, further issue of £25,000 4 per cent. first debentures of £100 each, Nos. 5,251 to 5,500, to be quoted in the official list. Application has been made to the committee to appoint a special settling day in and to grant a quotation to County of London and Brush Provincial Electric Lighting Company, Limited, £250,000 4½ per cent. second debenture stock.

Larne.—The Urban District Council have asked the Larne Electric Light Company to reduce their last prices under which they offer to supply current for public lighting. For lighting the incandescent lamps only in the evening the company tendered £399. 13s.; for morning lighting of the incandescent lamps the tender was £43. In the tender the total for morning and evening lighting of the incandescent lamps was £442. 13s., or an increase of £75. 3s. The total cost of the arc lamps was to be £173. 10s.

Barnstaple.—Application is to be made to the Local Government Board for the balance of £27,000 lighting loan previously asked for. The Town Council have agreed that on receipt of the specifications for lighting the music hall from Mr. Trentham, if the specifications are adopted, and if it is decided to light the hall with electricity, tenders for the work should be invited. The Mayor, with Messrs. Brown, Richards, Lindsley, and Andrew, have been appointed a committee to consider a new system of keeping the electric lighting accounts, and report to the Council.

Battersea.—The electrical engineer estimates that the cost of providing the necessary fittings for the whole of the houses on the Latchmere estate, including the 16 houses to be erected on the west side of Matthews-street, will be £1,920. 12s. 6d. Up to the present time the whole of the 79 applicants for the tenancy of the houses desire to use the electric light. Arrangements are to be made for the work of providing electric light fittings in the houses where required, to be proceeded with as soon as possible in accordance with the estimate prepared by the electrical engineer.

Islington.—The Lighting Committee have reported to the Council with reference to the reported intention of the Holloway Electric Supply Company to supply the new Marlborough Theatre by means of overhead wires crossing Holloway-road, that they were not aware that the said company had any statutory powers to supply electricity within the Council's area. Without such powers, to do so would be illegal, while the proposed overhead wires would be contrary to the Overhead Wires Act. In consequence the London County Council will be informed the Council strongly oppose the project.

Wallasey.—The Electricity Committee have decided to alter their charges for electric current from 5d. to 6d. per unit, subject to a reduction of 2d. instead of 3d. per unit for all supply above two units per quarter for each 8-c.p. lamp, while 16-c.p. lamps must consume four units per quarter before the reduction of 2d. comes into effect. For meter rentals the reductions are as follows: for 1 to 15 lamps of 30 watts (8-c.p.) each from 2s. to 1s. 4d. per quarter, 16 to 30 lamps 2s. 3d. to 1s. 6d., 31 to 75 lamps 3s. 3d. to 2s. 2d., 76 to 150 lamps 5s. to 3s. 9d., 151 to 200 lamps 7s. 6d. to 5s. 8d., 201 to 300 lamps 11s. to 8s. 3d.

Potchefstroom (South Africa).—There is considerable interest being manifested by the ratepayers of Potchefstroom in regard to the lighting of the town. Offers to do this had been received from Johannesburg firms, but the matter was adjourned *sine die*. The ratepayers, however, have expressed themselves as dissatisfied with this, and several prominent traders have ordered complete plants of

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their own. The Health Board have, as a result, brought up the matter again, and will consider the advisability of granting a concession for lighting the whole town and military cantonment.—*South African Exports.*

Croydon.—The electric lighting plant at the lunatic asylum just erected by the Corporation at Chelsham consists of two of Messrs. Belliss's non-condensing engines, dynamos, and booster set, laid down by Messrs. Mavor and Coulson, of Glasgow. The storage battery was supplied by the Chloride Electrical Storage Company, of Manchester, and the switchboard by Messrs. Frank Suter and Co., of London. The wiring was executed by Messrs. Wenham and Waters, Limited, of Croydon, and the total cost of the electric lighting arrangements was £6,000, the total cost of the asylum being close on £225,000. Mr. E. G. Rivers, A.M.I.C.E., acted as consulting electrical engineer.

Ripon.—At the last meeting of the City Council a letter was read from the Board of Trade pointing out that the Ripon Electric Lighting Order, 1901, did not contain any provision enabling the Corporation to transfer the undertaking to a company. The period within which the compulsory works specified in the order should be completed would not expire until July 26, and the order would remain in force until it was revoked by the Board of Trade. If the Corporation were able to satisfy the Department that they intended to take steps to carry out the compulsory works at an early date, the Board would be prepared to consider whether the revocation of the order might be postponed for a period.

Electric Cranes.—Official trials were made last week of the two new electric cranes which have just been installed by the Dover Harbour Board. These cranes, the equipment of which has cost £11,000, are exceptionally large and powerful, and have been constructed to the design of Sir William Preece and Messrs. Siemens. They are built so as to command both sides of the Admiralty Pier, and are to be used for the transhipment of mails and baggage in specially-built crates capable of containing 2½ tons. Under the new system, which came into operation on July 1, the usual Custom House delay will be saved, as the crates will be loaded up in London and Paris and carried straight through to either capital. Electrical cranes have also been erected at Calais, and the mail steamers have been specially altered for the shipping of the crates.

Oldham.—The new Corporation electricity station at Greenhill, Oldham, was opened last week by Mr. Alderman Harrop (chairman of the Electricity Committee). This new station was required owing to the increasing demands made upon the Rhodes Bank station for current, both for lighting and traction purposes. The engine-room, when full, will accommodate plant of 10,800 h.p. The present instalment gives 6,000 h.p., and 4,800 h.p. can be added without additional buildings; when required, it is proposed to add a third bay to the engine-room to contain four 2,500-h.p. sets. If the buildings are extended according to the present proposals the total capacity of the complete station will be approximately 20,000 h.p. When full, the boiler-house will contain 16 dry-back marine boilers and four vertical "Climax" boilers. The estimated cost of the station is about £156,000.

Launceston (Tas.).—We understand that the contract for the reconstruction of the electric light and power transmission plant for Launceston, Tasmania, has been placed with Messrs. Witting, Eborall, and Co., Limited, of Temple Bar House, London, E.C. This contract comprises the supply of four Francis type turbines of 445 b.h.p. each, these turbines being direct coupled to 300-kw. three-phase generators giving a terminal pressure of 5,000 volts; also high and low tension switchboards in generating station and sub-station, together with separately driven exciters, motors, transformers, and material for the overhead transmission line. The plant previously in use consisted of 100-kw. single-phase alternators giving 2,000 volts. The reconstruction of the present plant is being carried out by Messrs. Witting, Eborall, and Co., Limited, of Temple Bar House, to the specification of the Launceston city electrical engineer, Mr. William Corin.

Tipton.—At the last meeting of the District Council, Mr. Foster (solicitor) made a lengthy statement in reference to the dispute which had taken place between the Council and the Midland Electric Corporation in reference to the supply of electricity for lighting purposes. He remarked that there had been a prospect of costly litigation, but efforts had been made to find a *modus vivendi* between the Council and the Electric Corporation, with a result which he thought was very satisfactory. Under the terms of the new agreement, the Electric Corporation would pay to the Council a lump sum of something like £600, the whole of the costs incurred during the last three years, including those in connection with the promotion of the provisional order, the Board of Trade enquiry, and the preparation of the agreement. The Electric Corporation would pay to the Council £50 for the ensuing year, £150 per annum for the next two years, and £200 for the remainder of the 21 years; also 30s. per week for a meter inspector. A resolution approving of the seal of the Council being attached to the agreement was adopted.

Private Bills in Parliament.—Sir Robert Gunter's Select Committee on Wednesday gave their decision on the Walton-on-Thames and Warmley provisional orders. In each case the Urban District Councils were seeking confirmation of Board of Trade orders to supply electricity for lighting purposes within their districts, and they were opposed by the local gas companies, who objected, as contributories to the rates, to being called upon to contribute towards any loss which might arise from a form of competition directed against themselves. Mr. Balfour Browne, K.C., and Mr. Paddon each asked, on behalf of the gas companies, that a clause should be inserted to the effect that after the first year's working the undertakers should have a proper balance-sheet laid before them, and they should then fix such a charge (up to the maximum allowed by the Board of Trade) to consumers so that, as far as possible, the revenue of the year should balance the expenditure. After consultation, the committee passed the preamble of the Bill, and inserted a modified provision to the effect that such a balance-sheet should be made out after the first three years' trading, and that then the charges should be adjusted.

The Clifton-Oaksford Reproducer.—Last Friday we had the opportunity of witnessing an invention by Mr. Bert Oaksford, Peveril Drive, Nottingham, which will revolutionise the gramophone market. The improvement centres mainly in the flexible arm which carries a small sound-box, and which is pressed on the cylinder. This allows the stylus to follow the impression of the sound-waves, both vertically and with a rocking kind of movement. As a consequence, the bass notes, which are represented by the top of the wave curve, come out in their full value. The stylus is enabled to get clear of the vibration without shock and without tearing through it, and as soon as one vibration has passed, the sound-box springs back to meet the next. At Friday's demonstration two instruments were used, one of which only was fitted with Mr. Oaksford's invention, and the difference between that and the ordinary gramophone was most marked. There was a total absence of the usual tinny, squeaky sounds, and the full harmony of both vocal and instrumental music was reproduced to its fullest extent. In fact, it was quite pleasant to listen to the instrument even standing close to the receiver, which is saying a great deal.

Portsmouth.—On Friday, the King's birthday, the municipal telephone system was generally inaugurated by the Mayor (Sir W. T. Dupree), who subsequently entertained a company of about 100 to a sumptuous banquet in his apartments in the town hall. During the evening congratulatory messages were telephoned by Bailie Alexander, chairman of the Glasgow Telephone Committee, from Bournemouth and Brighton, and from the various councils of the districts served by Portsmouth. The installation was decided upon in 1900, and the construction took place in the summer and winter of 1902. Customers were speaking in October last, and already the committee finds itself unable to join up more subscribers, as the original estimate of £25,500 for 1,240 lines has been exhausted. Considerably more than originally planned, 1,000 lines have been connected up in the borough and over 150 in the surrounding district, which is served by aerial lines, while in the town the circuits are underground in cable, and distributed by overhead wires—24 to 36 on a pole. The Town Council has already authorised the Telephone Committee to borrow an additional £12,000 to raise the number of lines on the exchange to 2,000, and the actual work of extension is already in hand. The charges are £5. 17s. 6d. a year (unlimited use), £3. 10s. and ½d. toll, £2. 10s. and 1d. toll. Last month the profit was about £80 after all expenses had been met, and with an increasing income from tolls better results are confidently anticipated.

Colchester.—Application is to be made for sanction for the borrowing of the following amounts, in addition to the loan of £7,000 for which application has already been made—viz.: main extension, Lexden Village, £123; ditto, Butt-road, £70; ditto, Meyrick-crescent, £50; rewinding armature of H.B. 27-40 dynamo for traction purposes, £110; additional lifting gear, £60; contingencies, £17. 5s.—total, £430. 5s. The following statistics were contained in Mr. Sillar's last report: output of electricity in units during May, 1903, 17,825; number of consumers at end of May, 358; total number of 8-c.p. lamps connected, 22,732. The committee have reported consideration of two alternative schemes for extending the electric light mains to North-hill, North Station-road, and Bergholt-road. The scheme upon which they had decided provided for a feeder of sufficient size to supply 3,600 lamps; this would be continued to a point 1,900 yards from the electricity works, and would be linked to the network at the North Station railway bridge. Arrangements would be made for connecting a main in Myland-road when it should be laid, and for carrying a distributor for a distance of 1,150 yards up the Bergholt-road. The cost of the scheme would be £1,863, and the committee had resolved to defray this out of the £2,750 for main extensions in the loan of £8,500. The committee added "they were satisfied that the probable revenue to be derived will justify the expenditure."

Uganda.—A Reuter's telegram from Mengo dated April 28 says the extension of the telegraph system has been pushed on rapidly during the last six months, and now the line is open to Butiaba, on the shore of the Albert Nyanza. A branch line has been built to a place called Masinde, in Unyoro, a distance of some 50 miles from the main line. On all these extensions there is no extra charge, thus the mileage open for traffic now in Uganda is as follows: Mombasa to Port Florence, on the Victoria Lake, 584 miles; Port Florence to Kampala and Mengo, temporary line, 200 miles; Kampala to Entebbe, 25 miles; Entebbe to Albert Nyanza, 175 miles; Hoima, Unyoro, to Masinde, 50 miles—total, 1,034 miles. The charge over the whole of this distance is 2d. a word, with a minimum of 1s. 4d. for a message of eight words. There is also a system of telephones along the whole distance, so that traders and travellers may use the line when necessary at the charge of 1s. 4d. per conversation. These telegraph lines are called "temporary," but as they are constructed of bark cloth tree (a species of fig tree), and as these have extrordinary powers of germination, all the telegraph poles are now living trees, and should be almost equal in point of duration to iron poles, as the fig tree is a long liver. It is a novel sight to the traveller to see a line of telegraph poles in full blossom. Mr. H. W. Tyler is the person responsible for this great activity in the telegraph extension, and the Government have recently given him a permanent appointment on the staff of the Proctectorate as assistant superintendent.

Gravesend.—The resident engineer has prepared the following report on the question of supply to workmen's cars. He states it will be necessary to run one of the large generating sets to give current for this purpose. This will prove most uneconomical, and result in a loss instead of being profitable. There are three ways in which this could be avoided: (1) By installing a traction battery, a course under present circumstances he should not recommend. (2) By purchasing a small set, about 25 kw., sufficiently large to undertake the supply of lighting

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during the early morning, leaving the present battery to supply the trams. The cost of this set would be about £500. This method should be the cheapest way out of the difficulty, but there is always the possibility that the lighting load during those hours may grow beyond the capacity of such a set. (3) Purchasing a set about 80 kw. to 100 kw. at a cost of, say, £1,250, which would run the traction load from 5 a.m. until about mid-day. This set also run in parallel with one of the large generators would give the tramway company all the current they are at present entitled to. At present two large sets are run in parallel at week ends, and the load is such that both sets are working uneconomically. He is of opinion that this would be the most satisfactory method to adopt, having consideration to the future working of the undertaking as well as the present used. The electric lighting of the technical school is under consideration, also plans of a scheme for automatically fitting coal store and delivering from store to boilers. It is proposed that application be made to borrow the following amounts: Babcock and Wilcox, work on temporary shaft and circulating pipes, £409; Western Electric Company, Limited, additional tramway feeder, £533. 5s. 11d.; pilot wires, £66. 3s. 11d.; general mains, extras, £470. 10s. 2d.—£1,479.

Burnley.—The Electricity Committee have resolved that, subject to the approval of the Council, a new engine and dynamo, of 250 kw. capacity, be purchased and erected at the electricity station at an estimated cost of £4,000, and that new generator panels be added to the traction switchboard at an estimated cost of £105, and that the Council be recommended to instruct the town clerk to apply to the Local Government Board for sanction to the borrowing of £9,606. 7s. 8d., made up as follows: extension of buildings, £198; machinery, £8,790. 8s. 8d.; and main (Trafalgar-street), £617. 9s. The proposed new 250-kw. set is required in order to meet the increased demands for electrical power. The maximum demand for lighting during last winter (1902-3) was 413 kw.; it is practically certain that next winter the maximum will rise to 460 kw., and during each of the two following winters a like rise of 50 kw. may be expected. To meet this demand, the present machinery can give a maximum lighting output of 680 kw., allowing no margin for "stand-by." None of 1, 4, and 5 generators are now available for the production of power for traction, but it is proposed, by adding generator panels to the traction switchboard, to make No. 1 generator available for either lighting or traction. If the demand for energy for lighting purposes rises, as anticipated, to 560 kw. during the next three years, there will be barely sufficient power to meet that demand with No. 1 generator in reserve for both lighting and traction. The Tramways Committee have informed the electricity department that power should be provided for the running of 46 cars on the main and branch tramways. The committee reckon a less consumption of power than 15 kw. per car, therefore the department should be able to meet a traction demand of 660 kw. The present plant will give a maximum output for traction purposes of 500 kw., without any stand-by margin. This is clearly insufficient. This plant capacity may be increased, as already stated, by making No. 1 generator available for traction as well as lighting, but even if this be done the maximum traction capacity will amount to 600 kw. only, with nothing in reserve, and it must be remembered that the lighting reserve of 100 kw. is absorbed also.

Londonderry.—The Private Electric Light and Power Committee have received a report on electric motive power, free wiring, etc., in the city. The report on electric motive power stated that each brake horse-power supplied continuously for 50 hours per week and 50 weeks per annum would consume 2,000 units, which at 3d. per unit would cost £25. This price would be charged on the assumption that the full power was used continuously throughout the whole time, whereas there was practically not a single instance in connection with any industry requiring power where such conditions were fulfilled. It was reasonable to assume the motors connected in Londonderry would be working under somewhat similar conditions to those elsewhere when the cost per annum of 50 weeks at 50 hours per week at the rate proposed would be 1 b.h.p., £8. 6s. 8d.; 5 b.h.p., £41. 15s. 4d.; and 10 b.h.p., £83. 6s. 8d. The cost per annum for all sizes of motors would be in proportion. With regard to free wiring, the term was intended to convey that the wiring was carried out free of all initial cost, a rental being made instead. Such a system should certainly be arranged in Londonderry to encourage those who were reluctant to provide the necessary capital. In many towns companies had carried out the work, and their method of securing the interest on their capital expended and profit in each installation was based on the actual number of units of electricity consumed, a certain rate averaging 1d. per unit being made for the use of the wiring and fittings. Where the electrical supply, as in Londonderry, was in the hands of the Corporation, it was responsible for the collection of the free-wiring rent, and handing it over to the company. Such a system of charging was exceedingly simple, but was not on a fair basis, as the long-hour consumer, who was the most desirable class of customer, was charged a higher rate of rental for his wires and fittings than his less profitable neighbour. The average cost of wiring a 16-c.p. lamp was £1. But it is proposed that the rental of wiring and fitting should not be base on the number of units, but on the number of lamps, or on the capital expended under a buying-out system, whereby the rate should include interest on capital plus the amount necessary to repay the capital over a short term of years, when the wire and fittings would become the property of the consumer. Over a term of five years the annual rental per lamp installed would amount to 4s. 8d., which allowed for the repayment of principal with interest. The reports are to be printed and considered at the next meeting of the Council.

St. Marylebone.—The Electric Supply Committee reported at the last meeting that the London County Council had resolved not to grant the application made by the Borough Council for sanction to the borrowing of the amount required for the purchase of the electricity undertaking under the terms of the umpire's award without further statutory authority being given to the Borough Council authorising it to borrow for electric lighting purposes. Mr. Asquith had said that if "the County Council proves to be unable or unwilling to assent, I think the Borough Council should apply for a license, under Section 2 of the Act, to the Board of Trade, which, under the very exceptional circumstances of the case, would probably be disposed to grant the application." Mr. Fletcher Moulton advised that, if the London County Council refused its consent to the loan, an appeal should be made to the Local Government Board, and that the aid of the Board of Trade should be invoked. The committee stated that an appeal to the Local Government Board would mean an appeal for the reversal of the decision of the London County Council, and possibly a local enquiry; application to the Board of Trade for a license to supply electricity would not involve an appeal against the London County Council, but the license, if granted, would remove the difficulty, the existence of which was the reason given by the London County Council for refusing consent to the loan. The committee had also considered the further opportunity of applying to Parliament next session for the necessary statutory power to borrow the amount required. Although the obtaining of an Act of Parliament and complying with the Borough Funds Act would be troublesome, they thought there would be some important advantages to be gained by such procedure. They might secure a longer period for the repayment of the loan, and the price at which they were authorised to supply could be varied, and many other useful powers could be provided for in such a Bill. The great objection to this on the part of the company is the delay, and it is on account of the Council's delay in completing that the company is proceeding with their action for specific performance. In conclusion the committee said: "Having regard to the legal advice we have received, and to the fact that we may shortly have to satisfy the courts that we are not merely doing our best, but taking all proper measures possible, and also that the delay in completing the purchase is causing serious injury to the goodwill of the business, we think there should be no unnecessary delay waiting for the decision of either Government department, and that the application for a license and the appeal from the County Council's decisions should be made simultaneously." Resolutions authorising these steps were carried, also another providing that the town clerk take steps to promote a Bill in Parliament in the event of the Government department not communicating their decision by the end of September.

Manchester Electricity Works.—The statement of the accounts of the electricity department for the year ended March 31 has now been published. The accounts show that the revenue derived from the sale of current, etc., amounts to £197,169, and the working expenses to £112,316, leaving a gross profit of £84,853. Out of this sum the following requirements had to be met: interest on mortgage debt, etc., £43,561; sinking fund, £28,070; instalment of loan repayable to the Public Works Commissioners, £4,907—£76,538; resulting in a surplus of £8,315. This surplus has been carried to the reserve fund, which now stands at a total of £25,077. During the period under review formal sanction was given by Parliament to the Manchester Corporation General Powers Bill, 1902, which contained clauses authorising the construction of Stuart-street railway, bridges to connect Dickinson-street and Bloom-street works, and subways for cables; also empowering the Corporation to raise the sum of £75,000 in connection therewith. The total borrowing powers at the present date amount to £2,246,121. The past year has seen the completion of the buildings at Bloom-street station and the erection of the four 3,500-h.p. generators. The total capacity of this station is 14,000 h.p. At Dickinson-street station four belt-driven sets, each of 400 h.p. capacity, have been dismantled and sold. On the space set at liberty there have been erected two turbo-generators, each of 3,000 h.p., and by this alteration the capacity of the station has been increased from 11,800 h.p. to 16,200 h.p. The committee are pleased to report that the work in connection with Dr. Kennedy's installation of 15,000 h.p. at Stuart-street station and the 10 sub-stations in conjunction therewith has been pressed forward with all dispatch during the past 12 months, with the result that very excellent progress has been made, and the whole equipment is now rapidly approaching completion. Although very large increased demands have been made during the past 12 months for supplies of electric energy, notably in connection with the tram service, the committee, in consultation with Dr. Kennedy, undertook to be in readiness to supply the Tramways Committee with current for working the cars on the southern routes on Nov. 30 last, and for the Ashton-road and Oldham-road routes on March 31, 1903. It is gratifying to record that these engagements were fulfilled on the dates arranged, and the cars commenced running accordingly. Steady progress is being made with the work in connection with the additional installation of the 12,000 h.p. at Stuart-street station and the various sub-stations. A statement of the quantity of electricity generated and sold since the commencement of the undertaking, shows that in the year ended March, 1895, the number of units generated was 1,277,507, and that 1,168,382 units were sold. In the year ended March, 1903, there were generated 22,198,241 units, and 19,400,223 units were sold. There were 6,836 meters in use on March 31, 1903. The total capital expenditure on land, works, etc., has been £1,713,627. The average price obtained per unit for electricity in the year ended March 31 was 2·68d. There has been a gradual decline in the price since the year 1893-4, when it was 5·57d. per unit.

Isle of Thanet.—Messrs. Handcock and Dykes, in a supplementary report, point out that the Isle of Thanet Tramway and Lighting Company's proposition was on a different basis entirely from those last considered by the committee, inasmuch as under their proposition the Corporation would not have now to raise a loan. They say this offer might be considered from two points of view: (1) that of the consumer of electricity, and (2) that of the general body of ratepayers. From the general consumer's point of view it should be noted (say the experts) that under the Thanet Company's proposition—

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viz., to charge 6d. per unit the first two hours and 2½d. afterwards—the general body of consumers would probably pay 6d. a unit, as it is found in practice that the average consumption of electricity per lamp, taken over the whole kingdom, varies from 11 to 25 units per annum, which corresponds to an average use of from one hour to just over two, so that practically the ordinary consumer would never come on to their reduced rate. Messrs. Handcock and Dykes, assuming an average of two hours' use a day, and, secondly, an average of four hours' use a day, say the Thanet Company's proposition is inferior to those of Messrs. Edmundson and the National Electric Wiring Company. Turning to the question of this offer as it affects the general body of ratepayers, the experts find that there would be in the initial stage no difference between them, as, whether the Corporation accepted this offer or that of Messrs. Edmundson or the National Electric Wiring Company, either scheme would be free of expense to the town, as in the first case the money would be found by the Thanet Company, and in the second case, although the money would be borrowed by the Corporation, yet the interest and sinking fund would be guaranteed either by the company undertaking the work or by an approved assurance company. Assuming, however, that the Corporation wished to take over and work the undertaking themselves, under the Thanet Company's revised offer they could take over the mains at the end of 10 years at the actual cost to the company, plus a premium of 15 per cent., or at the end of 21 years without extra payment; but in both of these cases the Corporation would have to face the problem that they would possess no station of their own, and would then have to raise the money themselves, put down a new station, organise a staff, and undertake the generation of current, whereas, under the other two offers, at the same period, they would take over not merely the mains, but a complete station, which had been working for a number of years, which had a staff used to the work, and on which a large proportion of the capital cost had been already repaid. The experts consider the latter position a far superior one. Turning to Messrs. Edmundson's revised offer, it would appear that they were prepared to reduce their price from 7d. for the first hour and 4d. for the second to 7d. and 3d., as compared with 7d. and 2d. offered by the National Electric, and, further, that if the Corporation terminated the agreement at the end of 10 years the premium would be 5 per cent., instead of 10 per cent. as at first specified. The experts are of opinion that absolutely no financial liability would be incurred by the Corporation in the acceptance of either the offer of the National Electric or Edmundsons. They are of the opinion that by the time the Corporation took over the works they would find themselves in possession of a remunerative undertaking, which should prove a valuable asset to the town. Assuming, however, the very worst aspect of affairs, the Corporation would not take over the order until the termination of the agreement, by which time the whole of the loan would have been repaid, and the works would fall in relieved of all charges for interest and sinking fund, and without the Corporation having to pay a single penny. The experts consider that the keen competition among so many companies, whose directors are shrewd business men, to obtain control of this provisional order is a proof that the impression is that this electrical undertaking in Ramsgate will soon be a financial success. The matter is to be further discussed at a special meeting of the Council.

PROVISIONAL PATENTS, 1903.

JUNE 22.

13911. Improvements in automatic electric circuit breakers. Arthur Bernard Reynders, Carl Bennett Auel, Robert Donald Thain Alexander, and John Rudolph Spurrier, Westinghouse-building, Norfolk-street, Strand, London.

13912. Improvements in magnetic holders-up for drills and the like. William Henry Allen, Richard William Allen, and Charles Cæsar Hawkins, 24, Southampton-buildings, Chancery-lane, London.

13391. Improvements in secondary batteries. Lothar Fiedler and Frederic Julius Gerard, 22, Southampton-buildings, Chancery-lane, London.

JUNE 23.

13937. Therapeutic electromagnetic and faradic healer. Frederick Courtenay Fisher, 64, Hampton-park, Redland, Bristol.

13945. An improved electrical motor starting switch. Ughtred Horsfall, Joseph Crowther, and Thomas Cardwell Wild, all trading as "The New Contact Controller Company," 1, North-parade, Parsonage, Manchester.

13970. Improvements in indicator jacks for telephone switchboards. William Aitken, Beachcliff, Sandon Promenade Egremont.

13971. Improvements in telephone exchange systems. William Aitken, Milton-road, Edge-lane, Liverpool.

13973. Improvements in and relating to electric recording instruments. David John Steele and Charles Kratt, 75, Waterloo-street, Glasgow.

13903. Improvements in induction coils. John Splitdorf, 56, Ludgate-hill, London. (Date applied for under Patents Act, 1901, April 8, 1903, being date of application in United States.) (Complete specification.)

13992. An improved electric sparking plug for internal-combustion engines. Hugo Hirst and Herbert John Coates, 71, Queen Victoria-street, London.

14021. Improvements in galvanic batteries. Paul Brandt, 6, Lord-street, Liverpool. (Complete specification.)

14028. Improved process and apparatus for the production of metals of the alkali group and alkalies by electrolysis. Edgar Arthur Ashcroft, 111, Hatton-garden, London.

JUNE 24.

14062. An improved electrical cash-checking machine. Edgar Guess, 31, Tasman-road, Clapham, London.

14067. Improved automatic reversible dynamo to give a constant voltage irrespective of speed. Alec Gavan Inrig, Calydon, Goldworth-road, Woking, Surrey.

14079. Improvements in controlling systems for electric motors. The British Westinghouse Electric and Manufacturing Company, Limited, Westinghouse-building, Norfolk-street, Strand, London. (The Westinghouse Electric and Manufacturing Company, United States.)

14106. Improvements in electrically-operated ventilators. Herbert John Haddan, 18, Buckingham-street, Strand, London. (The Bergmann Electricitätswerke Aktiengesellschaft, Germany.) (Complete specification.)

14107. Improvements in and relating to electrically-operated lifts. Arthur Henry Adams and John Thomas Moulds, 11, Southampton-buildings, Chancery-lane, London.

JUNE 25.

14163. Improvements in apparatus for electric lighting. Frederick William Le Tall, Westinghouse-building, Norfolk-Strand, London. (The Cooper-Hewitt Electric Company, United States.)

14164. Improvements in gas or vapour electric apparatus. Frederick William Le Tall, Westinghouse-building, Norfolk-street, Strand, London. (The Cooper-Hewitt Electric Company, United States.)

14165. Improvements in gas or vapour electric apparatus. Frederick William Le Tall, Westinghouse-building, Norfolk-street, Strand, London. (The Cooper-Hewitt Electric Company, United States.)

14166. Improvements relating to gas or vapour electric apparatus. Frederick William Le Tall, Westinghouse-building, Norfolk-street, Strand, London. (The Cooper-Hewitt Electric Company, United States.)

14167. Improvements in systems of electrical distribution. Frederick William Le Tall, Westinghouse-building, Norfolk-street, Strand, London. (The Cooper-Hewitt Electric Company, United States.)

14168. Improvements in systems of electrical distribution. Frederick William Le Tall, Westinghouse-building, Norfolk-street, Strand, London. (The Cooper-Hewitt Electric Company, United States.)

14169. Improvements in systems of electrical distribution. Frederick William Le Tall, Westinghouse-building, Norfolk-street, Strand, London. (The Cooper-Hewitt Electric Company, United States.)

14170. Improvements in starting means for gas or vapour electric apparatus. Frederick William Le Tall, Westinghouse-building, Norfolk-street, Strand, London. (The Cooper-Hewitt Electric Company, United States.)

14171. Improvements relating to gas or vapour electric apparatus. Frederick William Le Tall, Westinghouse-building, Norfolk-street, Strand, London. (The Cooper-Hewitt Electric Company, United States.)

14172. Improvements in systems of electrical distribution. Frederick William Le Tall, Westinghouse-building, Norfolk-street, Strand, London. (The Cooper-Hewitt Electric Company, United States.)

14173. Improvements relating to breaking and controlling electric circuits. Frederick William Le Tall, Westinghouse-building, Norfolk-street, Strand, London. (The Cooper-Hewitt Electric Company, United States.)

14174. Improvements in systems of electrical distribution. Frederick William Le Tall, Westinghouse-building, Norfolk-street, Strand, London. (The Cooper-Hewitt Electric Company, United States.)

14175. Improvements in gas or vapour electric apparatus. Frederick William Le Tall, Westinghouse-building, Norfolk-street, Strand, London. (The Cooper-Hewitt Electric Company, United States.)

14176. Improvements in electric heaters or rheostats. Frank Clarence Newell, Westinghouse-building, Norfolk-street, Strand, London. (Date applied for under Patents Act, 1901, June 27, 1902, being date of application in United States.) (Complete specification.)

14190. Improvements relating to wireless telegraphy. Sidney George Brown, 45, Southampton-buildings, Chancery-lane, London.

14199. Improvements in machines for cutting turbine vanes. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Shepherd T. Fonda, United States.)

14204. Improvements in or relating to telephone systems with central battery. Gottlieb Magnus Teodor Piltz, 111, Hatton-garden, London. (Complete specification.)

JUNE 27.

14211. Improved electric switch and circuit breaker. Verity's, Limited, and Edwin John Selby, 31, King-street, Covent Garden, London.

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14231. Improvements in arc lamps. Joseph Wilfred Bowley, 4, St. Ann's-square, Manchester.

14247. Improvements in "electric resistances." Hans von Kramer, 121, West George-street, Glasgow.

14269. Improvements relating to electrical fire-alarms and other electrical signalling systems, telegraphy, telephony, wireless telegraphy, and the like. Egerton Goolden Pulford, 10, St. George's-crescent, Liverpool. (Complete specification.)

14286. Improvements in cases or covers for the protection of electrical apparatus. Charles Mark Dorman and Reginald Arthur Smith, Ordsal Electrical Works, Salford. (Complete specification.)

14295. Improvements in electromagnets especially applicable for use in electromagnetic separators. The Edison Ore-Milling Syndicate, Limited, 188, Fleet-street, London. (Thomas Alva Edison, United States.)

14299. Improvements in telegraph apparatus. Henry Braun, 8, The Avenue, Barnet, London.

14300. Improvements in and relative to electrical alarm or signalling apparatus. George Rarp, 60, Queen Victoria-street, London.

14304. Improvement in sparking plugs for electric ignition of gas or oil engines. John Baxter Jarvis, Devon House, Clapham Common, London.

14309. An electric roasting oven. George Edmond Dutertre and Marie François Andre Nodet, 77, Colmore-row, Birmingham.

14318. Improvements in apparatus for regulating the supply of current in electric mains. Herbert William Butler, 47, Lincoln's-inn-fields, London.

14363. Improvements in telephone call recording systems. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (The Automatic Telephone Meter Company, United States).

14373. An improvement relating to the illumination of railway or like signals by electric incandescence lamps. Siemens Bros. and Co., Limited, and Luiz Moraes Gomez Ferreira, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

14374. Improved device for securing the covers or doors of boxes and other receptacles in a tightly-closed condition. Siemens Bros. and Co., Limited, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Siemens und Halske Actiengesellschaft, Germany.) (Complete specification.)

14375. Improvements in switches for use in connection with selective electric signalling apparatus. Charles Mark Jacobs and Arthur Harold Nicholson, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

COMPLETE SPECIFICATIONS ACCEPTED.

To be published July 16, 1903.

1902.

6884. Telephonic apparatus. Graham.

13853. Electric switches. British Thomson-Houston Company, Limited. (Hewlett and Button.)

13614. Telephone connections on the party-line system. Oppenheimer. (Actiengesellschaft Mix und Genest.)

14109. Electromagnets. Timmis and Timmis.

14349. Electrostatic apparatus for measuring potentials. Ferguson and Kelvin and James White, Limited.

14430. Type-printing telegraphic instruments. Higgins.

15716. Electric cable or conductor junction and like boxes. Burnet.

16014. Wattmeter for the measurement of electrical power. Drysdale.

16492. Electrical cut-outs and regulators. Leitner and Lucas.

17222. Electric cranes, winches, and the like. Stokes.

17388. Systems of electrical distribution. Lake. (General Electric Company.)

17667. Maximum demand indicator for alternating electric currents. Evans.

17687. Maximum demand electrical indicators. Lake. (General Electric Company.)

17688. Commutator brushes. Lake. (General Electric Company.)

18076. Systems of electrical distribution. British Thomson-Houston Company, Limited. (Troy.)

18077. Electric current collectors. British Thomson-Houston Company, Limited. (Priest.)

18079. Protective devices for electric circuits. British Thomson-Houston Company, Limited. (Steinmetz.)

18082. Charging devices for storage batteries. British Thomson-Houston Company, Limited. (Lemp.)

18090. Electric meters. British Thomson-Houston Company, Limited. (King.)

18229. Field coils for dynamo-electric machines. Lake. (General Electric Company.)

18319. Electric arc lamps. British Thomson-Houston Company, Limited. (Fleming.)

18321. Systems of electrical distribution. British Thomson-Houston Company, Limited. (Stone.)

18323. Lightning arresters. British Thomson-Houston Company, Limited. (Johnston.)

18324. Systems of dynamo-electric machines. British Thomson-Houston Company, Limited. (Jeannin.)

18326. Means for preventing creeping of electric meters. British Thomson-Houston Company, Limited. (Lunt.)

18586. Electric fuses or cut-outs. Morse.

19110. Electric arc lamps. Green.

1903.

5973. Intercommunication telephone wall sets and the connections or wiring thereof. Berliner and Birnbaum.

7697. Incandescent electric lamps. Drecker.

9015. Electrical generators for producing alternating currents of low frequency. Siemens Bros. and Co., Limited. (Siemens und Halske Actiengesellschaft.)

9149. Pull-down or safety apparatus for the trolley poles of electric cars. Birkbeck. (Electric and Steam Railway Supply Company.)

9206. Methods of and apparatus for transforming electrical energy. Hewitt. (Date applied for under International Convention, April 25, 1902.)

9353. Shade holders for electric lamps. Birch.

9372. Insulators applicable to overhead tramway wires. Penny.

9586. Mechanism for controlling electric circuits. Tate and Newbery.

11193. Radiators for wireless telegraphy. Blondel.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.	Last price
Commercial and Industrial.—	£	£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1 ..	½-¾
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1 ..	¼-½
British Insulated and Helsby Cables, Ord., 1-100,000	5 ..	6¾-7¼
—— 6 per cent. Cum. Pref., 1-100,000	5 ..	5¼-6
—— 4½ per cent. Mortgage Debentures	100 ..	101-105 xd
British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red.	100 ..	104-106
British Westinghouse Elec. and Manuf., 6 per cent. Pref.	5 ..	5¾-6
—— 275,001-375,000	5 ..	—
—— 4 per cent. Mortgage Debenture Stock	100 ..	100-102
Brush Electrical Engineering, Ordinary, Nos. 1-105,731	2 ..	¾-1¼
—— Non. Cum., 6 per cent. Pref.	2 ..	1¼-1⅝
—— 4½ per cent. 1st Debenture Stock	100 ..	99-102
—— 4½ per cent. 2nd Debenture Stock	100 ..	87-92 xd
Callender's Cable, Debentures	100 ..	106-110
—— Ordinary	5 ..	12-13
—— 5 per cent. Pref.	5 ..	5¼-6 xd
Crompton and Co.	3 ..	2-2¼
—— 5 per cent. Debentures	100 ..	102-106
Edison and Swan United, "A" Shares, 1-99,261	3 ..	¼
—— "A" Shares, 01-017,139	5 ..	1½-2¼
—— 5 per cent. Debentures	100 ..	75-80
—— 4 per cent. Deb. Stock, Red.	100 ..	71-75 xd
Electric Construction, Limited, Nos. 1 to 112,100	2 ..	1⅜-1⅞
—— 7 per cent. Cumulative Pref.	2 ..	2¼-3
—— 4 per cent. Perp. 1st Mort. Deb.	100 ..	100-103
Ferranti Limited, 5 per cent. 1st Mort. Deb. Stock, Red.	100 ..	90-95 xd
General Electric Company (1900), 5 per cent. Cum. Pref.	10 ..	9¼-10 xd
—— 4 per cent. 1st Mort. Deb. Stock	100 ..	99-102
W. T. Henley's Telegraph Works, Ordinary	5 ..	14-15
—— 4½ per cent. Preference	5 ..	5-5¼
—— 4½ per cent. Debentures	100 ..	108-112
India Rubber, Gutta Percha, and Telegraph Works	10 ..	18¼-19⅛
—— 4 per cent. Debentures	100 ..	100-103
Parker, Thos., Limited, Ordinary	10 ..	14¼-15½
Telegraph Construction and Maintenance	12 ..	33-36
—— 5 per cent. Bonds	100 ..	102-105
Electric Lighting and Supply.—		
Blackheath & Greenwich District Ordinary 1,201-101,200	1 ..	⅛-¼
—— 4½ per cent. Deb. Stk. Certs., Red. and Conv.	100 ..	118-121
Bournemouth and Poole, Ordinary	10 ..	12¼-13¼
—— 4½ per cent. Cum. Pref., 7,501-15,000	10 ..	10-11
—— 6 per cent. Cum. Second Pref., 15,001-22,500	10 ..	10¼-11¼
—— 4½ per cent. Debenture Stock, Red.	100 ..	104-107
Bromley (Kent) Electric Light and Power Co., 4½ per cent. 1st Debenture Stock, Red.	100 ..	101-104
Brompton and Kensington, Ordinary	5 ..	10¼-11
—— 7 per cent. Preference	5 ..	10¼-10¾
Calcutta Electric Supply Corp., Ordinary, Nos. 1-40,000	5 ..	6¼-7⅛
—— Nos. 20,001-30,000	5 ..	7-8
Cambridge Electric Supply Company, Ltd., £10 Ord.	8 ..	14¼
—— " " £10 Ord.	6 ..	10⅜
Central Electric Supply, Ld., 4 per cent. Guar Deb. Stock	100 ..	106-109
Charing Cross and Strand, Nos. 1-70,000	5 ..	9-9½
—— 4½ per cent. Cum. Pref.	5 ..	5¼-6
—— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000	5 ..	4⅜-5
—— 4 per cent. Debenture Stock, Red. (Prov. Certs.)	100 ..	104-106
Chelsea Electricity Supply	5 ..	6-6¼
—— 4½ per cent. Debentures	100 ..	107-110
City of London, Ordinary	10 ..	11⅜-12¼
—— 6 per cent. Cumulative Pref.	10 ..	13-14
—— 5 per cent. Debenture Stock	100 ..	121-126
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100 ..	102-10⅝
County of London and Brush Provincial, Ordinary	10 ..	8-9
—— 6 per cent. Cum. Pref.	10 ..	12-13
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	100 ..	109-11
Edmundsons' Electricity Corporation, Ordinary, 1-50,000	5 ..	6¼-7
—— 6 per cent. Cum. Pref.	5 ..	6-6¼
—— 4½ per cent. First Mort. Deb.	100 ..	108-111
Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-30,000	5 ..	3¼-4¼
—— 5 per cent. Debenture Stock, Red.	100 ..	96-98 x
Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000	5 ..	6-6¼
—— 4½ per cent. First Deb. Stock, Red.	100 ..	102-106
Hove Electric Lighting, Limited, Ord., 1-13,000	5 ..	8-9
Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000	5 ..	11-12
—— 4 per cent. Debenture Stock Red	100 ..	103-106

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Name.	Amount paid.	Last price.
	£	£
Kensington and Knightsbridge and Notting Hill	100 ..	103-106
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10 ..	9½-10½
London Electric, Ordinary	3 ..	2-2½
—— 6 per cent. Pref.	5 ..	5½-6
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100 ..	100-102
Metropolitan, Ordinary	10 ..	17½-18½
—— 4½ per cent. First Mortgage Debenture Stock	100 ..	10 -112
—— 3½ per cent. Mortgage Debenture, Red.	100 ..	97-100
Newcastle-upon-Tyne Electric Supply, Ordinary	5 ..	100-103
—— Preference	4 ..	102-105
Notting Hill Electric Lighting	10 ..	13½-14½
—— 4 per cent. First Mort. Debs., Nos. 1-500 (Reg.)	100 ..	99-102
Oxford Electric, Ordinary, 1-96 and 407-14,510	5 ..	5-6
—— 4 per cent. Debenture Stock	100 ..	98-101
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100 ..	100-102
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5 ..	3-3½
—— 4 per cent. Debenture Stock	100 ..	88-93
South London, Ordinary	5 ..	3½-4
St. James's and Pall Mall, Ordinary, 101-20,080	5 ..	15½-16½
—— 7 per cent. Pref.	5 ..	8½-9½
—— 3½ per cent. Deb.	100 ..	98-101 xd
Urban Electric Supply Co., Ordinary, 8-30,007	5 ..	5-5½
—— 5 per cent. Cumulative Preference, 50,001-80,000	5 ..	5-5½
Westminster, Ordinary	5 ..	12-13
—— 5 per cent. Cum. Pref., 110,101-138,251	5 ..	6½-6¾

Electric Railways.—

Central London, Ordinary	100 ..	104-107
—— 4 per cent. Pref.	100 ..	101-104
—— ,, ,, deferred	100 ..	107-110
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100 ..	117-120
City and South London, Consolidated Ordinary	100 ..	70-72
—— 4 per cent. Debenture Stock	100 ..	116-119
—— 5 per cent. Pref. Stock '91	100 ..	130-133
—— ,, ,, ,, '96	100 ..	129-132
—— ,, ,, ,, '01	100 ..	128-131
Liverpool Overhead, 5 per cent. Pref.	— ..	13-13½
—— Ordinary, 1-50,000	— ..	7½-8
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	— ..	103-104
Waterloo and City, Ordinary	100 ..	98-101

Electric Tramways.—

Anglo-Argentine, 1-250,007	5 ..	4¾-4¾
—— Permanent 5 per cent. Debenture Stock, 1888	100 ..	124-129
Blackpool and Fleetwood Tramroad	10 ..	13½-14½
Brisbane Tramway Invest., Lim., Ord., 1-75,000	5 ..	2¾-3¼
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5 ..	4¼-4¾
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100 ..	100-103 xd
British Columbia Electric Railway Co., Ord., Nos. 1-20,000	100 ..	69-72
—— Non-Cum. 5 per cent. Pref., Nos. 25,001-38,600	100 ..	93-96
—— 4½ per cent. 1st Mt. Debs., Nos. 1-6,250, of £40 each	40 ..	104-106 p.c

Name.	Amount paid.	Last price
	£	£
British Electric Traction, Ord., 1-300,000 & 60,001-80,000	10 —	13½-13¾
—— 6 per cent. Cm. Pf., 30,001-60,000	10 —	12-12½
—— 5 per cent. Perpetual Debenture Stock	100 —	122-125
Buenos Ayres and Belgrano Tram., Ord., 1-100,000	5 —	2¾-3
—— "A" 6 per cent. Cm. Pf., 1-40,000	5 —	5¼-5½
—— "B" 6 per cent. Cm. Pf., 1-27,500	5 —	4¾-5¼
—— 5 per cent. Deb. Stock, Red.	100 —	105-108 xd
—— Prov. Cert., all paid	100 —	97-100
Cape Electric Tramways, Nos. 1-480,000	1 —	2¼-2⅜
City of Birmingham Tramways, 5 per cent. Cum. Pref.	10 ..	5-5½
—— 4 per cent. 1st Mortgage Deb., 1-3,000 (1917)	100 —	99-102
Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red.	100 ..	103-105
Cork Electric Tramways and Lighting Co., Ordinary	10 ..	13-14
—— 5 per cent. Cum. Pref.	10 ..	11-12
—— Debentures	100 ..	96-99
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10 ..	13½-14½
—— 6 per cent. Pref., Nos. within 1-60,000	10 —	15-16
—— 3½ per cent. Mort. Debs., 1-3,000, Red.	100 —	94-97
Imperial Tramways, Ordinary	all —	22-22½
—— 6 per cent. Cum. Pref.	all —	14½-15½
—— 4½ per cent. Deb. Stock	100 —	112-114
Isle of Thanet Electric Tramways and Lighting, 5 per cent. Cum. Pref., Nos. 30,001-60,000	5 ..	4-4½
—— 4 per cent. Debenture Stock	100 ..	92-95
Kidderminster and District Lighting and Traction, Pref.	5 —	3½-4
London United Trys. (1901), 5 per cent. Cum. Pref.	10 ..	11½-12 xd
—— 4 per cent. 1st Mt. Db. Stock, Red.	100 ..	105-107
Metropolitan Electric Trams., Deferred, 1,000,001-1,314,016	1 ..	½-¾
—— 5 per cent. Cum. Pref., 500,001-814,016	1 ..	½-1½
New General Traction, Ordinary	5 ..	½-1½
—— 6 per cent. Cum. Pref.	5 ..	2-3
—— 5 per cent. Mortgage Debentures, 1-1,713 (Regd.)	100 —	91-96
Oldham, Aston, and Hyde Tramway, Ordinary	10 —	10½-10¾
—— 5 per cent. Cum. Pref.	10 —	11½-12½
Perth Elec. Tramways (W.A.) 5 per cent. 1 Mort. Deb. Stk.	100 ..	98-102
Potteries Electric Traction, Ordinary, 20,001-40,000	10 —	9½-10½
—— 5 per cent. Cum. Pref., 1-20,000	10 —	8½-10½
—— 4½ per cent. Debenture Stock	100 —	102-105
South Lancashire Electric Traction and Power Company—		
—— £250,000 Ordinary	1 —	1
—— £101,152 5 per cent. Preference	1 —	1
—— £528,083 4½ per cent. Debenture Stock	100 p.c. —	100 p.c.

Telephones.—

National Telephone, Preferred	100 —	102-104
—— Deferred Stock	100 ..	82-84
—— 6 per cent. Cum. First Pref.	10 —	13-14
—— 6 per cent. Cum. Second Pref.	10 —	12-13
—— 6 per cent. Non-Cum. Third Pref.	5 —	5-5½
—— 5½ per cent. Deb. Stock, Red.	100 —	96-98
—— 4 per cent. Deb. Stock, Red.	100 —	101-103
Oriental Telephone and Electric Company	1 —	13/16-15/16

TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line	Traffic Returns for week			Increase or decrease.		Miles of single track open.		Accounts for past year.							Cost per car mile.
	Ending	1903.	1902.	Week.	Current year.	1903.	1902.	Ending	Total receipts	Passengers carried.	Car miles run.	Receipts per Pas-s'nger	Receipts per Car mile.	Receipts per Mile of track.	
		£	£	£	£				£			d.	d.	£	d.
Aberdeen Corporation	June27	1,247	1,295	− 48	+ 4,863	19¼	17¼	May 31	37,931	9,099,715	794,641	0·98	13·02	1,970	6·14
Ayr Corporation	—	—	—	—	—	8	6	Sept. 25	12,503	2,979,276	290,099	1·00	10·34	1,560	4·7
Birmingham Tramways	,, 27	5,359	5,879	− 520	+ 6,014	6¼	6¼	—	—	—	—	—	—	—	—
Blackburn Corporation	,, 26	909	1,195	− 286	+ 674	24	24	March 25*g*	40,964	7,234,106	826,558	1·36	11·87	1,705	7·44
Blackpool Corporation	,, 25	1,025	998	+ 27	+ 1,689	17½	16½	,, 31	211,168	6,169,121	784,443	1·52	10·8	—	—
Blackpool-Fleetwood Tramways	,, 27	684	946	− 262	+ 974	16½	16½	Dec. 31	30,923	2,049,677	584,989	3·62	12·68	1,932	6·99
Bolton Corporation	,, 28	1,937	2,519	− 581	+ 3,161	25	25	March 31	85,704	17,761,605	1,896,247	1·15	10·75	3,430	5·87
Bournemouth Corporation	,, 24	932	—	—	—	10½	—	—	—	—	—	—	—	—	—
Bradford Corporation	,, 28	4,011	4,567	− 556	+ 5,770	39	—	—	—	—	—	—	—	—	—
Brighton Corporation	,, 28	947	1,046	− 98	+ 5,190	6½	—	,, 31	—	10,432,508	1,031,928	1·00	10·10	—	—
Bristol Tramways Company	,, 26	5,481	5,093	+ 388	—	51½	51½	Dec. 31	223,480	41,192,899	5,724,114	1·30	9·38	4,348	—
Burnley Corporation	,, 27	792	933	− 141	—	—	—	—	—	—	—	—	—	—	—
Cardiff Corporation	,, 27	2,060	2,294	− 233	+ 9,136	—	—	—	—	—	—	—	—	—	—
Carlisle Tramways Company	—	—	—	—	—	—	—	,, 31	—	2,216,583	320,129*h*	—	—	—	—
Central London Railway	,, 27	7,059	10,041	−2,982	+ 2,147*h*	6	—	,, 31	367,225	45,305,110	1,276,971*a*	1·87	66·6 *a*	59,076	35·6 *a*
City and South London Railway	,, 28	2,444	2,880	− 436	+ 1,871	6⅝	—	,, 31	165,003*a*	19,069,319*a*	—	—	—	—	—
Cork E. T. and L. Company	,, 25	566	660	− 94	+ 238	—	—	—	—	—	—	—	—	—	—
Darwen Corporation	,, 26	233	338	− 105	− 47	7·23	—	March 31*g*	12,341	2,360,735	254,279	1·25	11·65	1,707	9·36
Dover Corporation	May 22	216	259	− 43	+ 44	3	—	—	—	—	—	—	—	—	—
Dublin & Lucan Electric Railway	June20	20,513	20,432	+ 81	— *h*	—	—	Dec. 31	5,796	364,796	102,087	3·81	13·62	859	7·68
Dublin U. T., electric cars	,, 26	5,161	5,757	− 595	} +5,950	46	46	March 31	126,121	24,553,133	3,429,356	1·23	8·82	2,741	5·06*h*
Dublin S. District, Electric	,, 19	861	819	—											
Dundee City Tramways	,, 24	867	790	+ 77	—	22	22	May 15	35,874	9,084,522	752,814	0·93	11·276	1,630	—
East Ham Corporation	,, 27	804	688	+ 116	+ 2,718	10·75	7·52	March 31	25,341	9,971,337	650,224	0·61	9·35	2,357	—
Farnworth U.D.C.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Glasgow Corporation	,, 27	13,973	13,217	+ 755	+ 7,097	124	101	May 3	653,200	177,179,549	14,008,750	—	—	—	—
Halifax Corporation	—	—	—	—	—	30½	27½	—	—	—	—	—	—	—	—
Huddersfield Corporation	,, 22	1,130	1,108	+ 122	—	34	35	March 31	56,631*h*	9,738,213	1,218,539	1·4	11·14	1,618	6·38
Hull Corporation, E. S.	,, 27	1,862	2,181	− 318	+ 1,385	19	19	,, 31	87,707*h*	21,065,999	2,218,696	1·00	9·49	5,004	5·07
Ilkeston Corporation	,, 24	191	—	—	—	—	—	—	—	—	—	—	—	—	—
Kirkcaldy Corporation	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Leeds Corporation	,, 27	6,023	6,655	− 632	+ 5,712	77	—	March 25	262,656	57,239,779	5,773,651	1·11	10·91	3,283	—
Liverpool Corporation	,, 20	9,669	9,759	− 90	+13,983	101	95	Dec. 31	504,304	108,906,472	11,705,425	1·11	10·34	5,000	6·88
Liverpool Overhead Railway	,, 28	1,660	1,690	− 30	+ 3,689	15½	15½	June 30	79,252	10,466,726	986,185*a*	1·82	19·30*a*	5,110	— *a*
Newcastle-on-Tyne Corporation	,, 27	4,325	4,247	+ 77	—	36	36	Dec. 15	127,852	28,411,899	2,767,444	1·08	11·09	3,551	—
Portsmouth Corporation	May 2	1,406	1,318	+ 88	—	29	29	Sept. 30	47,651	9,168,137	868,157	1·24	13·17	1,643	—
Rochdale Corporation	June22	150	107	+ 43	—	4½	--	March 31	5,416	925,281	127,456	1·38	10·27	—	7·66
Salford Corporation	,, 8	5,607	2,403	+3,204	+11,096	—	—	—	—	—	—	—	—	—	—
Sheffield Corporation	,, 28	4,757	—	—	—	46¼	46¼	Mar. 25	1,31,837	49,176,631	3,791,993	0·93	12·01	4,140	7·82 *f*
Southampton Corporation	,, 25	1,045	1,139	− 93	—	11	11	,, 31	35,874	9,084,522	752,814	0·946	11·436	3,760	—
Sunderland Corporation	,, 28	1,405	1,871	− 446	+ 542	18·48	17·18	,, 31	59,930	13,967,121	1,270,957	1·03	11·3	3,243	6·43
Wallasey U.D.C.	,, 27	738	968	− 230	+ 1,242	10·5	10·5	,, 31*g*	31,307	5,690,378	654,550	1·32	11·47	2,981	6·97

Includes maintenance of permanent way and proportion of profits paid to the tramway companies for term of unexpired lease. *a* Train mile.
h Half-year's figures. *c* Include rail and tram. *f* Including one section of horse traction. *g* 1903.

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NOTES.

Wireless Telegraph Conference.—It is stated that a "preliminary" wireless telegraph conference will be held at Berlin on Aug. 4, which will be attended by "persons interested in the subject." It is not stated, however, whether the conference will be of an international character or whether it will be open to public attendance.

Royal Institution.—A general monthly meeting of the members of the Royal Institution was held on the 6th inst., Sir James Crichton-Browne, treasurer and vice-president, in the chair. The following were elected members: Lord Oxmantown, Mr. R. S. B. Hammond Chambers, K.C., Mr. M. B. Field, Mr. H. D. McLaren, Mr. G. Marconi, Mr. R. Pearce, Mr. E. P. S. Roupell, and Mr. W. Wavell. The special thanks of the members were returned to the Misses Gladstone for their present of a portrait of Dr. John Hall Gladstone, F.R.S.

Atlantic Wireless Telegraphy.—Mr. Vivyan, the engineer in charge of Marconi's wireless telegraph station at Table Head, on the other side of the Atlantic, states that he is sending messages of different lengths to Poldhu, in Cornwall, daily, but that the replies are still being sent by cable, owing to the installation of new apparatus on this side not yet being completed. He is further responsible for the statement that the apparatus at Table Head now works with ease, and that the transmission of messages is attended with the "greatest possible success."

Kew Observatory.—The officials at the magnetic observatory in Kew Gardens have found a new site for the station in Scotland, where stray electric currents from electric tramways will fail to have the present disturbing effects on the magnetic instruments. It is proposed to remove the observatory to a farm in the parish of Eskdalemuir, about 15 miles above Langholm. The farm is the property of the Duke of Buccleuch, who has expressed his willingness to grant an extensive site, and it is expected that the ground will be marked off shortly. Eskdalemuir enjoys almost perfect isolation, which is particularly suited to the delicate work it is proposed to carry out at the new station. It is an extensive upland pastoral parish in Dumfriesshire, and is 15 miles away from any railway.

Books Received.—From the Institution of Civil Engineers we have received a number of volumes which, for the most part, are reprints of papers read and discussed before the institution or some of its associated societies. Those that appeal to us more particularly as having an electrical interest are the following: Address of Mr. John Clarke Hawkshaw, the president, delivered in November, 1902; "Limmat Valley Electric Road Railway," by Mr. Chas. S. Du Riche Preller, Ph.D.; "Wrought-Steel Conduits," by Mr. H. F. Lloyd; "Automatic Circuit Breakers," by Mr. B. Hopkinson; "Electric Tramways," by Messrs. C. and B. Hopkinson and Ernest Talbot; and "High-Speed Electrical Generating Plant," by Mr. T. H. Minshall. In most cases the discussions that took place on these papers are given. Another useful volume issued by the institution is one giving a large number of abstracts of papers published in scientific transactions and periodicals. We have also to acknowledge the "Year-Book" of the Armour Institute of Technology of Chicago, and the May number of the *Wisconsin Engineer*.

Prussian Railways.—The Prussian State Railways Administration is pursuing the right course in regard to electric traction. It has already established a good lead in the displacement of steam locomotion by electrical working, and has just decided on another step in the same direction. Briefly, the decision is to run all the trains on the suburban railway between Berlin and Lichterfelde by electric traction. This is said to be an outcome of the long series of trials on the military railway between Berlin and Zossen, which proved the advantage of propelling trains by electric power. An experimental train has been running on the Berlin-Lichterfelde section for the past month with much success, and on the 15th inst. steam locomotives will be entirely banished from the line. The method of working will be by motorcars, each train consisting of two long coaches, one second and one third class, each with separate compartments for smokers. The advent of electrical working on one of Berlin's suburban lines is regarded as the beginning of a new era in railway locomotion in that city, which will soon see steam haulage on all the suburban lines replaced by electric propulsion.

Physical Society.—At the ordinary meeting of this society held in the Physiological Laboratory, University of London, on the 26th ult., Dr. Waller gave a demonstration of "The Effect of Light on Green Leaves." The origin of these researches was the result of the consideration of the retinal effects after light stimulation, and the wish to have a sensitive surface naturally spread out for examination. The effect of light is to produce a current (of an E.M.F. of the order of 0·01 volt), at first from the illuminated to the dark parts in the leaf, and later (or as an after effect) from dark to illuminated. These currents are apparently an index of two opposite processes in the leaf—*i.e.*, dissimilation and assimilation—and give very close analogies to the analogous processes in animal tissues—*e.g.*, nerves. Dr. Waller also demonstrated the "blaze" currents in animal and vegetable tissues. These are seen when a strong exciting current (such as an induction shock of sufficient voltage) is led through a pair of non-polarisable electrodes, and these are then connected with a galvanometer. An electrical response (of greater energy than the exciting current) is given in a direction commonly homodrome to the latter—*i.e.*, in the reverse direction to the ordinary polarisation counter currents. This "blaze" response is the algebraic sum of post-anodic and post-kathodic currents; the resultant is commonly homodrome, but an antidrome blaze, distinguished from polarisation by its much greater order of magnitude, is also seen.

Absence of Electrification in Condensation.—It has long been known that neither in cases of ordinary evaporation or condensation is there an accompaniment of electrification. On the other hand, when a mass of water is suddenly shattered as in jets, the electrification produced is marked. The electrification soon vanishes, however, whereas the nuclei persist. The question thus occurs, whether in ordinary slow evaporation the absence of an electric effect may not be due to the fact that the charges vanish too quickly to be noticeable. The matter has been enquired into by Mr. C. Barus, who has communicated to the American Physical Society the results of an examination of the case for sudden condensation and the rapid evaporation of fog particles. To test this question, a graduated electroscope was introduced into the condensation chamber. To insulate it in the saturated atmosphere, the stem was enclosed in a rubber tube open below, and only in contact with the stem at the top (sealing-wax joint). The tube was thoroughly dried before insertion into the chamber, and the instrument showed satisfactory insulation for a half hour or so, after which it was removed for desiccation prior to new experiments. Condensation was produced by sudden exhaustion, as usual. The nuclei used were obtained from the air as well as from phosphorus. The method of experiment consisted in observing the normal leakage of the charged electroscope by observations

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made every half minute. Nuclei were then introduced, and the experiment repeated with the alternate sudden production and sudden dissipation of fogs between each observation. The two curves of leakage were not distinguishable even when the fogs were of the densely opaque character due to phosphorus. The error of the method was about 5 per cent., with somewhat larger uncertainty for the case of fog evaporation.

The Gordon-Bennett Cup.—From a technical point of view, electrical interest in the great "motor Derby," as it has been called, is not large. The race for the Gordon-Bennett cup, however, serves to indicate the spirit of automobilism which is pervading the people, and the immense interest which has been taken in this year's contest is evidence of the progress which the motorcar is making in this country. The Irish race was the fourth of the series of contests for the cup given by Mr. James Gordon-Bennett, and resulted in a victory for a representative of Germany—M. Jenatzy, on a Mercedes car. He did the run of 370 miles in 10 hours 15min. 1-5sec. It cannot be said that the race proved an instruction in any particular branch of automobilism, except, perhaps, that in such contests more depends on chance than on the skill of the driver or the mechanism of the car. For instance, all the American and English competitors were knocked out of the race by accidents which happened to their cars, and for which they were in no way responsible. We are glad to be able to record that no fatality occurred, as was the case in the recent Paris-Madrid automobile contest, although the Irish course is said to have offered many a dangerous incline and curve to motors running at an average speed of something like 45 miles an hour. All things considered, the race was a very successful and popular one, and there has naturally been considerable exultation over the German victory, although motorcars are not generally popular in Germany.

American Pacific Cable.—America is now the proud possessor of a direct cable to the Far East, and it is particularly gratifying to that country, and incidentally to the engineers engaged on the work, that the enterprise was accomplished by July 4—a day memorable in the history of the independence of the United States. On the evening of the 4th inst. the last connection of the cable, which has been laid by the Commercial Pacific Company, was made at Honolulu, when President Roosevelt sent his greetings to General Taft at Manila and to the people of the Philippines. The new cable with which American enterprise has girdled the Pacific is probably the outcome of the example set by England and the European Powers of connecting their colonies by cables which they can control in time of war. According to a Reuter message from New York, the President of the United States at 11.20 on Saturday night sent the following message to Mr. Mackay, the president of the Commercial Pacific Company, who was with him at Oyster Bay, New York, so that the message was cabled round the world in a westerly direction: "Congratulations and success to the Pacific cable, which the genius of your lamented father and your own enterprise made possible." The message came back at 11.35 p.m. Mr. Mackay's reply to Mr. Roosevelt, which was sent eastward around the globe, returned in 9½ minutes. The text was as follows: "I thank you deeply for your message, and earnestly hope that the Pacific cable, by opening the wide horizon of the great East, may prove a useful factor to the commerce of the United States."

King's College.—Thursday last week was "Prize Day" at King's College, when Sir Wm. Anson, M.P., distributed the prizes gained by students during the past year. The Rev. Dr. Headlam, the new principal, in opening the ceremonies, remarked that the engineering faculty had been entirely reorganised under Prof. Capper, who at the present time was engaged in working out a new departure in engineering education which might be of great importance for the country. In the course of an address after distributing the awards, Sir Wm. Anson observed that the feature of education at the present time was the direction which it took towards practical utility. They had been lately informed that a great impulse would be given to technological study in London by the offer which had been made to the London County Council of money in order to form a great technological institute How far-reaching that offer might be it was impossible to say, but it seemed to suggest very large and very fortunate results to the practical studies of this country. He learned also that the engineering school of King's College was likely to take a new development, and that the students of engineering in the college would be able to combine in a singularly happy way practical work with scientific study. It was plain that these practical scientific studies would take a large place in the education of London, which was a most important factor in the education of the whole country. But he begged those who took an interest in technological study to remember that technology and engineering did not represent the sum total of human interests, and that there were other departments of the field of knowledge into which in their leisure hours they might wander The annual conversazione followed, the guests, who numbered about 2,000, being received by the Principal and Mrs. Headlam.

Motor Speed Trials.—The world's record for the flying kilometre was substantially lowered in the motor speed trials which took place in Phœnix Park, Dublin, last Saturday. The interesting feat was accomplished by Baron De Forest on his 70-h.p. Paris-Madrid Mors, who brought the record, which previously stood at 29 seconds, down to 26⅘ seconds. This represents travelling at the rate of 86 miles an hour. In other contests on Saturday previous records were also greatly reduced, including those for motor cycles and tourist cars. The great event of the day was that involving a contest in which racing cars ran against each other instead of against the clock. Such a competition was only made possible by the possession of a broad and straight course, and happily there were no casualties. Hill-climbing and speed trials, the third important event in the programme of the Automobile Club's "Irish Fortnight," took place on Tuesday at Newcastle, in County Down. There were, as usual, plenty of competitors, and the hill selected for the contest offered a severe test, having a gradient of 1 in 7. The race was open to all types of cars, and the Henry Edmunds trophy was carried off by Mr. Campbell Muir on his 60-h.p. Mercedes, Mr. C. S. Rolls on his 80-h.p. Mors being placed second. The course was officially declared to be 1,200 yards in length, and the winner accomplished the run in 32⅖ seconds, or at the rate of 76 miles an hour. Those securing first place in the other events were as follows: Motor cycles (hill climbing)—Mr. A. C. Wright on an Ormonde bicycle equipped with a Kelacom motor; motor cycle speed trial, Class A—Mr. W. Hacking, Ormonde bicycle, Kelacom motor; Class B—Mr. H. Martin, Excelsior Cycle, Motor Manufacturing Company's motor; *Graphic* trophy for tourist cars—Mr. J. Scott Montagu, M.P., 22-h.p. light Daimler; speed trial for racing cars, Class A—Mr. A. Rawlinson, 30-h.p. Daracq; Class B, Mr. Louis Rigolly, 100-h.p. Gobron-Brillie.

Tramway Subways. — In entering upon a form of tramway construction which has never before been

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attempted in this country, the London County Council are wise in taking steps to acquire all possible information with regard to such schemes from actual experience in other countries. When the scheme in hand is for the construction of a tramway subway, one's attention is immediately directed to America, where, we believe, the city of Boston has the credit of carrying out the first shallow tramway construction in the world. At any rate, this is by far the most important work of its kind which has yet been executed, and it will be remembered that the details of the construction and method of working of this subway were reported upon by the tramways manager (Mr. A. Baker) and the electrical engineer (Mr. J. Rider) to the London County Council after their visit to America in 1901. Since then, however, there has been in progress the construction of an important tramway subway in New York, and it is proposed that Mr. Rider shall again this summer visit America with the purpose of informing himself of the methods which are being adopted in connection with the most recent construction of subway tramways. As our readers are aware, the County Council have commenced to carry out the construction of the tramway subway authorised by Parliament to be made under the new thoroughfare from Holborn to the Strand, and it is, therefore, very desirable, having regard to the importance and magnitude of the work, that the engineer under whose direction it is to be executed should have an opportunity of examining the conditions under which similar works are carried out in the States. Mr. Rider has, as was the case two years ago, promised to devote a portion of his annual leave to this purpose, and his committee are hopeful that it will be possible for him, while in America, to examine the most recent forms of tramway construction in New York and other cities, and thus obtain knowledge which will be of great value in connection with the execution of the tramway construction works to be carried out by the Council in London.

Engineering Standards Committee. — Messrs. Robert Atkinson, Limited, of Salisbury House, London-wall, E.C., inform us that, under the authority of the Engineering Standards Committee, they are preparing and issuing codified lists of the committee's findings in a form which should prove of great assistance to all buyers and sellers of British engineering sections. To render this publication a standard work of reference, arrangements have been made to include in it complete lists of the manufacturers and merchants who roll or stock the standard sections. Messrs. Atkinson have just issued a pamphlet giving a short history of the committee and their work, which will no doubt interest many of our readers. It contains a list of the various committees and sub-committees engaged in considering the question of standardisation, together with the names of the members who compose them, and a statement of the work with which each is occupied. The committee on electrical plant is divided into four sub-committees. One, on generators, motors, and transformers, is collecting evidence as to how far standardisation can be introduced in the construction of these machines and their component materials. Another, on temperature, is conducting experiments to determine the ability of different insulating materials to withstand heat, and also the deteriorating effects produced by their exposure to heat over long periods. A third is considering the standardisation of cables and of underground conduits other than tramway conduits, and is engaged in drawing up standard tables which should simplify and cheapen the manufacture of cables. The fourth is occupied in the preparation of standard tables and specifications for wires and with other matters directly affecting the construction of telegraphs and telephones. Other committees are concerned with screw threads and limit gauges, with pipe flanges, and with cement, there being also a committee for publications and calculations, and another for finance. Some two dozen representatives of public departments such as the War Office, the Admiralty, the Board of Trade, and the India Office, are serving on these different committees, and the Government has further shown its appreciation of the work by coming to their financial assistance with a grant of £3,000, as announced some time ago.

Proposed New Automobile Legislation.—In the House of Lords on Tuesday Lord Balfour of Burleigh introduced his Bill to amend the Locomotives on Highways Act, so far as it relates to automobiles. In the first place the Government proposes that, through the agency of the county and borough councils, every motorcar shall be registered, and carry a mark indicating the number as well as the local authority in whose district it has been registered. The responsibility for this identifying mark being at all times visible is laid upon the driver of the car. Then, as regards licenses, Lord Balfour proposes that any one who drives a car "for hire, fee, or reward" shall have to procure a license, but this obligation does not extend beyond such drivers, and it is not proposed that anyone other than those persons who drive for hire or reward shall be obliged to take out a license. In the event of a conviction a license may be suspended, endorsed, or forfeited, at the discretion of the Court. It is not proposed that the license shall be a test or guarantee of skill, as obviously there is no security that the most skilful man may not be the worst offender. On the important question of speed the Government's proposals are, on the whole, fair and equitable. It is proposed that the absurd 12-mile limit shall be repealed *in toto*, "except as respects any special limits or places," to which it may be applied by a regulation of the Local Government Board, with a view to the public safety. Further, a prohibition is put on all "reckless or dangerous driving," as evidence the following provision: "If any person drives a motorcar on a public highway recklessly or at a speed which is dangerous to the public, having regard to all the circumstances of the case, including the nature, condition, and use of the highway, and the amount of traffic which is actually at the time or might be expected to be on the highway, that person shall be guilty of an offence under the Act." Finally, the penalties for offences against the Act are increased, and there is indication, from what Lord Balfour stated in the House of Lords, that for a third offence imprisonment without the option of a fine may be imposed by the magistrates. The Bill was somewhat severely criticised by Lord Rosebery and others, but eventually it was read a first time. The second reading is fixed for next Tuesday, so that the Bill has a good chance of becoming law early next year. The measure applies to Scotland and Ireland as well as England.

Paris Tramways.—More than once lately have we had occasion to refer to the crisis which is surely approaching in regard to the electric tramways in Paris. As everyone knows, the majority of the tramway undertakings in Paris are operating at a loss, which is generally attributed to over-capitalisation, due to the compulsory adoption of the expensive underground conduit system. A contributory cause, perhaps, is the low fares which the municipal authorities compel the companies to run their cars at. With both these restrictions the public is, not unreasonably, perhaps, wholly in agreement. The companies are thus placed "between the devil and the deep sea." They are now looking to the overhead trolley system for salvation,

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but appearances incline to show that they are again destined to failure in their meritorious attempt to place their undertakings on a profit-earning basis by adopting a cheaper system of traction. In the first place, the Parisians, who are known to be exceedingly jealous of the appearance of their streets, are up in arms at the new proposals, which they regard as heralding the approach of "a hideous network of overhead cables." On the other hand, the municipal authorities are very much opposed to the overhead trolley system also, it is believed, for æsthetic reasons. Thus the Paris tramway companies are in anything but an enviable position, and matters are made worse by the case of the East Parisian Tramway Company. Our readers will remember that last April this company obtained permission to use the trolley system for six months, as a temporary measure, while the tunnelling work for the underground railway was going on under the tramway company's line of route. Naturally enough, the company want to retain this system of working, but most unreasonably, in our opinion, the County Council of the Seine is offering the most strenuous opposition to this proposal, and has even refused to enter into negotiation on the subject. Other electric tramway companies in Paris are in much the same position, and matters are fast approaching a crisis, which at least can result in no worse position for the companies than they at present occupy. A suggestion for forcing the local authorities to be more conciliatory is made that on a given day all the tramways in Paris should stop running, thus causing great public inconvenience. We are afraid, however, that the companies are very much under the thumb of the local authorities, and even this resource is denied them, for the probable consequences would be that their concessions would be cancelled.

Electricity in Mining.—At the meeting of the Institution of Mining Engineers in London last week, two very interesting papers on electrical subjects were contributed respectively by Mr. A. S. E. Ackermann and Mr. A. Campbell Cormack. The former dealt with pneumatic and electric locomotives in and about coal-mines, the information being based upon the author's recent tour in the States. He pointed out that the local conditions in America are very different from those obtaining in this country. In America the seams are much thicker and nearer the surface, the dip is very much less, 5 per cent. being the maximum, while faults are almost unknown. Further, a large percentage of the mines are drift mines. The electric haulage system adopted is the overhead trolley, very similar to the electric trams in this country. Pneumatic locomotives are more cumbersome than electric. In some mines both the locomotives and the coal-cutters are worked by pneumatic power, but the more usual arrangement is to have electric haulage, even where the cutting is done with pneumatic machines. It has been stated that the cost of an electric installation is only one quarter that of a pneumatic plant, but the author does not think the difference can be quite so great. In upkeep the electric system also has the advantage, while the efficiency of electrical transmission of energy is considerably higher than that by air. In the discussion which took place on this paper, Mr. Dixon considered that compressed air properly employed would be as cheap as electrical energy for use in coal-mines. Mr. T. E. Forster, referring to the compressed-air locomotives used some years ago in Lord Durham's collieries, said they were only partially successful, owing probably to the smallness of the section. With a big section seam electric locomotives could, he thought, be used with advantage. Mr. J. Gerrard, H.M. inspector of mines, argued that before electricity could be introduced into mines electrical experts must be more agreed than they were at present as to what was safe and what was unsafe. In the second paper, that by Mr. Cormack, the author took up the subject of electrical plant failures. He insisted that with reasonable care in design, manufacture, and working, electric machinery could be and had been made more reliable than steam, gas, or oil power plants. As the result of an analysis of the breakdowns that had occurred to several thousand machines, chiefly to dynamos and motors, extending over a period of four years, Mr. Cormack showed that constructional defects were responsible for 39·36 per cent. of the breakdowns, and of these 18·36 were due to bad design, 7·4 to the perishing of insulation, and 13·6 to bad workmanship. Defective attention caused 22·5 per cent. of the breakdowns. In the discussion, Mr. G. S. Corlett said he had traced the history of 65 machines employed in collieries, and he found that the average number of failures was two per annum. Mr. Chandler suggested that a committee should be appointed to consider the whole question of coal-cutting machines, and the suggestion was referred to the council of the institution for consideration.

Pollak-Virag Rapid Telegraph.—The invention which goes under the above name has been elaborated during the past six years by Messrs. Autal Pollak and J. Virag, who claim to have achieved some remarkable results in operation. We have just received from the inventors a paper describing this letter-writing rapid telegraph system, which is very interesting, especially as they state that telegraphing is now going on successfully with their apparatus between Berlin and Frankfort-on-Main, a distance of about 370 miles. In abstract the *modus operandi* is as follows: The text of the telegram to be dispatched is noted down on paper ribbons in perforations, reminding one of the Morse signs. This notation is made by means of a perforating device which is perfectly independent of the telegraph apparatus. The sign transmitter deals with these paper ribbons quite automatically. The paper ribbon is carried through two rollers. One of these rollers consists of rings, isolated from one another, each ring being electrically connected with the corresponding junctures of a battery, giving different degrees of potentials. Immediately the wire brush, pressing on the roller underneath the paper ribbon, passes over a hole in the same, the battery sends during a certain period a current through the brush into the line. In this way one is able to dispatch about 400 current impulses per second. The receiver makes use of the vibrations caused by the current in the sensitive diaphragm of a telephone to receive these rapid series of impulses. By means of a mirror resting on a point firmly fixed in front of the vibrating diaphragm, the vibrations throw rays of an incandescent lamp on to a ribbon of sensitive paper. In this way the vibrations of the diaphragm are photographically fixed in the shape of a wave line. An ingenious part of the invention is the improvement by means of which the inventors, through double transmitting and receiving apparatus of twofold impulses sent on a double wire, impart to the small mirror mentioned a twofold movement—namely, a vertical and horizontal axial vibration or movement. By a successful combination of these vibrations, the reflected ray writes the text of the telegram in the well-known letters of the written Latin alphabet on the light sensitive paper ribbon. The photographic development and fixing take place automatically in a special part of the receiver, so that the portion of the ribbon leaving the apparatus which contains the full contents of the telegram can be delivered direct to the person addressed. It is claimed to be possible with the

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Pollak-Virag system to transmit at a speed of 50,000 words per hour, according to the length and the nature of the wire.

London County Council Tramways.—Lord Avebury's criticisms of the working of the London County Council tramways south of the Thames have, unfortunately for him, not the merit of accuracy, and we do not expect that the statements—many of them erroneous—which he made before the Industrial Freedom League will carry much weight among thinking men. In case, however, there should be some who are inclined to agree with Lord Avebury's view that the undertaking under municipal control is working at a loss, when it might be profitably carried on by private enterprise, it is well to refer to a letter which Mr. J. Williams-Benn, chairman of the Highways Committee of the London County Council, has published in the daily Press. Mr. Benn repudiates Lord Avebury's statements almost in every particular, and shows that the £200,000 a year offer which his lordship alleges the Council received from a private company for a lease of the Council's system was not an offer which the Council could accept. It did not, as was conveyed by Lord Avebury, represent a net annual profit of £200,000 per annum to the Council, as the latter would first have had to raise the money to buy the lines (about 100 miles), and then when the interest and sinking fund was provided the offer dwindled down to a very insignificant figure. Lord Avebury's main allegation is that the Council have lost £30,000 in the past year, forgetting to state that during that period the lines were under reconstruction for electric traction, which resulted in temporary interruptions of the tramway service. But we cannot do better than quote Mr. Benn on this point, as the argument he puts forward is convincing beyond contradiction. He says: "I am sure Lord Avebury will be fair, and take the whole of the period since the London County Council started, because now that electric cars are running we are rapidly increasing our receipts. He will then see that, instead of a loss, the Council has secured a substantial profit on its southern system of £79,000, and, further, a reserve fund of £25,000. But Lord Avebury asserts we have lost money, because we did not lease these lines to a company instead of working them ourselves. There is a complete answer to that. Our predecessors, the London Tramways Company, made a definite offer, duly reported to the Council, based on the North Metropolitan rent, which was approved by Lord Avebury. The controller reported that after deducting interest and sinking fund charges the offer would yield £14,250 per annum net profit to the Council—*i.e.*, £57,000 for the four years. But we have secured £79,000 and a reserve fund of £25,000, and that after giving the men one day's rest in seven, without reduction in wages, better wages to the poorer classes of labour, and a 10 hours' day, all-night services, and a large increase of those halfpenny fares which have proved so helpful to 50 millions a year of workers. If these poor people travelled on Lord Avebury's company lines they would pay £100,000 a year extra in fares, for, alas, there are no halfpenny fares in the frigid north. There the old hours of labour and wages obtain, and all-night services have been few and far between."

High-Frequency Discharges.—At an extra meeting of the Junior Institution of Engineers, held at Finsbury Technical College, Mr. R P. Howgrave Graham, A.I.E.E., lectured on "High-Frequency Electric Discharges," attracting a large audience. The lecturer first explained the principles of self-induction and capacity, and the conditions necessary for their combination to produce oscillatory discharges of exceedingly high frequency. This was elucidated by mechanical analogies, including one based on hydraulic principles, and perfected by Prof. Northrup. As direct proofs Mr. Graham spoke of the reduction of the frequency to so low a value as to cause the spark to emit a musical note, and of the measurement of the oscillation period by photographing the discharge with the aid of moving plates or revolving mirrors. The range of frequency of electric oscillations up to 30,000 million per second was briefly sketched, and, as a rough guide, the figure given for most of the experiments shown was from 400,000 to 800,000 per second. Some attention was given to practical details, including sources of supply, regulation of spark gap, and the use of strip connections to allow for the confinement of these currents to the surface layers of their conductors. The enormous effects of self-induction were demonstrated by the lighting of an ordinary 100-volt lamp, short-circuited by two or three feet of ¼in. copper rod. Equally striking induction effects were shown, including the lighting of a lamp at 7ft. distance by the currents induced in a secondary of only three turns of rather large area, the primary being a similar coil on the opposite side of the lecture table. The lecturer emphasised the importance of syntony, and showed an experiment in which a lamp was caused to vary between darkness and extreme brilliancy, the tuning being performed by sliding a wire along an adjustable self-induction until a point was reached where the natural vibration period of the receiving circuit was identical with that of the transmitting coil a few feet away. After a demonstration of other high-frequency phenomena, Mr. Graham explained that currents which would kill at ordinary periodicities could be passed with impunity through the human body at very high rates of vibration, and showed a 100-volt glow lamp worked by the current flowing through him from hand to hand. He then dealt at some length with the medical aspect of the subject, and exhibited a neat and well arranged high-frequency medical apparatus made by Mr. Hillier and Mr. Cossor, of Farringdon-road. An account, illustrated by lantern slides, was then given of the work of Nikola Tesla and others, after which several beautiful experiments with a large Tesla coil were shown, including direct and brush discharges at very high voltages. Mr. Graham took long sparks to his body, charging it to a high alternating potential, faint glows and brushes being visible at his finger tips. These became purple tree-like discharges, ending in pale-blue streamers a foot long on approaching the free hand to a plate on the other coil terminal. Sparks 1½in. long were given to members of the audience from the lecturer's hands, and isolated vacuum tubes were made to glow brightly in the space surrounding the apparatus, which, with all metal objects attached to it, gave out brushes and streamers at all points. The very high-voltage current, after passing along a single transmission wire of No. 40 Eureka, flowed through the primary of a small coreless transformer and into an insulated metal plate, there being no return wire. The secondary of only five turns lit a 25-volt lamp. Eventually the transmission wire was cut and the power for a smaller lamp was transmitted by electrostatic induction between two plates more than a foot apart. Mr. Graham, in speaking of the future possibilities of high-frequency work, entertained hopes that at some future time power might be successfully transmitted to a distance without connecting wires, but concluded by expressing his opinion that at present it cannot be said to extend its sphere of usefulness beyond electro-therapeutics and wireless telegraphy. A vote of thanks was accorded the lecturer, special reference being made to the highly successful series of brilliant experiments with which the lecture was illustrated.

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THE TEMPORARY POWER STATION AT THE WORLD'S FAIR, ST. LOUIS, MO.

In order to furnish the electrical energy necessary before the opening of the Louisana Purchase Exposition, and especially to take care of the lighting and illumination during the dedication ceremonies which took place on April 30, May 1 and 2, a temporary power station was erected on the World's Fair ground. The building, which is constructed of wood, is located just north of the boiler-house and occupies a space 10m. by 30m. Two-thirds of this space consists of the boiler-room, the engines and generators occupying the remainder. The following machines and apparatus are now installed in this power plant: one 700-h.p. marine-type boiler, furnished by the Düsseldorf Rattingen-Roehrenkesselfabrik, formerly Dürr and Co., Rattingen-Düsseldorf; one 300-h.p. Morrin-Climax water-tube boiler furnished by the Clonbrock Steam-Boiler Company, Brooklyn, New York (Fig. 1); one 250-h.p. boiler, the same make; one Sorge-Cochran feed-water heater and purifier with a normal rating of 1,500 h.p., furnished by the Harrison Safety Boiler Works, Philadelphia; one Cochran separator of the same make; two duplex steam-boiler feed pumps having a capacity of 385 L. per minute, when working against a boiler pressure of 11½ atmospheres—these are furnished by the National Steam-Piping Company, Upper Sandusky, Ohio; one 300-h.p. high-speed automatic tandem compound steam-engine, running at 225 revolutions per minute, with flywheel governor, furnished by the Buffalo Forge Company, Buffalo, New York—this engine is direct connected to a 200-kw. two-phase Stanley generator (Fig. 2) operating at 2,200 volts and 60 cycles (the Stanley Electric Manufacturing Company, Pittsfield, Massachusetts, is the maker); one 240-h.p. high-speed Skinner engine with flywheel governor running at 212 revolutions per minute, furnished by the Skinner Engine Company, Erie, Pennsylvania—this engine is direct connected to a 150-kw. single-phase Warren generator at 60 cycles, operating at 2,200 volts and 60 cycles; one exciter set, consisting of a single-phase alternating-current motor of 5 h.p., 110 volts, 60 cycles, 1,750 revolutions per minute, direct connected to a direct-current dynamo of 4½ kw., 125 volts (Fig. 3)—this set was furnished by the Wagner Electric Company, St. Louis, Missouri; one direct-current dynamo, 4 kw., 60 volts, made by the Northern Electric Company, Madison, Wisconsin—this machine furnishes exciting current

FIG. 1.

for the Stanley generator, and is belt-driven (Fig. 2); three single-phase static transformers (Fig. 4) for constant current, with a capacity of 100 arc lamps, 6·6 amperes each—these were furnished by the General Electric Company, Schenectady, New York; two distributing switchboards (Fig. 4) for the arc lamp installation; two switchboards (Fig. 2) containing switchboards and instruments for the generators. The accompanying figures

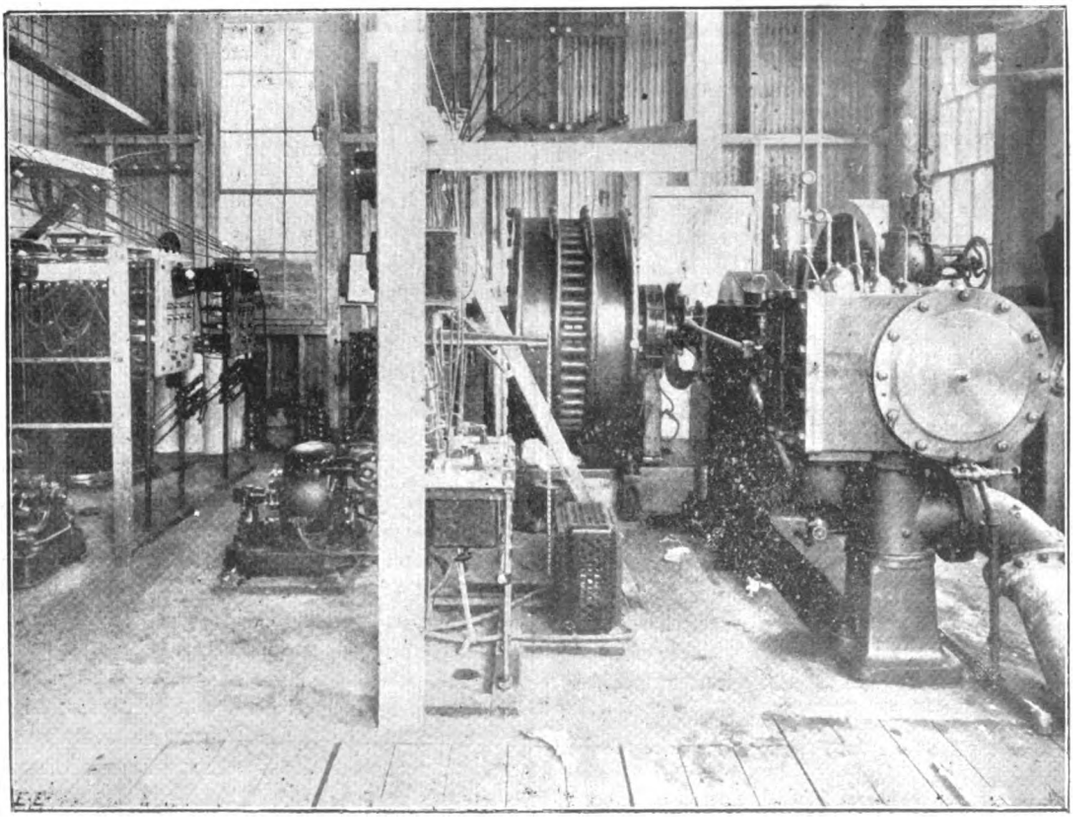

FIG. 2.

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illustrate the above-mentioned machines and apparatus, and some of the peculiarities of these may be of interest to European engineers. The Morrin-Climax

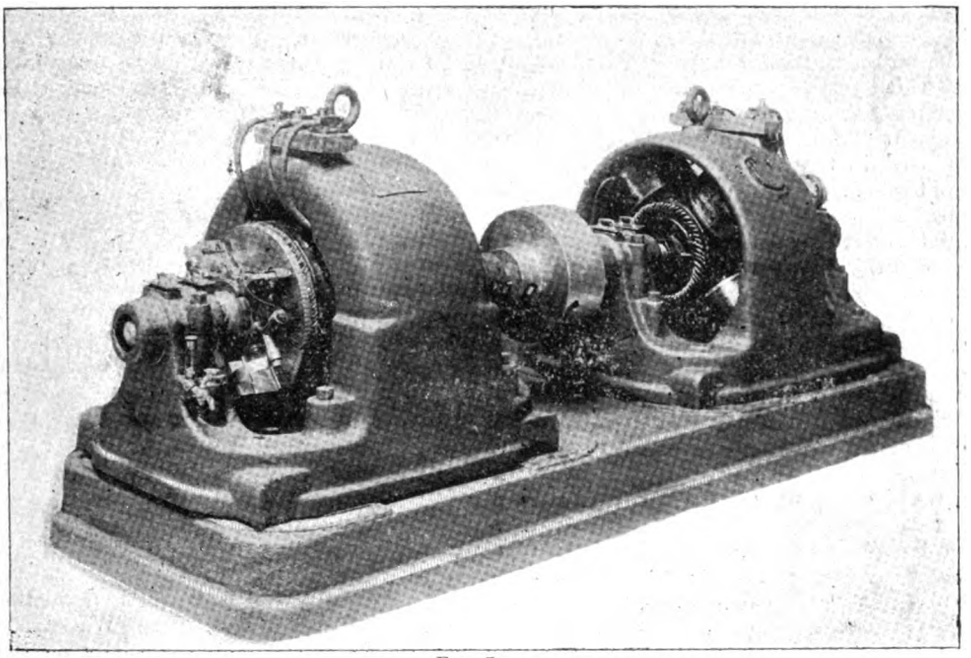

FIG. 3.

boilers (Fig. 1) are of the vertical water-tube type; the water-tubes being placed spirally around the vertical cylinder, the upper end of which forms the steam-drum; the exterior form of the entire boiler is that of a vertical cylinder. The firing is done by hand through four firing holes placed around the base, which has a practical disadvantage in that the fireman must go round the whole boiler in order to keep his fires fed; it is also awkward to handle the coal. The gases strike the lower tubes, and, after passing up the entire height of the boiler, enter the flue; this construction may not be without criticism so far as the real theory of steam-boiler construction goes, but it is worthy to note the simplicity of the mechanical construction and the ease with which the boiler may be installed. The mantle of the boiler is, as can be seen by the illustration, composed of several steel plates bolted together, on the inside of which is a layer of firebrick. These bricks are 200mm. square and each is secured to the sheet by means of a bolt; the joints between the bricks are smeared with cement mortar, and it can be seen that the boiler can be readily installed without the help of a trained mason, and, in fact, the boilers here shown were installed under the supervision of a foreman employing only ordinary labourers. The great advantage of this construction becomes evident when it is taken into consideration that on account of the strictly organised labour unions ruling the entire country, special work must be executed by the men belonging to a labour union. These workmen are three to five times more expensive than the common

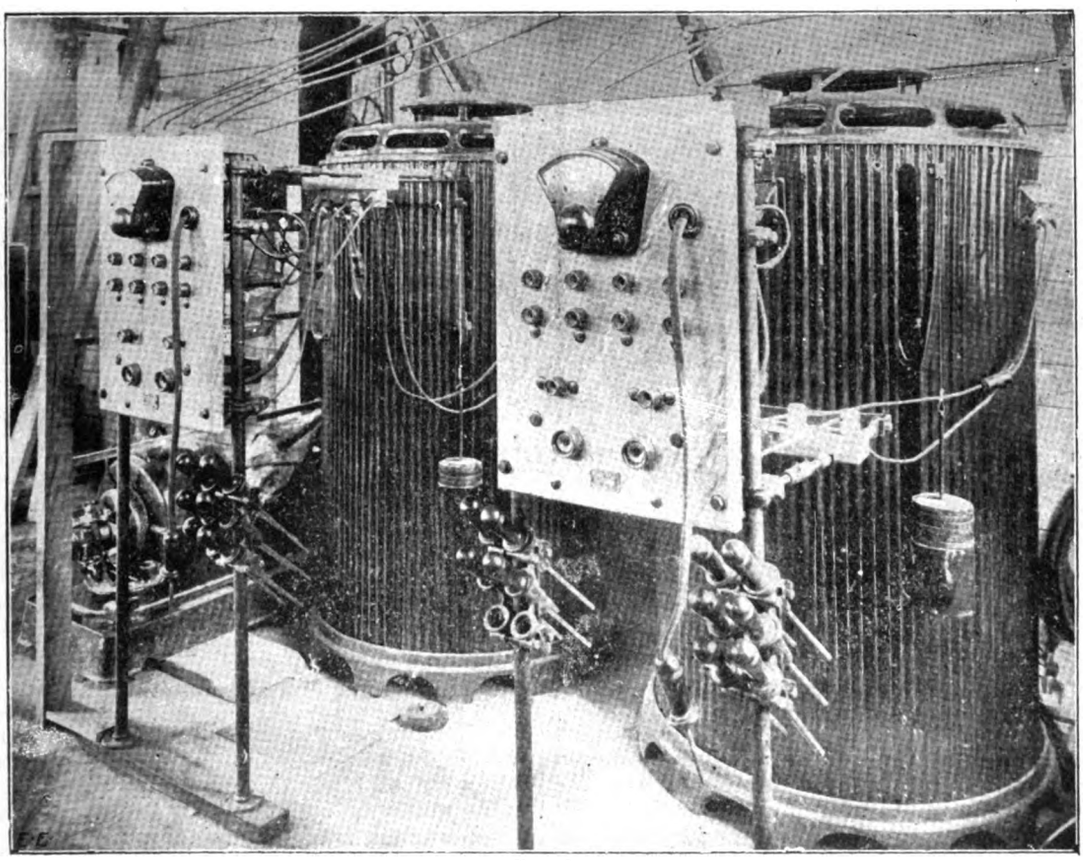

FIG. 4.

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helper, and thus the economy in the boiler installation is apparent. In the States everything is made for the purpose of saving expensive installation forces. Each of the mantle sheets is provided with a door, by which the tubes are accessible for small repairs. In case a tube must be removed, the whole plate can be taken out.

Regarding the steam-engines, it may be briefly stated that they are provided with common slide valves, whereas such sized machines for driving electrical machinery in Europe are always built with Popet valves. Popet valves are seldom employed in the United States, and even the largest engines of 8,000 h.p. to 15,000 h.p. on the Manhattan Elevated Railroad in New York work with Corliss valves. Another essential difference between the American and European types is in the governor. The flywheel governor as shown on these engines is employed extensively in the States, chiefly on account of the simplicity and cheapness of construction, even though it is true that these governors are not as exact in regulation. Wherever weight governors are employed they are always driven by a belt, and only very recently has the American engineer got to realise the disadvantage of this construction and begun to employ a chain or gear transmission. The cheapness of the belt construction seems to be the only reason for still clinging to this type. Both the Stanley and Warren generators are of the revolving-field inductor type, the fields of both being excited by stationary coils, so that only the pole-pieces revolve; thus no slip-rings are necessary. The construction of the Stanley generator is very similar to that of a machine described in January, 1895, by Dolivo von Dobrowolsky. The magnetising coil is placed in the middle of the machine, and is embraced by the pole-pieces, which are semi-elliptic in form. On the one side of the coil all poles are north and the other south. If the exciting current is constant, the magnetic relations existing between coil and core are constant; if the field be revolved, current is generated by a succession of north and south poles supplied by the armature. That of the Stanley only the levers and blind contacts is placed over the marble plate bearing the live contacts. This machine shows still another interesting device which is seldom found on European machines. In Fig. 1, on the left side of the steam-engine, an iron case will be seen, to which two wires are connected. This iron case encloses two magnetic coils, the purpose of which is, according to the statement given by the manufacturer, to demagnetise the shaft of the steam-engine which is magnetised by the magnetic stray field of the machine. The Warren generator is, as mentioned above, built essentially on the same principle as the Stanley generator, but the exciting coil is placed on one side, and, therefore, the poles rotating before the armature are either north or south. This machine has also a similar supplementary magnetic coil for the purpose of correcting the stray magnetic field of the machine. This coil, enclosed in an iron case, resembles very much a pulley, and is placed in this case in front of the machine, and not between dynamo and steam-engine.

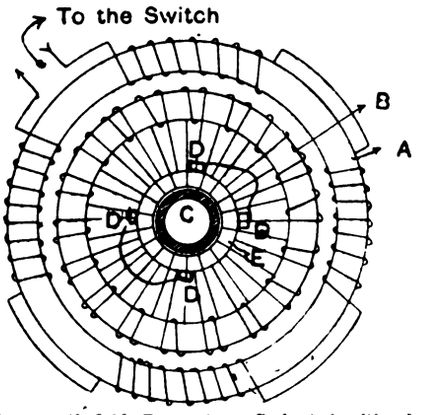

FIG. 5.—A, magnetic field; B, armature; C, short-circuiting device D, brushes; E, commutator.

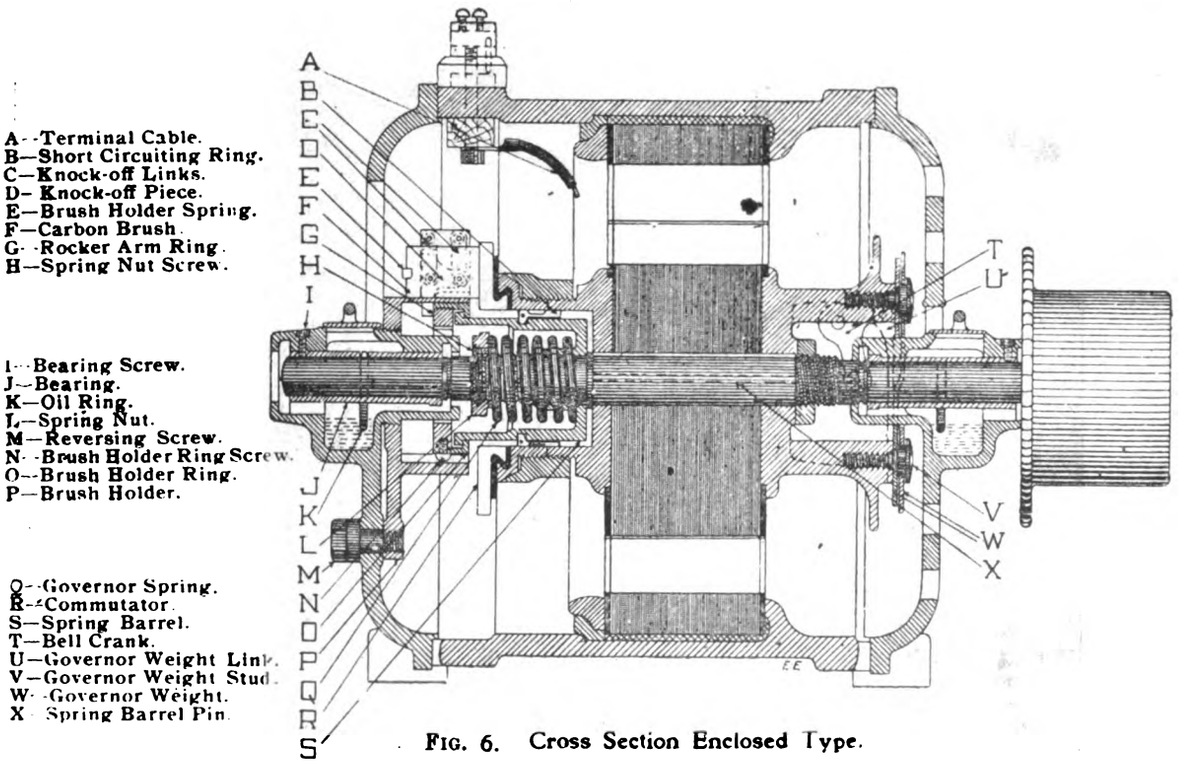

FIG. 6. Cross Section Enclosed Type.

generator is the scheme for independent voltage regulation in two phases. The terminals of the phase are conducted separately to a marble panel attached to the machine. The windings of the last armature coil of each phase are sub-divided, and from these sub-divisions taps are connected with a series of contacts of the panel; by shifting the lever over these contacts the voltage can be altered between the limits of 10 and 15 per cent. of the total voltage of the machine. In order to prevent a short-circuit between two adjacent sub-divisions when the lever touches two contacts, a choke coil is inserted. A second marble plate carrying

The Northern exciter embodies no novel features. The Wagner exciting set consists of a single-phase alternating-current motor driving a direct-current generator, and is worthy of notice. The principal patents covering the construction of the motor were granted to Prof. Arnold, of Karlsruhe, the United States patents being granted in 1895. Single-phase alternating-current motors have been built on similar principles as early as 1893 by the Maschinenfabrik Oerlikon, but this firm did not continue the manufacture of these motors on a large scale, on account of the fact that three-phase current has almost

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entirely supplanted the single-phase system in Europe. In the United States a great number of single-phase alternating-current stations are employed, and even now preference is often given to the single-phase system on account of its simplicity and cheapness in wiring. It may be also noted that several prominent American engineers are now experimenting with a single-phase alternating current for electrical railroad work. The connections of the single-phase Wagner motor are shown diagrammatically in Fig. 5. The stationary field is fed with single-phase current; the rotary is wound similar to an ordinary direct-current machine, and is provided with a commutator. The brush-holder has four arms provided with brushes, these four

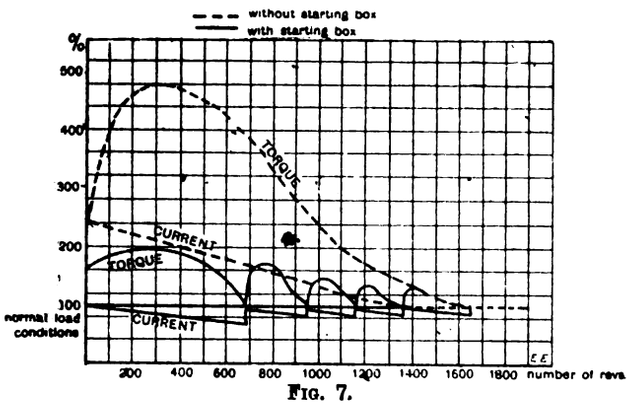

FIG. 7.

arms being spaced 90deg. Two neighbouring brushes are short-circuited so that the armature windings are connected in parallel-series. In starting the motor, the field is closed by means of a double-pole switch and the motor starts quickly, although loaded, and, as soon as it has reached a certain speed, all segments of the commutator are short-circuited by means of a very ingenious mechanism. This device has the advantage of keeping the exciting current of the motor within very small limits, and the mechanical construction of the motor, especially that of the short-circuiting device, is shown in Fig. 6. The commutator, as shown, consists of an annular ring instead of a cylindrical surface, and the brushes are placed horizontally and are shifted laterally, and the shifting of the brushes, and consequent short-circuiting of the commutator segments, is produced by means of the shell, S, which can be displaced along the axis, and is moved by means of the centrifugal regulator, W. Very little sparking accompanies the starting of this motor, and the operation of the shifting device is very reliable.

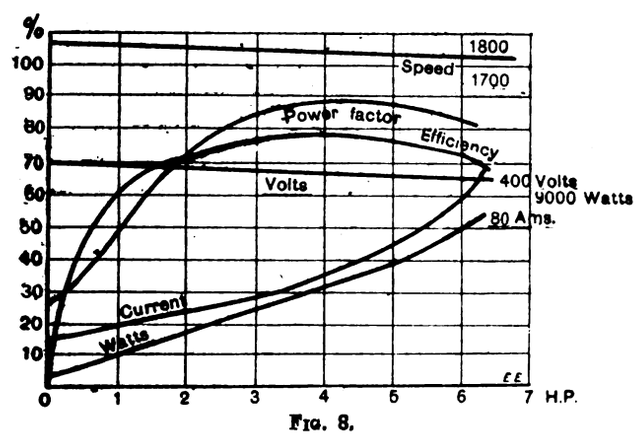

FIG. 8.

The Wagner Company builds this motor in sizes from ¼ h.p. to 35 h.p., to be connected directly on single-phase lighting lines. These motors have met with great success in the States, and are not only used in single-phase installations, but are very often connected to one phase of a three-phase circuit. The wear and tear of the commutator is very small, as the motor is running most of the time with the armature short-circuited and the brushes removed. No replacing of the commutator has been necessary on the motors that have been in regular service for six years, and, in recognition of these excellent results, the Wagner Electric Company was recently granted a medal by the Franklin Institute, Philadelphia. The accompanying curves (Fig. 7) show the results obtained with a 3-h.p. motor. Using speed as abscissa, the ordinates are plotted showing the torque and consumption of current under all conditions of normal load; the solid curve shows the result of using a non-inductive starting box, and the dotted curve is obtained without the use of a starting box. The motors will start with an overload of 40 to 50 per cent. Fig. 8 shows the speed, power factor, efficiency, watt consumption, and current consumption of several motor sizes operating under a given voltage. The transformers (Fig. 4) are used to supply the arc lamps installed on the Exposition grounds. This

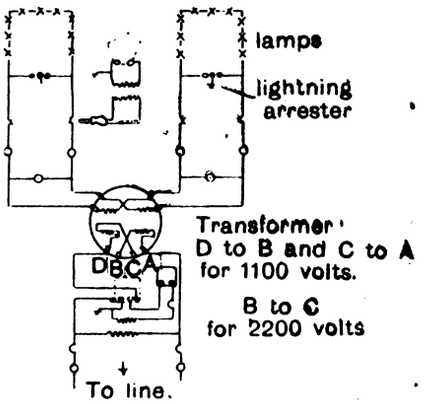

FIG. 9.

system differs materially from the European practice, and some detailed information may be of interest: The lamps are connected in series in groups of 30 to each circuit, and at the present time there are four circuits; the transformers regulate for constant current and variable voltage in the secondary circuit. The diagram of connection (Fig. 9) shows the manner of connecting the transformers and lamps; the lamps consume $6\frac{6}{10}$ amperes with a pressure on the arc of 72 volts, and they are provided with a small starting resistance and an automatic short-circuiting device to cut out the lamp in case of accident to the coils

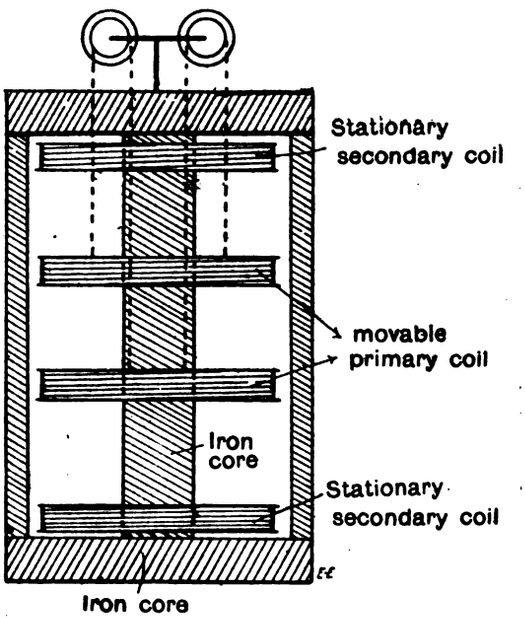

FIG. 10.

or of extinguishing of the arc. The vibrations produced in the iron cores of the coils are absorbed by a small blade spring of phosphore-bronze to which the cores are attached, and this system of connecting arc lamps in series is extensively employed in the States. The transformers are, of course, designed for constant current, and are constructed in different ways according to the size and the methods of cooling; the small types have a stationary primary coil, whereas the secondary coil is suspended and balanced by a counter-weight. The transformers illustrated in Figs. 4, 9, and 10 are air-cooled; the secondary coils are placed at the two extremities, and are stationary, while the primary coils, seen in the middle, are movable; the movable coils are

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balanced one against the other, and a variable weight serves for balancing the repulsive force between primary and secondary coils. The intensity of this repulsive force depends on the current flowing in the coils, and the intensity of current may therefore be increased by adding weight, or decreased by decreasing weight. The transformers regulate from one-third to full load within one-tenth of an ampere, and the efficiency varies according to the size from 94·6 to 96 per cent., and the power factor from 0·77 to 0·78, and these transformers are often built for 10,000 volts. The transformers employed in the World's Fair station can be either connected to 2,200 volts or 1,100 volts across the primary (see diagram of connection, Fig. 9). A switchboard is furnished with each transformer, and this switchboard is, as shown in Fig. 5, connected mechanically with the transformer. The peculiar switches used with these panels, and serving for making the different connections, should be noticed; the connections being made by introducing a 250mm. copper rod into a brass tube (see Fig. 4). In order to make the necessary connection, 12 of these rods must be put in place; this is certainly not very practical, and besides the disadvantage of this feature, there is a possibility of the switchboard attendant touching the bare rod, and thus coming into contact with the high-tension circuit. The switchboard instruments are installed upon a marble plate supported by an iron frame, and bare live parts either on the front or on the back side of the switchboard are entirely avoided; the fuses are replaced by automatic circuit breakers, which have been perfected in this country to give great satisfaction. As lightning arresters three small bronze cylinders are used for each pole in this installation; these cylinders are 50mm. diameter and the same height, and are placed one after the other with an air-gap of 8/10mm. between the cylinders. The surfaces of these cylinders are not corrugated, and in addition suitable carbon resistances are placed in the grounded circuit.

TRACK CONSTRUCTION, WITH SPECIAL REFERENCE TO RAIL JOINTS.

BY F. H. DAVIES.

The great comparative weight and speed of electric tramcars has introduced problems into track design that were undreamt of by the permanent-way engineer of 30 years ago, and these difficulties have not been lightened by the necessity of maintaining all the rails in perfect electrical contact. Track construction of the present day is the outcome of years of experience, and as such has become to a great extent standardised, generally differing only in such details of weight and measurement as are compatible with the use the track is to be put to. An unfortunate exception to this is the gauge. While the majority of tramway systems in this country have been put down to the usual 4ft. 8½in. gauge, there are many, chiefly, however, of old design, that differ from this figure. Three feet six inches seems to be the gauge that finds favour next to the above, then 4ft. and 3ft. Glasgow stands by itself with a gauge of 4ft. 7¾in. The reason for the very wide divergence of opinion on this subject is difficult to see; presumably the adoption of anything under 4ft. 8½in. is on account of narrow streets necessitating narrow cars, and this appears to be the only valid reason, or, at any rate, the only one that is worth consideration.

The appearance of cars of a narrow gauge is certainly not attractive, and the gears and motors are apt to be somewhat more cramped than is desirable. Fortunately, practice seems to be levelling itself down to the 4ft. 8½in. measurement, and as ideas on standardisation are at the present time so strong, it may almost be confidently expected that this gauge will shortly be used to the exclusion of all others, with the possible exception of the 3ft. 6in. for special purposes. That all-important item of track construction, the rail, has passed through many stages both of shape and composition. Originally — that is to say, after wooden rails had had their day—it consisted of a plain cast-iron strip, 4in. wide, spiked on to a parallel wooden track in 5ft. or 6ft. lengths. Naturally this system had many faults, the chief of which were fragility and troubles caused by the great number of joints. To get over these faults, the rails were next made of wrought iron, and in longer lengths. Tramway affairs remained like this for some considerable period, until finally they were made commercially possible by the introduction of the rolled-steel girder rail, which has apparently come to stay; as for the last 25 years the improvements that have been made in it, although important, have merely been in details, such as shape and chemical composition, to suit various requirements.

The chemical composition of a steel rail naturally has a very great bearing on its life, electrical resistance, and general utility. Some authorities have advocated a comparatively soft and ductile rail, while others—and at the present day the majority—prefer one containing a larger percentage of carbon, and therefore of a harder nature. This percentage varies according to the weight of the rail per yard, and the best practice seems to determine it at from 0·35 per cent. for a 50lb. rail to 0 55 per cent. for a 100lb. These figures are the minimum and maximum extremes respectively for the weights quoted, and rails of intermediate weight should have a proportionate percentage, as, for instance, a 60lb. to 70lb. rail 0·38 to 0·48 per cent., and an 80lb. to 90lb. 0·43 to 0·53 per cent. A greater proportion of carbon than this tends to make the rail very brittle, and consequently liable to fracture. In America, however, this percentage has been considerably increased for heavy rails, as in cases Harveyised steel has been used showing in a 100lb. rail as much as 0·76 per cent. at the surface. With this type of rail no doubt this high percentage is practicable, as it applies only to the surface, which has a good backing up of more ductile metal, with the consequence that the rail is not particularly brittle as a whole. However, with the usual rail, such a percentage in the light of ordinary experience seems to invite disaster, and it would be interesting to hear what results have been obtained with rails of this description. An increase of carbon and hardness naturally goes hand in hand with an increase of electrical resistance. This, however, is not a matter of great practical importance, as considerations of wear and brittleness confine the proportions of carbon used, and consequently variations of the electrical resistance, to a very small range. Phosphorus as a constituent is not desirable, as it tends to increase brittleness. The average percentage is about 0·06 per cent., and it should never exceed 0·1 per cent. Sulphur is very undesirable, and should be kept as low as possible, as it has the effect of making the rails seamy. Silicon produces compactness and density in the metal. It increases the resistance of the rail in a greater degree than carbon, and in proportion should never exceed 0·2 per cent. Manganese very largely increases the specific resistance and causes crystalisation in the rails if present in excess. Its presence is, however, necessary in the manufacture of steel, and it is generally found in the proportion of from 0·7 to 1·1 per cent.

The jointing of rails is a subject upon which there seems a wide divergence of opinion, some—chiefly in this country—adhering to the usual form of joint made with fish and sole plates, and others—chiefly in America—to the cast-welded or electrically-welded joint. Whichever system is in use, too much care cannot be expended in the design and making of joints. The noise created by all electric cars when running at any speed is chiefly caused by pounding at the rail joints, and besides being objectionable from this point of view, this pounding is the cause of rapid depreciation at the rail ends and trouble with the bonds and joints. It also causes the concrete bed on which the rails are laid to wear away, and in this manner depreciation goes on with compound interest, so to speak. It has been suggested that a way out of this trouble would be to instal a split or double rail, so arranged that the joint of one half of the rail would be situated opposite the centre of the other half. While this system would undoubtedly reduce the pounding and noise, it seems scarcely practicable on the score of expense, not only with regard to first cost, but also maintenance. There would sure to be trouble with the two halves of the rail opening out, and consequent expense

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would be incurred by the necessity of frequently pulling up the bolts.

To completely get over pounding, creeping of the rails, and consequent trouble with the joints and bonds, there is only one method, and that is to make the rails continuous by the aid of the above-mentioned cast-welded or electrically-welded joints. It has been, and is still, urged against this system that expansion and contraction due to changes in temperature are bound to produce buckling and general destruction of the road paving In practice, however, this has not been found the case to any serious extent, the reason undoubtedly being that the rails are held too firmly to allow of any great movement, and that, unlike railway track, they are to a great extent protected from variations of temperature by being almost entirely covered by the road paving. This latter is a point that has to be borne in mind when comparing the actions of railway and tramway lines. The result of temperature variation on a welded rail is, therefore, chiefly confined to molecular alterations and strains in the rail itself. That these strains are great there is no doubt, but that they do not exceed the tensile strength of steel is certain; and as the tensile strength of a good cast-welded joint is practically equal to that of the rail, and sometimes, as has been proved, even superior to it, there appears to be but little foundation for the fears that are entertained by some as to the effects of temperature variation. It is, of course, impossible to provide against flaws in the rail or joint, and in cases where fracture has occurred through cold it has been generally traced to this cause. If an expansion slip joint is placed about every 500ft., the fear of warping or fracture may be entirely dismissed. At crossings and the like it is necessary to securely anchor the nearest joint, as otherwise there is danger of the rails being pulled out of alignment by temperature changes.

The process of making the Falk cast-welded joint is roughly as follows: The rail ends and sides are scraped bright either with emery cloth, or preferably by a sand blast. This is very necessary, as the least oxide or scale interferes greatly with proper amalgamation. A tight-fitting cast-iron mould is now placed round the joint, and a cap on the top of the rail to protect the surface. The molten metal, consisting generally of a mixture of 50 per cent. hard silicon pig, 25 per cent. soft, and 25 per cent. scrap iron, at a considerably higher temperature than is usual in casting, is now poured in. The metal cools rapidly on the outside surface in contact with the mould, and there forms a scale. The web of the rail being thin is rapidly brought to a white heat, and fluxion ensues, thus making a perfect mechanical and electrical joint. To ensure perfect amalgamation, it is necessary for the rail to be scrupulously clean, and the metal to be of the right composition and poured at a very high temperature. It is also advisable to heat the rail ends slightly before pouring. When the joint is cooled, in a few minutes, the mould and cap are removed and the top of the rail filed smooth. The usual length of this joint is 14in., and the weight of metal used varies with the size of the rail from 70lb. to 140lb. It has been feared that the great heat to which the rail is subjected by this system would have the effect of annealing it at the joint. However, trouble in this direction does not appear to have arisen in practice. As an additional precaution, and in order to give the joint an even better hold on the rail than it gets by amalgamation, short iron plugs are sometimes inserted through the web close at the ends of the rails. These plugs fit tight in the rail, and, being finally embedded in the casting, have a good grip on it, and take most of the strain off the amalgamation.

The electrically-welded system is scarcely through the experimental stage, and is subject to the great objection that it is rather costly and necessitates cumbersome and expensive plant to perform the operation. Doubtless for this reason the cast-welded joint is much more prevalent, producing as it does a practically equal effect at a lower cost. When either of the above joints is used, bonding—that is, across the joints—becomes unnecessary, as the joint is electrically continuous and of practically equal conductivity to the rail. The usual cross bonds between the two rails of the track are, however, of course still necessary. This abolition of joint bonds is a great point in favour of the welded system. As the process is somewhat expensive, especially when carried out in a small way, there is practically no saving in capital cost, but maintenance has generally been found to drop considerably. A case in point that may be quoted is that of the French line between Lyons and Oulling, where the maintenance fell from £200 per kilometre per year to £4 after the introduction of the Falk cast-welded joint. This saving was, of course, not effected on bonding only, but there is no doubt it played a considerable part in it.

There are a great number of varieties of ordinary bonds, most of which attain the end of making good electrical contact between the rails in much the same way, the differences lying in methods of fixing to the rails and allowing for expansion and contraction. It is this last point, combined with the effects of pounding and vibration, that causes all the trouble with bonds working loose. It is obvious that, to be successful under these trying conditions, a bond must possess a very firm and permanent grip, that at the same time must introduce practically no resistance into the electrical circuit. The necessity of a good return path for the current is well known, and what has probably drawn most attention to it is the destruction by electrolysis of metal pipes in proximity to the track that has been frequently observed where the return circuit has not been all that it should be. With good bonding this trouble disappears to a great extent, and it is necessary, therefore, always to instal a type of bond which possesses all the above advantages. On the face of things, the welded bond, consisting of a corrugated copper strip welded to the ends of the rails, would appear to answer the purpose very well; but the trouble with this type is that under ordinary working conditions it is impossible to be certain of a good weld, and consequently the contact has frequently a higher resistance than it should have; also the cost of applying these bonds is very great. Much the same objections apply to the soldered contact bond, which consists of two large copper lugs connected together by waved copper wires. The continual vibration and movement of the rails in time has a very bad effect on the soldering, and the cost of installation is heavy. What is termed the "plastic bond" has been introduced as a solution to these difficulties, but, although possessing many good points, it has never been taken up to any very great extent. In the Edison-Brown plastic bond—about the only one in use at the present time—electrical continuity is preserved by the fishplates, the joint between them and the rail being made electrically perfect by a plastic metallic composition. These bonds have been very satisfactory when properly applied, but great care is necessary that the contact surfaces of the rail and fishplates are perfectly free from scale or rust, and properly amalgamated by the Edison process before application of the compound. A good feature is that they simplify track construction and maintenance by reducing the parts at the joints that are likely to go wrong to a minimum. Another example of the plastic bond is that in which continuity is maintained by a plate of copper placed under the fishplates, through which latter set screws are passed to keep the plate in tight connection with the rails. The contact surfaces are amalgamated by a good conducting plastic alloy. This bond allows free movement of the rail by providing what is practically a lubricated conducting surface, which is certainly an ingenious idea. It has been proved, however, to have several defects, the chief of which are varying and sometimes high resistance and rather heavy initial cost.

The mechanically attached copper bond seems to be the one most in favour, and the results obtained by some of the best makers are very satisfactory. The "Neptune" bond, made by Messrs. Felten and Guilleaume, may be cited as an example. It consists of a drop forged copper rod with an expanding slotted lug at each end. These lugs are passed through holes in the web of each rail, and expanded by steel drift pins driven in on the same side of the rail as the bond is inserted, as shown in section in Fig. 1. The great feature of this bond is that the driving in of the steel pin opens out the slotted ends on the far side of the rail, thus forming a shoulder and making it impossible for the bond to work loose even if the pin is

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withdrawn. By the great pressure exerted the copper is naturally forced into complete and permanent connection with every part of the hole in the rail. This bond is easily and quickly applied, and is cheap in first cost. It has been made more flexible, and therefore improved, by the substitution of stranded wire or several waved copper strips for the solid bar; in the latter case it is, however, still drop forged out of one piece. The protected rail bond manufactured by the Forest City Company is another first-class variety. It is a flexible bond composed of a number of flat copper strips less than ¼in. wide, provided with U bends so as to take up all movement or vibration; these strips are fused to solid copper terminals, which are expanded by a special arrangement into the holes in the rail. These bonds are placed under the fishplates, hence their name, and it is claimed for them that owing to their shortness and position the result is a joint of very low resistance and cost.

The requisites of a good bond are, firstly, that it should have ample but not too great contact surface with the rail. A small contact under high pressure is preferable to a large area under a lower pressure, as in the latter case damp is apt to get in and cause corrosion. It is most important that the bond should have the most intimate connection with the rail possible, and that the pressure should be sufficient to force the copper into even the minutest irregularities in the surface of the hole. Where the pressure is distributed greatly, this becomes impossible.

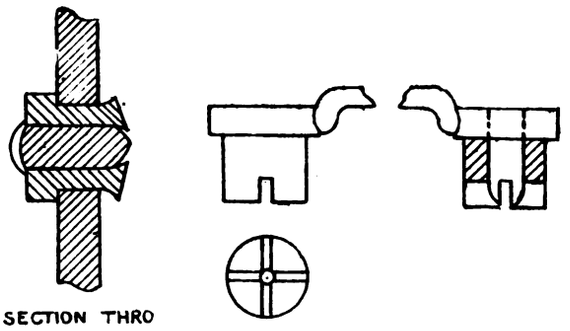

FIG. 1.

Secondly, the bond should be composed of one metal only—that is to say, in the conducting path—and that metal should be one that will not corrode by contact with the rail. Thirdly, it should preferably be made in one solid piece, but if this is not possible, as is frequently the case with flexible bonds, the terminals should be welded on. Fourthly, the lugs that make contact with the rail should be as simple as possible, and not composed of many parts, as each joint introduces a certain amount of resistance into the circuit. The lugs should invariably be expanded in, under as great a pressure as possible, and it is desirable that they should possess when fixed some form of shoulder, like the "Neptune" bond, which reduces risk of working loose to a minimum, and greatly takes up the strain of vibration and expansion from the contact area.

As regarding the fixing of bonds, it is necessary that all contact parts should be scrupulously bright, clean, and dry, and for this latter reason bonding should not be done in wet weather if possible. It is not advisable to use oil as a lubricant when drilling the holes in the rails for the reception of the bonds, as there is sure to be a film left that will for a time increase the resistance.

THE MODERN EQUIPMENT OF DOCKS, WITH SPECIAL REFERENCE TO HYDRAULIC AND ELECTRIC APPLIANCES.*

BY WALTER PITT, M.I.C.E.

Fifteen years ago Lord Armstrong, speaking in a discussion at the Institution of Civil Engineers, said "He felt satisfied that in point of safety, controlability, and adaptability for various purposes, electricity had little chance of ever rising to the level of hydraulic power." In the interval that has elapsed an immense change has taken place, the electric transmission of power is rapidly superseding all other methods, and nowhere is the change more marked than in the equipment of docks. It was the requirements of docks that first caused attention to be paid to the production of a practicable method of distributing power over a large area, and resulted in the evolution of the hydraulic system of power distribution, a system which has for many years been worked out with such thoroughness, and which has done such excellent work, that a modern hydraulic dock plant had come to be considered as almost beyond criticism, and yet at the present moment we may say that he would be a more than conservative engineer who would seriously recommend the adoption of a complete hydraulic equipment in a new scheme of any magnitude.

In dockyards we find in every direction, and separated often by considerable distances, appliances that require power to drive them. In the warehouses there are cranes, travellers, and lifts; on the quays there are jib cranes, capstans, and coal tips; and about the entrances and locks there are sluice-lifting gear and gate winches; in addition, there are generally workshops, sometimes on a very complete scale; and last but not least, the whole place has to be lighted at night. All these duties have to be performed in the first place effectively, and, in the second place, economically. The first thing is always to do the work well, rapidly, continuously, with the minimum of stoppages and breakdowns, and also with the minimum of skilled attention; the second consideration is to do all this at the minimum of cost, giving due weight to first cost, upkeep, and working expenses.

It cannot be denied that the hydraulic appliances that are to be found in a well-equipped dock fulfil admirably all that can reasonably be demanded of them with regard to those requirements that I have put in the first line, and which arise from the point of view of the man who merely has to use the machine and not to provide and pay for it. In spite of this, however, we find that a rapid change is taking place, although, as usual, we have allowed ourselves to lag somewhat behind our neighbours, and if we turn to the Continent we find that the change over from hydraulic to electric appliances about docks is becoming almost universal. I need only mention, amongst others, Hamburg, Rotterdam, Genoa, Bremen, Naples, etc. If we look for the reason of this change, we soon find it. The electric transmission of power can do everything that the hydraulic transmission of power can, and a great deal more besides, and it does it at a cheaper rate. With the same set of engines and boilers every appliance that requires power can be driven, the workshops can be kept running and the docks can be lighted, and there is that combination of a day and a night load which is dear to the heart of every electrical engineer.

In the restricted limits of this short opening paper it may be as well to give a few words to the most important of dockyard appliances, the crane. In respect of first cost, probably there is not very much difference between the cost of an electric and of a hydraulic crane installation. The electric crane is in itself more expensive than the hydraulic, the electric generating plant is perhaps slightly cheaper than the hydraulic power generating plant; but in the case of the connecting link between the power-house and the cranes we find an immense advantage on the side of the electric leads as compared with the cost of hydraulic mains. When we look at the efficiency of the crane as a machine, we find that the electric crane easily surpasses the hydraulic; the quantity of cargo loaded or unloaded for every electrical horse-power delivered at the crane is greater than that for a hydraulic horse-power.

In a paper by Mr. Philip Dawson, A.M.I.C.E., in *Traction and Transmission* for May, there are some interesting data on the power required by electric cranes in loading and unloading vessels at Continental ports, with comparative tests between electric and hydraulic cranes when working under exactly similar conditions, and I have also, through the courtesy of Mr. Baxter, the mechanical engineer of the Clyde Navigation, been given the results of a test made

* Paper read before the Engineering Conference of the Institution of Civil Engineers.

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at Glasgow on March 19 and 20 last. The two cranes at Glasgow work side by side. One is a compound five-ton and three-ton hydraulic crane, and the other is a three-ton electric crane by Stothert and Pitt. The work is precisely similar, the hydraulic and electric cranes having in the previous 13 months discharged and loaded about 41,000 tons and 44,000 tons respectively. The cycle at the test was:

Lift	30ft.
Slew	100deg.
Lower	10ft.
Lift (empty bucket)	10ft.
Slew	100deg.
Lower	30ft.

Mr. Baxter gives the results reduced to cost of power delivered at the crane per 1,000 tons of cargo unloaded. I have analysed the figures on a similar plan to that adapted by Mr. Dawson, and have reduced them to equivalent watt-hours per cycle, with the following results:

	Load— 1 ton.	2 tons.	2½ tons.	3 tons.
Hydraulic crane	236·7	236·7	236·7	236·7
Electric crane	83·3	160·4	197·9	241·9
Ratio H/E	2·84	1·47	1·2	0·983

The foreign test given by Mr. Dawson tells the same story, but comes out a good deal better for the hydraulic, as the crane was a triple compound; the cycle was a somewhat longer one, the lift being 36·1ft., the lower 13ft., and the slew 140deg. The respective watt-hours per cycle are:

	Load. ½ ton.	¾ ton.	1 ton.	1¼ tons.	1½ tons.
Hydraulic crane	82·0	127·2	127·2	172·4	172·4
Electric crane	48·5	58·5	73·5	80·5	105·5
Ratio H/E	1·69	2 17	1·74	2·15	1·63

We thus see that in these two independent tests the hydraulic crane power consumption varied approximately between one and three times that of the electric crane per cycle of operations.

The question of the relative cost of the watt-hour delivered to a crane on either system will no doubt be dealt with in the discussion. As a basis of comparison, we may remember that electricity at 1½d. per unit is the mechanical equivalent in foot-pounds, or watt-hours, of pressure water at 9·8d. per 1,000 gallons, or 5s. 1d. per 1,000 cubic feet, the pressure being 750lb. per square inch, and we must also remember that we have to deal with the cost of power delivered at the work after allowing for all losses in transmission. But there is an aspect of the case that would carry the day in favour of electricity, even if the cost of working were slightly more, instead of less, and this is the extreme flexibility of the system, the great ease with which extensions can be carried out, and entirely different classes of work performed. An isolated machine can be placed in a remote corner, and there is no trouble in getting power to it economically; there is a general adaptability that quite turns the scale in favour of electricity, and it does not freeze up in winter.

Space will not allow me to go into descriptive details of particular machines on either system, but with regard to electrical appliances it may be said that a thoroughly satisfactory system has been produced. There is, however, still the battle of multiphase *versus* continuous current to be fought to a finish, and no doubt points of detail will be much modified and improved in the future—*e.g.*, the last word has not yet been said about controllers and resistances, especially capstan controllers; but, taken as a whole, the electric equipment of docks is here and has come to stay.

Summarising my argument: (1) the first cost of an electric installation is not more than that of a hydraulic plant; (2) the cost of up-keep is no more; (3) the electric machines are more efficient, and take less power for the same work done; (4) the power is less costly to generate; (5) the transmission losses are less; (6) the general adaptability is incomparably greater.

Discussion.

Mr. A. B. Ellington said it was really somewhat difficult to take Mr. Pitt quite seriously. He began by quoting Lord Armstrong, and with regard to safety and controlability Lord Armstrong was right then, and no doubt would be right now if he cared to express an opinion. He agreed that there was no power which was available for use which had the same adaptability as electricity. He contended that in the case of docks the adaptability of hydraulic power was sufficient. He then proceeded to deal with the figures mentioned in the paper in order, he said, to show that from his point of view nearly every argument that had been put forward in the paper was wrong. The 1½-ton hydraulic crane was put at 172 watt-hours per cycle, but he was quite sure there were plenty of makers who would be quite willing to put up cranes which would not consume more than 120. The amount of the electric crane was 105, but he did not think that would be anything like realised in ordinary practice. To attain it at all there must be some very special circumstances by which the very high efficiency could be obtained, and the motors must also be extremely efficient. There was no reference at all to the accumulator, which was the foundation of the hydraulic system—it was like criticising the play of "Hamlet" and leaving the character of Hamlet out of it. No speeds were given, and no rates of efficiency could be worked out satisfactorily, but he was quite sure he was within the mark when he said that the lifting of that crane ought to be done in under 15 seconds. They heard that the first cost of an electric installation was no greater than that of the hydraulic. He submitted that if the figures were properly compared, and if the hydraulic power was properly put down, having regard to the way in which the maximum efficiency of hydraulic machines could be obtained, then that was also untrue. He asserted that every electrical engineer who was dealing with that question was seeking to get something as good as hydraulic. There was an extreme discrepancy in coal consumption between electrical power and hydraulic. The reason for the greater economy was to be found in the hydraulic generating plant being worked at a varying speed at a varying load, but that every electric plant had to work at a constant speed at a varying load, so that the economy of the hydraulic plant was very much greater than that of the electric. He said that there had been some carelessness in presenting the paper in that form. Of course Mr. Pitt was an enthusiast, and he was very interesting, and would like to have a nice discussion and all that, but on p. 2 he said: "With the same set of engines and boilers every appliance that requires power can be driven, the workshops can be kept running and the docks can be lighted, and there is that combination of a day and a night load which is dear to the heart of every electrical engineer." It sounded nice, but it meant nothing.

Mr. Cecil Brown said he felt it incumbent upon him to speak as there had been such an attack on the paper. He was asked last year to prepare a scheme in connection with a Bill to equip in an up-to-date manner a harbour and docks, and he thought it was desirable to go thoroughly into the question of equipment almost before the building of the dock, and he advised the promoters that he thought it would be better to consider the equipment first and make that thoroughly efficient, and just spend what money they had left in making the dock. He did so, because he thought it was better to have a smaller dock thoroughly equipped than a larger one not so thoroughly equipped. He found it pretty much as that paper stated: that the cost of electric installation was pretty much the same as that of hydraulic, and there was one point in which it was ever so much better. He made an estimate for the electrical equipment, and as the Bill was before Parliament, he might just state that the cost would be £24,000 for the plant and £10,000 for the generating plant. He believed Sir Leader Williams had some electric cranes working on his canal, and he thought if the fairies could give him a wish, it was that the whole of that canal should be worked by electricity at the present moment.

Mr. Baxter, Mr. Stokes, Mr. G. H. B. Homfray, Mr. J. M. Dobson, Mr. P. Sothert, Prof. Jameson, Mr. C. J. Hobbs, Mr. B. J. Arkwright, Mr. J. C. Dove, and Mr. Robson having spoken, Mr. Pitt replied.

RADIUM AND OTHER RADIOACTIVE SUBSTANCES WITH A CONSIDERATION OF PHOSPHORESCENT AND FLUORESCENT SUBSTANCES. THE PROPERTIES AND APPLICATIONS OF SELENIUM AND THE TREATMENT OF DISEASE BY THE ULTRA-VIOLET LIGHT.*

BY WILLIAM J. HAMMER.

(Continued from page 864, Vol. XXXI.)

There are also many insects, such as fireflies and glow-worms, and many deep-sea fishes, which have the properties of producing phosphorescence. Phosphorescence is exhibited among other animals by the infusorian noctiluca, marine radiates, polyps, etc., which are the principal causes of phosphorescence of the sea. In Fig. 1 is shown an illustration of the Pyrophorus Noctilucus. This tropical beetle has been most carefully studied by Prof. S. P. Langley and F. W. Very, and the efficiency of the light given off tested by the Langley bolometer; and they have demonstrated that practically all the energy which its phosphorescence represents appears as light; and the light given off by this insect is the most

* A lecture delivered at a meeting of the American Institute of Electrical Engineers and the American Electrochemical Society, New York, April 17, 1903.

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efficient light known, it being produced at about one four-hundredth part of the cost of the energy which is expended in the candle flame.* Sir Oliver Lodge says if the secret of the firefly were known, a boy turning a crank could furnish sufficient energy to light an entire electric circuit. And Prof. Langley says: "There seems to be no reason why we are forbidden to hope that we may yet discover a method (since such a one certainly exists and is in use on the small scale) of obtaining an enormously greater result than we now do from our present means of producing light." Langley believes the light of these insects is due to chemical action, as it is decreased by nitrogen, which checks combustion, and is increased by oxygen, which increases combustion, and furthermore, the product is apparently carbon dioxide. We also may produce phosphorescence by rubbing crystals together, or by friction of other bodies, or by cleavage, such as fracture of lump sugar in the dark. Among plants, phosphorescence was first recorded by A. Linnæus, whose daughter discovered it in the nasturtium. Phosphorescence or flashes of light are often observed, especially just after sunset, in the common red and yellow marigold, the tuberose, sunflower, poke weed, martagen lily, and the poppy. The root stock of khus-khus grass and the sap of certain tropical vines and subterranean plants, some liverworts, ferns, mosses, fungi and algæ, and the mycellium of fungi in decaying wood phosphoresce. This phosphorescence is said to be due to slow decay and oxidation, either in the mycelia or fructifications of the fungi. Heat and dryness soon dissipate it.

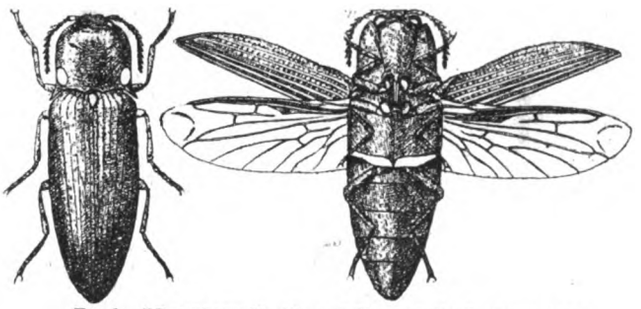

FIG. 1.—"Pyrophorus Noctilucus" (life size), the Producer of the Cheapest Form of Light Known.

Having considered certain of the phenomena of phosphorescence and fluorescence, I wish now to call your attention to these remarkable substances which have recently been discovered, which give off light the moment they are created, without having to be stimulated by any form of heat, light, electrical, or other vibrations, so far as we are at present cognisant of, and these substances are attracting a great deal of attention, and are likely to teach us more about the constitution of matter, and the co-relation of the vital and physical forces, than any substances which have been created since the world began. I refer to "radium, polonium, actinium, and thorium."

RADIUM AND OTHER RADIOACTIVE SUBSTANCES.

To the discovery of M. Henri Becquerel, member of the Institute of France, in 1896, of those remarkable radiations emanating from uranium, the science, if we may so term it, of radioactivity owes its foundation. Great importance must, however, be attached to the previous investigations into the phenomena produced on the interior and exterior of vacuum tubes of various kinds by such men as Varley, Hittorf, Crookes, Lenard, Röntgen, Hertz, J. J. Thomson, Goldstein, Schmidt, Ebert, Wiechert, Geissler, Kaufmann, Puluj, Perrin, Villard, Wien, Wiedemann, Majorana, Birkland, Deslandres, Poincaré, Edison, Tesla, Rowland, Michelson, E. Thomson, Moore, Rollins, Campbell-Swinton, and others, which investigations had already wrested from Nature so many secrets bearing upon the constitution of matter and paved the way for the Becquerel rays. Two important links in the chain were supplied by the experiments of M. Henry† and M. Niewenglowski.‡ The former showed that phosphorescent sulphide of zinc penetrated black paper and affected a photograph plate, similar to Röntgen rays, and the latter in his experiment replaced the usual cover of a loaded photographic plate holder by a thin sheet of aluminium, on top of this he placed four glass squares sprinkled over with sulphide of calcium, rendered phosphorescent by exposure to sunlight. A jeweller's glass bell jar was put over each plate, and the whole apparatus was then placed in a dark room for 23 hours. On developing the negative, the plate showed an excellent image of the squares of glass and the bell glass covers which had been made through the aluminium, a substance heretofore supposed to be entirely opaque to light; the white line shown bordering the squares of glass (where the plate had not been affected) indicated that the rays had here been bent or refracted in passing through the edge of the glass, demonstrating that he was only dealing with ordinary light rays. Subsequently Prof. Becquerel investigated the effect of phosphorescent substances on photographic plates covered with black paper, such as is used for covering X-ray plates, and which while transparent to X-rays is impervious to ordinary light waves (a plate so protected may be left in the sunlight for 24 hours), and he exposed various uranium salts to sunlight to try their effect, at times placing an aluminum, copper, or glass plate between the paper and the photograph plate or film. On one occasion after he had placed some double sulphate of uranium and potassium on a photographic plate the weather became stormy, and he placed his plate with the uranium salts upon it in a drawer, where it remained for several days on account of continuance of the cloudy weather. It then occurred to him to develop the plate, and much to his surprise he found a well-defined impression upon the plate, and this caused without any effect of phosphorescence due to exposure to sunlight. This led to his discovery and investigation of the remarkable radiations which have since been known by his name.*

I have here some samples of the first substances employed by Becquerel, consisting of double sulphate of uranium and potassium and double sulphate of uranium and ammonium, for which I am indebted to the courtesy of Dr. C. F. Chandler, of Columbia University. Peligot, in 1840, succeeded in isolating metallic uranium from the chloride. Well-known forms of it are also uranium arsenate, uranium carbonate, uranium niobate, uranium phosphate, uranium silicate, and uranium sulphate. Uranium was first discovered in 1789 by the German chemist Klaproth, he naming it after the planet "Uranus." I have here various forms of this uranium, and also some metallic uranium prepared in the electric furnace by Moissan, which is more powerful than any other form of uranium. Uranium, although widely distributed, is never found in large amounts, and forms several minerals. The commonest of these is "uraninite," commonly known as "pitchblende," which is a compound oxide containing 81½ per cent. of uranium, 4 per cent. of lead, and ½ per cent. of iron with oxygen and water, and sometimes magnesia, manganese, or silica. The pitchblende which contains the largest percentage of radioactive material which has thus far been discovered is the Bohemian pitchblende. It is also found in Saxony in small pockets, and a distinct vein of it has been found in Cornwall, England. Prof. Curie informed the writer that he had secured some excellent radioactive pitchblende from the United States (Colorado). The ore as mined in Cornwall yields 18 to 20 per cent. of the metal, this being the most important source, and this is usually put on the market in the form of uranium sesquioxide, and is largely used for giving porcelains a velvety black when heated in the annealing fire, and to some extent for imparting a greenish-yellow fluorescence to glass. It has also been suggested to use it on account of its high resistance in connection with incandescent lighting

Following the original discovery of the Becquerel radiations in 1896 came the discovery in 1898 of "polonium" by Prof. Pierre Curie and Mme. Sklodowska Curie, who in investigating Becquerel radiations from uranium found

* "On the Cheapest Form of Light," by S. P. Langley and F. W. Very, No. 1,258 Smithsonian Misc. Coll.

† *Comptes Rendus*, Feb. 10, 1896. Vol. cxxii., p. 312.

‡ *Ibid*, cxxii., p. 386.

* *Comptes Rendus*, Feb. 24, 1896, vol. cxxii., p. 420.

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some samples of pitchblende, from which the uranium is extracted, which was much more powerful than any uranium they had found, being four times the radioactivity of metallic uranium. Concluding naturally that the Becquerel radiations were due to some unknown substance in the pitchblende, they commenced a most painstaking search for it, and discovered a substance associated with bismuth, which it resembled very much in its chemical characteristics, to which Mme. Curie gave the name

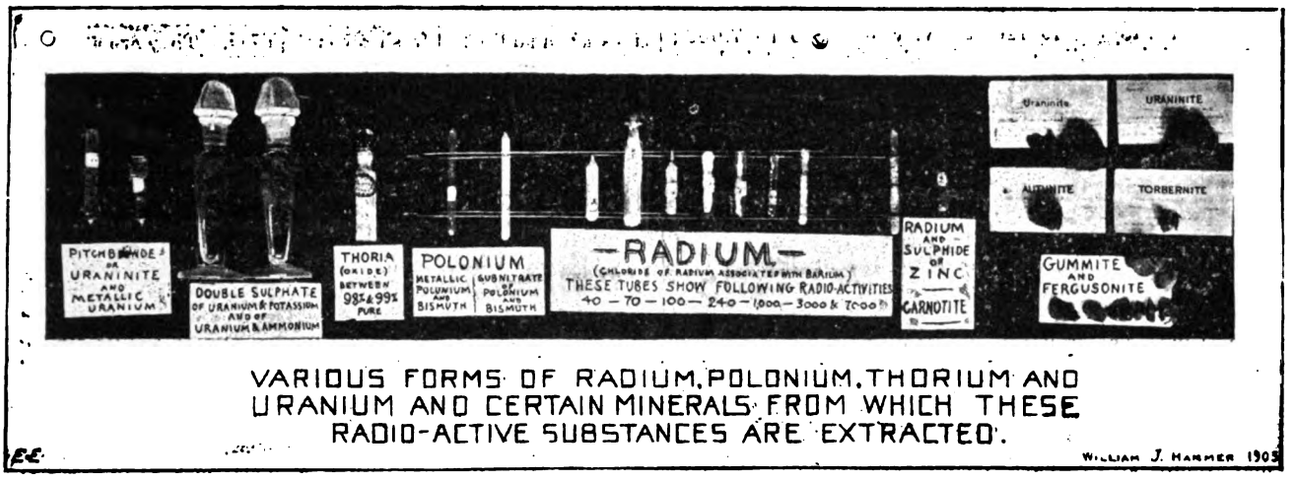

FIG. 2.—Radioactive Substances.

"polonium," after her native land, Poland. I have here, perhaps, the only sample in this country at present of metallic polonium, which in colour resembles somewhat the particles of nickel; and here also is some sub-nitrate of polonium. Where substances are referred to as possessing a certain "radioactivity," for instance, 300, it means that the radiations are 300 times as powerful as the original radiations emanating from uranium, which were discovered by Becquerel, and which are taken as a standard of comparison. The two tubes which

M. Bemont, succeeded in isolating a second substance found in pitchblende, which was associated with barium and possessed many of the chemical and other characteristics of that substance, and to this they gave the name "radium." Of this we shall treat later. In 1899 was discovered the third substance in pitchblende, which possessed the chemical and other characteristics of thorium with which it was associated, and to this Debierne gave the name "actinium." It is precipitated by ammonium sulphhydrate. Crookes states that actinium is identical with

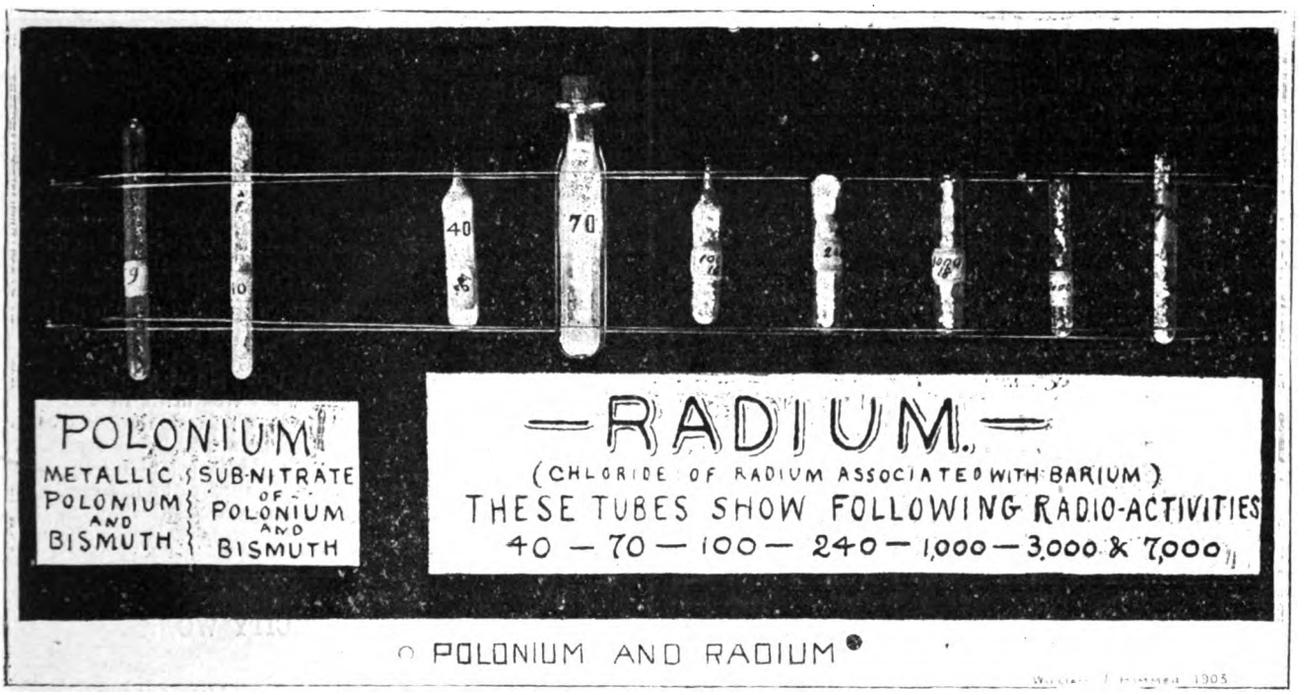

FIG. 3.—Showing Two Tubes of Metallic Polonium and Bismuth and Subnitrate of Polonium and Bismuth, and Seven Tubes of Chloride of Radium and Barium in the possession of the Author. (About two-thirds natural size.)

I have here to-night are of the sub-nitrate and metallic form, and possess a radioactivity of only about 300. The sub-nitrate form is a white powder, and the metallic, as said, resembles in appearance particles of nickel. Polonium is precipitated by hydrogen sulphide. Polonium apparently loses its power much more rapidly than radium, and the Curies have not been able to prepare any in which the rays have been deviable, although Giesel has prepared a form possessing both deviable and non-deviable rays; and Elster states that when polonium is placed in a vacuum the rays may be deviated by a magnet to a greater extent

the substance which he had isolated from uranium, and to which he gave the name "uranium X." The rays from actinium are deviable. Of the three substances to which I have referred, radium is by far the most important, and is of extraordinary interest. It is doubtful whether any substance has been discovered in the history of the world of such stupendous interest and importance and possessing such puzzling characteristics as radium, which seems so at variance with well-established scientific theories as to the constitution of matter. In Fig. 2 are shown in consecutive order from left to right a tube containing pitchblende, or

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uraninite, from which radium, polonium, and actinium, as well as uranium, are extracted; a tube containing metallic uranium made in the electric furnace by Moissan; two flasks containing double sulphate of uranium and potassium, and double sulphate of uranium and ammonium, these being the original salts of uranium with which Becquerel experimented when he discovered the Becquerel rays; a tube containing thorium, the most radioactive substance next to radium; two tubes of polonium and bismuth, one tube of metallic polonium and the other sub-nitrate of polonium; seven tubes of chloride of radium associated with barium ranging in radioactivity from 40 to 7,000; a tube containing radium and phosphorescent sulphide of zinc; and a tube containing carnotite, which, together with the samples shown of uraninite, autunite, torbernite, gummite, and fergusonite, are among the mineral substances which are rich in radioactive materials. Other active minerals are orangite, euxenite, broggerite, cleveite, monazite, samarskite, xenotime, æschynite, niobite, arrhenite, hielmite, sipilite, chalcolite, etc. In Fig. 3 the two tubes of polonium and the seven tubes of radium are shown about two-thirds their natural size. Radium, actinium, and polonium, Prof. Curie states, possess an activity which is a million times that of uranium. Prof. Curie says radium emits exactly the same quantity of Becquerel rays when in the liquid air as it does at normal temperature of the atmosphere. The luminosity of the chloride of radium is stronger in the liquid air than in the atmosphere at a normal temperature. My friend, Mr. R. R. Bowker, whom I met in Paris last fall, told the writer that he had shortly before that been dining seated between Lord Kelvin and Prof. Becquerel, and that Lord Kelvin had turned to him and said that the discovery of Becquerel radiations had placed the first question mark against the principle of conservation of energy which had been placed against it since that principle was enunciated.

(To be continued.)

TRADE NOTICES AND NOVELTIES.

Dick, Kerr, and Co.'s Modified Standard Car.

Messrs. Dick, Kerr, and Co., Limited, have recently delivered to the Leicester Corporation a sample car, built by the Electric Railway and Tramway Carriage Works, Limited, Preston, Lancashire, which embodies some features that are new and important in railway car construction. These features are principally an improved method of ventilation and an improved design of interior finish, which, taken together, have produced a very satisfactory car, and one which is a long way in advance of what has come to be universally known as the "Preston standard top-seat car." The provision made for ventilation will be readily understood from the annexed diagram, which shows a cross-section of a top-seat tramcar roof constructed to provide for an inlet of fresh air, and an outlet for the foul hot air that ascends to and fills the upper part of the car. The inlet for fresh air is provided for through the usual line of hinged windows placed above the large fixed glass windows universally used in recent tramcar work. These hinged windows were first adopted by, and have since become an essential feature of, the Preston standard top-seat car. They are shown in the diagram at the points marked A A, and the circulation of the air that takes place from the outside into the car is shown by the arrows marked B B. These hinged windows, which are arranged in the outside walls of the car on each side, have proved to be the best means for the admission of fresh air into the car that has yet been devised, and they have been universally copied by all the principal car-builders throughout England in tramcar work. With the use of these windows experience has shown that the only thing wanting for thoroughly ventilating a tramcar was some provision for a further supply of fresh air from the outside into the car, and a means for the escape of the foul hot air which ascends to the roof, and which cannot get out without interrupting the current of fresh air passing into the car through the hinged windows already referred to. This increased supply is provided for by a hinged sash on each side of the end door in each end of the car, marked on the diagram F F. These sashes can be opened in exactly the same way as the sash, A A, at the sides when additional fresh air is required. They are also provided with perforated louvre panels, G G, on the outside, and being in the end of the car they admit of a large supply of fresh air passing into the car without interfering with the arrangement of coloured signal lenses, and without allowing the admission of water in wet weather. The outlet for the foul hot air has been provided for by a recess made in the roof of the car, marked C C, and which, as shown in the diagram, is just above the hinged windows above referred to. The circulation of the foul hot air through this recess to the outside is shown by the arrows marked D D. On the outside of the car on each side and connecting with this recess are fixed ventilators, marked E E, constructed in such a way that no air can pass into the car at these points, but the ventilators are exhausting, or drawing, the hot air out when the car is running. It will be noted that this recess, C C, not only connects direct with the interior of the car, but that it also connects with the roof space, H H H, between the millboard ceiling and the main deck, and that this space, which in ordinary tramcars is a dead air-space without means of escape, is thoroughly ventilated by this arrangement. If required, a further outlet for the hot air in the top of the car may be provided for by perforating the millboard ceiling to connect with this space and indirectly with the ventilators on the outside of the car. It will also be noted that this exhaustion of the air by the ventilators through the recess and roof space is not arranged with any means for preventing their action, and the escape of the foul hot air continually taking place. The effect of this construction and arrangement of ventilation is that the interior of the car is constantly provided with a circulation of fresh air into and the foul air out at the points named, absolutely without dangerous or annoying draughts. The application of this principle of ventilation to the car lends itself to a very satisfactory treatment in the way of interior design and general finish, which adds very largely to its appearance. The accompanying illustrations clearly show this. The woodwork connected with the interior finishing is done in oak and mahogany, and, as the illustrations show, has been treated in an entirely new and original way, much to the advantage of its general appearance.

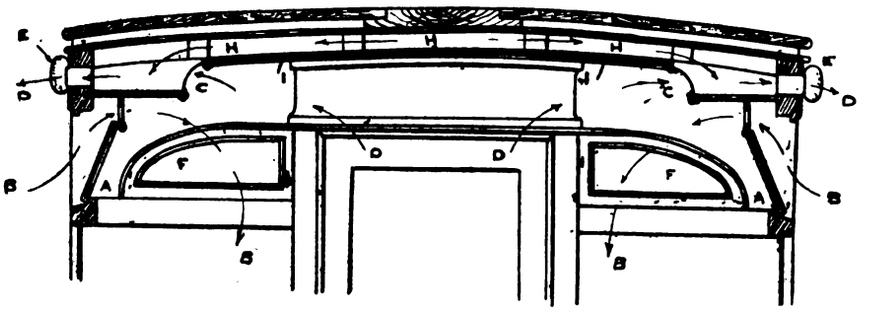

Diagram showing Method of Ventilation—Dick, Kerr, and Co.'s Modified Standard Car.

DONCASTER ELECTRICITY WORKS.

The engineer's report on the third year's working of the electricity department of the Doncaster Corporation to March 31 last has just been issued. It states that at the beginning of the first year (April 1, 1902) the amount of capital expended was £45,727. During the year a further amount of £8,748 has been expended, bringing the total expenditure at the end of the year to £54,475. 13s. 1d. The increase in the amount of plant installed in the power station during the year was 220 kw. This is entirely taken up by the power required for the tramways. Part of the capital expended was to compound the then two largest dynamos in the station in order to make them serviceable for supplying both the traction and lighting loads. The fuel economiser, too, has given very satisfactory results in the saving of fuel, and from the results up to the present the undertaking promises to pay for itself in two or three years' time. The condensing plant was not completed before the end of the year, and had not then started working, but the great benefit of this will be marked in the next year's working. The

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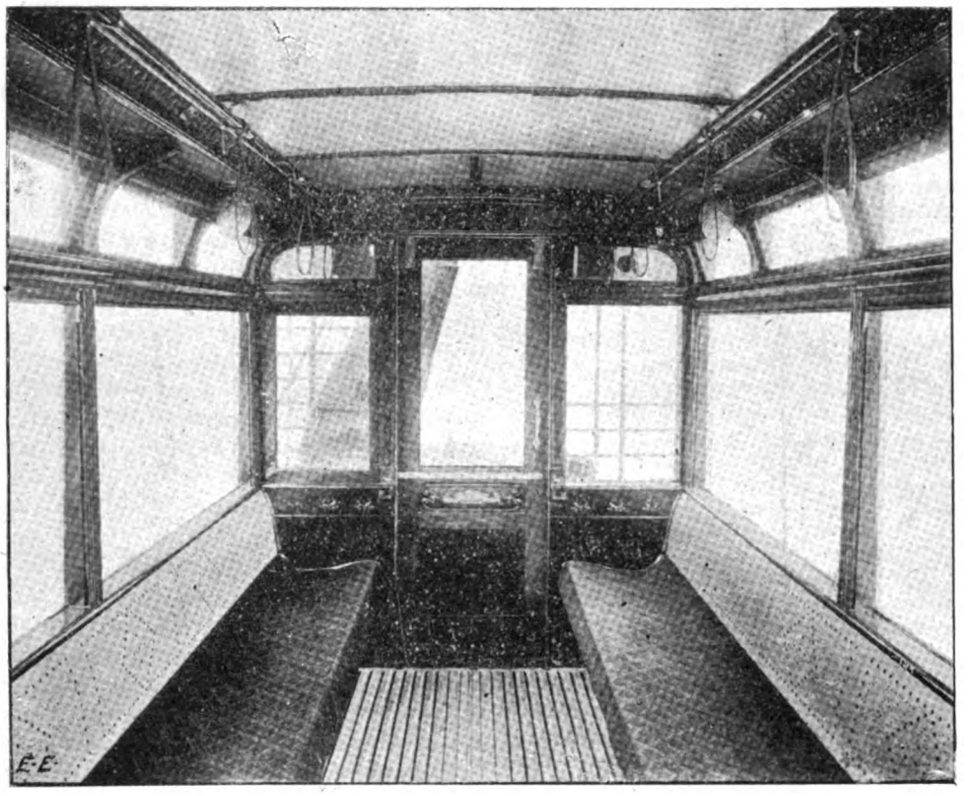
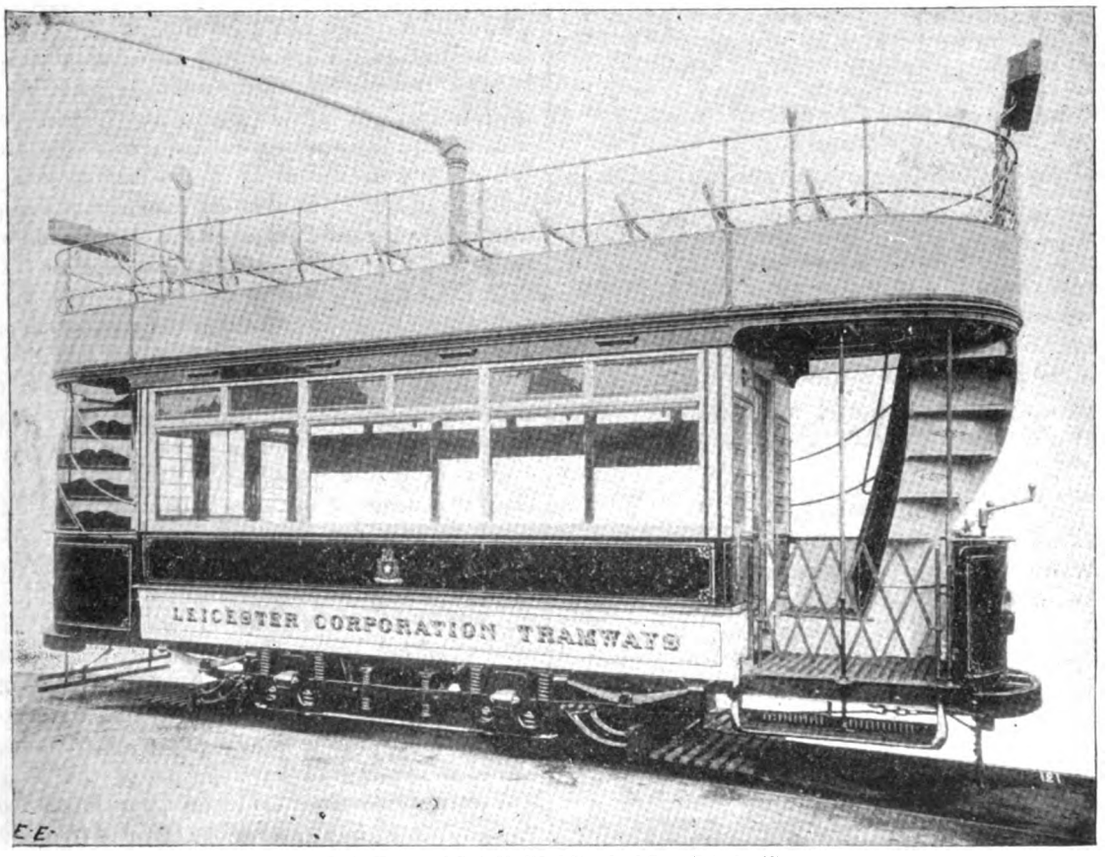
progress of the connections of consumers has been satisfactory. The number of consumers at the end of the year was 258, and the number of lights (8-c.p. lamps) 20,344. The motors connected



Dick, Kerr, and Co.'s Modified Standard Car—Interior View.

numbered 26, with a total horse-power of 166·5. The number of units sold was 139,458 for lighting, 31,107 for power, 238,640 for traction—total, 409,205. The number of units generated was 478,699. The total revenue amounted to £24,484. 14s. 3d., and the expenditure



Dick, Kerr, and Co.'s Modified Standard Car—Exterior View.

to £22,755. 1s. 3d., leaving a gross profit of £1,729. 13s. The average price per unit obtained was 2·54d. The price obtained for lighting alone was 4·45d. per unit. The maximum load on station in kilowatts was 510·5. With regard to the gross profit (£1,729. 13s.), after paying all charges on working costs there is this surplus available to go towards paying off interest and sinking fund. Although this is not sufficient to meet the capital charges, yet it is considerably more than was available from the previous year's working, showing an increase of 387 per cent., and promises well for the department soon being able to be considered as a paying concern. In conclusion, Mr. W. Wyld expresses his best thanks to the whole of the committee for the support they have given him in the various suggestions he has from time to time brought forward, and trusts that the results may be such as to not only fully justify the support which they have given him, but to thoroughly satisfy the committee that they have been material in assisting to make the undertaking a successful one.

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THE

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TO CORRESPONDENTS.

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PROGRESS.

It has been our custom for some years past to *report* the annual meetings of the Verband Deutscher Elektrotechniker. As reward we have on several occasions had the satisfaction of bringing to the knowledge of our readers important developments or inventions, details of which had been purposely reserved for publication at these meetings. This year's proceedings, according to the account rendered by our correspondent, the introduction to which has already appeared in these columns, were marked by the absence of any very special announcements. That great development which the Germans are craving to instil into their industry, fresh vigour and prosperity, seems as far off as ever, and the situation consequently remains depressed. It is not so much from the lack of orders as from the unremunerative prices obtained that the electrical industry in Germany is suffering. Over-capitalisation and the too hasty extension of works have been chiefly responsible for the trouble, but, fortunately, most of the concerns involved have been of sufficiently stable proportions to endure, and can look to the future without much fear as to the outcome. The balance between productive capacity and normal demand has been severely upset, but is bound to be restored sooner or later as the natural consequence of an improving home market. Meanwhile, the capital invested yields but a poor return, and this is where the shoe pinches. In their distress the Germans have certainly proved themselves resourceful, and have met depression with effective means to prevent undue competition from within, besides endeavouring to obtain more economical production. In some cases amalgamations have been effected between large firms, and in others small firms have been absorbed by the large ones. In the Siemens-Schuckert combine we have an example of the former, and in the absorption of the electrical department of Gebr. Körting, Hanover, by the Allgemeine Elektricitäts-Gesellschaft, Berlin, a good instance of the latter case. One of the principal objects attained by the Siemens-Schuckert combine will be the concentration of the dynamo construction departments of the joint concern at Nürnberg, while the establishments in Berlin will be devoted exclusively to the manufacture of instruments, cables, etc. But not even commercial depression has been without its advantages to the German industry, if we are to take the president of the Verband, Herr Geheimerath Prof. Dr. Ulbricht, seriously. In his address the president pointed out that the prevailing commercial depression had enabled greater attention to be paid to scientific and technical problems, whereby the way was prepared for future material developments. As examples of recent progress made, Herr Ulbricht mentioned the use of induction coils coupled in series for compensating the capacity of telephone lines, thus enabling the voice to be clearly heard and understood over increased distances, and the extended use of the telephone in railway work. He referred also to the increased utility of asynchronous machines derived through improved methods of winding, and to the use of multiphase currents of different frequencies in the same conductor, which justified the hope of greater economy of transmission through long conductors. The successful production of nitrogen in a marketable form by electrical means, the development of the steam-turbine, and recent improvements in lamps, were further commented upon in turn. But whether our German friends are indeed justified in assuming that extra stimulus has been given to research by the prevailing lull in commercial activity is open to question, especially as the pioneering work in some of the directions indicated was initiated outside the Fatherland. However, that may be as it may, we should be the

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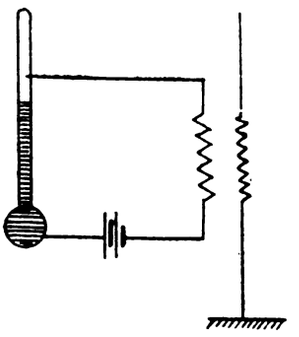
last to grudge them progress in the scientific development of their electrical industry, since we are all striving for the same end and greet progress irrespective of its source. Much as has been already accomplished, there remains more to be done, especially at the consumer's end of the transmission line. Take, for example, the question of lighting. No great stimulus has yet been given to electric illumination such as was given to gas by the Welsbach mantle. It may be that the Nernst lamp is yet destined to effect a general reversion to electric lighting, but the symptoms of rapid development are absent. Judging by casual observations, we should say that this lamp is gaining favour at a slower rate in Germany than here. Probably its slow evolution from the experimental to the commercial stage still has a retarding effect on its introduction. Greater initial cost, high minimum candle-power, and extra complexity as compared with the ordinary form of incandescent lamp, no doubt also stand in its way, but these objections will scarcely maintain a preponderating influence in face of the economy effected.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

WIRELESS FIRE-ALARM.

SIR,—Allow me to bring under your notice an application of wireless telegraphy which, however modest it may be, might be of real use. The invention has the object to call the fire brigade's immediate attention, automatically and without wires, to fire or to any dangerous rise of the temperature in the buildings where the apparatus is installed.



It consists of a mercury thermometer, in the bulb and tube of which platimum contacts are inserted. The contact in the bulb is placed at the degree where the temperature becomes dangerous. The contacts communicate with the ordinary wireless telegraphy apparatus. The transmitter, which consists of a special cog-wheel, transmits automatically the name of the street and the number of the house of the building in danger. The contact in the tube is not reached by the mercury as long as the temperature remains normal. When the apparatus is at rest, if the temperature rises to the critical point the mercury column touches the contact, the circuit is closed, and the transmitter sends the requisite information to the receiver. This apparatus should, it appears to me, prevent many a catastrophe by advising the fire brigade in good time. In the hope that you will allow me space for the above in your columns, I have the honour to remain—Yours, etc.,

EMILE GUARINI.

RE COMPOUND WINDING.

SIR,—Does Mr. McCausland ask this question in a spirit of sarcasm, since an answer more enigmatical would be difficult to conceive? Taking the answer as it stands, it is full of untold possibilities, for a motor which, under ordinary circumstances, requires less current with increased load has yet to be designed; and a *motor* giving an increased E.M.F. under load is indeed a *rara avis*.

To see what really takes place in a compound motor when loaded, we may first consider the case of a simple shunt motor. When the armature of the motor revolves due to the reaction between the current flowing in it and the lines of force generated in the field, it is at the same time acting as a dynamo, and a back E.M.F. is induced, proportional to the speed, in accordance with the equation

$$E = E_1 - C R_a,$$

where E = back E.M.F.;
E_1 = E M.F. supplied to motor terminals;
$C R_a$ = volts drop due to armature resistance.

This equation may be said to govern the behaviour of the motor when under load. For suppose that due to an increase of load, the speed is momentarily reduced; then E in the equation, being proportional to the speed, is decreased. But as E^1 is supposed constant, and R_a is constant, the armature current must increase, and in doing so supplies the torque necessary to overcome the increased load. Hence we see that for a shunt motor an increase of load results in a larger armature current and slightly decreased speed and back E.M.F.

It is easy to see how the addition of series coils on the field magnets will modify the above conditions. As before, due to increased load, the armature current will increase, and consequently also the current in the series coil. The field by this means being strengthened, a large torque is exerted, tending to pull the motor up to speed again. The compound-wound motor therefore occupies a place intermediate between the series motor and the shunt motor. It has to a greater or lesser extent, depending upon the nature of the compounding, the advantages peculiar to the series motor—viz, a larger starting torque without excessive current—but due to the variation in the field, it has not the constancy of speed for which shunt motors are usually designed.—Yours, etc, L. D. WAINWRIGHT.

QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any questions should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

599. Describe the electrical equipment necessary for a large 500-volt electric crane to lift, say, 50 tons, preferably a travelling crane, with special reference to the method of starting and controlling.—D. R.

600. Distributors run along a main road, and a consumer's residence is situated 180 to 190 yards up a side road, which is a public bridle path and footway. Is it legal to charge the consumer for the whole cost of such main, or would he come under the Board of Trade minimum charge clause of the provisional order—*i.e.*, "to pay in the aggregate for a supply of energy for three years a sum not exceeding 20 per cent. upon the cost of laying such distributor to the nearest available source of supply"?—H. F.

ANSWERS.

Question No. 589.—A shunt-wound 500-volt four-pole motor drives the circulating pump of a surface condenser, and as this motor is semi-enclosed, the two bottom sets of brushes are difficult to get at for cleaning purposes, etc. It is now proposed to use two sets of brushes only instead of four. What alterations must be made to the armature in present use? and if an entire new armature is necessary, show exactly how it must be wound.

Answer to No. 589 (*awarded 7s. 6d.*).—Unfortunately "R. M." has not in his question specified the manner in which the present armature of the motor is wound, whether ring or drum; or, if the latter, whether lap or wave. It is therefore difficult to answer the question in its present form directly, or to do more than just consider some of

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the general principles involved in the problem for the most probable cases. An easy means of identifying the winding of a drum armature may perhaps be mentioned—namely, by simple inspection of the top layer of end connections at the two ends of the armature. In the common form of straight-out end connections of the armature coils of a wave winding the wires at one end are parallel with those at the other end, so that any one wire is connected at, say, the pulley side to another wire under the next pole, which wire is in its turn connected on the commutator side to a wire under a still further pole, whereas in the case of a lap winding the wires of the top layer of end connections at the two ends, if produced, would meet at approximately 90deg., and any one armature wire is connected to two *adjacent* wires under the next pole, instead of two wires under different poles.

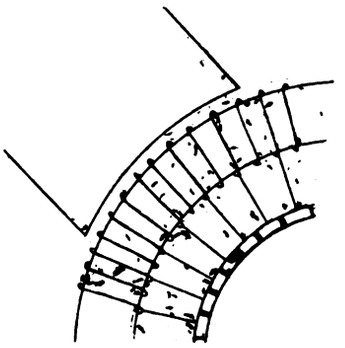

FIG. 1.

The various ring windings may, perhaps, be dismissed from consideration; these windings have been pretty extensively used in the United States, but are now, in this country at least, the exception rather than the rule. In any case the remarks which apply to the lap winding will generally apply also to the ring winding, if the latter is wound as a continuous ring, such as is shown diagrammatically in Fig. 1; while in the less general case, when the coils under any one pole are connected to the coils under another pole of the same polarity, as in Fig. 2, the winding may be looked upon as being very nearly equivalent to a wave-drum winding; the winding of Fig. 2 when completed would have 13 coils (on the six-pole machine), re-entrancy being attained at the end of the fourth complete encircling of the armature. The simple winding of Fig. 1 properly requires four brush sets, spaced equally round the armature, while the series winding of Fig. 2 requires only two sets placed at 90deg. apart, but may be run with four sets if more convenient.

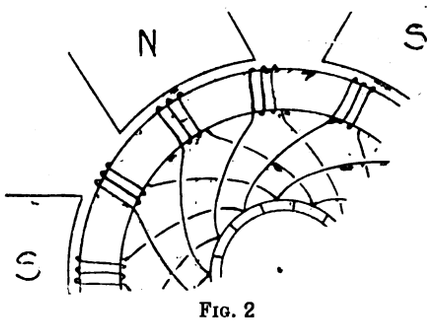

FIG. 2

Motors for 500 volts are very usually wave-drum wound. A simplex wave winding, of two possible circuits only, may be used and run with either two or four sets of brushes; to enable a shorter commutator to be used, one half the brushes may be taken from two spindles and placed on a second pair of spindles, the commutation and current collection being unaffected. A winding of this type for a four-pole machine is partly drawn in Fig. 3. It has 14 face conductors, and re-enters on itself after encircling the armature three times. If the armature is coil-wound, the dotted lines indicate the position of the coils at the commutator end of the machine, the full lines representing the connecting wires from one coil to another, with a junction at the commutator segment. With such a wave winding, should there be four brush sets used at present, and should the commutator be of ample length parallel to the shaft, in order to run with two brush sets it would simply be necessary to increase the brush collecting surface on the two spindles to double the present area to ensure normal conditions for collection and commutation.

Assuming, now, that the motor has a lap-wound armature—that is, that the connecting wires at the commutator end of the coils, instead of going forward to a conductor under the next pole (as in Fig. 3), return, after connection to the commutator segment, to the next conductor or coil under *the same* pole, the last wire being finally joined to the first after one complete round of the armature, or, less probably, after two rounds, or even three. This form of winding has commonly as many brush sets as there are poles on the machine, and in a four-pole machine the current will thus have four distinct paths through the winding—namely, from the two positive brushes to the

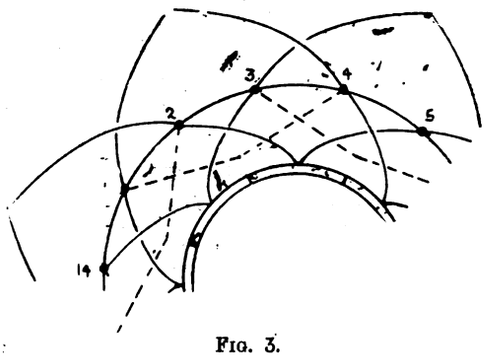

FIG. 3.

two negative. Ordinarily, a motor so wound, unless with a cross-connected commutator, could not be satisfactorily run with two brushes.

The simplest means of adapting a four-pole lap winding for running with two brush sets would probably be to carry out a system of cross-connections; the number of segments in the commutator being divisible by 2, each segment must be connected to the segment immediately on the opposite side of the commutator by a wire of a sectional area double that of the present armature wire, the operation probably necessitating the dismantling of the commutator and its rebuilding. Once carried out, a pair of doubled brush sets 90deg. apart will now fulfil all the functions of four brush sets spaced equally round the commutator, the heating, speed, and sparking conditions being quite normal.

Should it be thought advisable to strip the armature, and rewind as a wave winding to run at the same speed and voltage and with two brush sets, it will be necessary to halve the number and double the section of the armature wires when winding as a simplex two-circuit winding.—E. W. S.

Answer to No. 589 (*awarded* 7*s.* 6*d.*).—There are two methods of connecting up the conductors of a multipolar drum armature, commonly known as "lap" or "wave" winding. In the lap winding, the armature conductors are connected up into as many paths in parallel as there are number of poles; but in the wave winding they are always connected up into two paths in parallel independent of the number of poles. We thus see that with a given number of conductors on the armature the voltage generated by a wave winding will always be $\frac{\text{number of poles}}{2}$ times the voltage set up by a lap.

Figs. 1 and 2 give a diagrammatic view of the two windings, with the commutator spread out into a flat band. If the wave winding was applied to a four-pole machine, the commutators bars marked with an asterisk in Fig. 1 would be one and the same—*i.e.*, we should have gone all round the commutator. We can now see that the potential difference between each pair of commutator bars in the wave-wound armature will be twice, or $\frac{\text{number of poles}}{2}$ times that of the lap, since between them we have two armature coils in series instead of one. In a four-pole lap-wound armature, since there are four circuits in parallel, we must have four sets of brushes to collect the currents, but in a wave-wound armature, as we only

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have two circuits, we need only have two sets of brushes. These two sets of brushes must, of course, be 90deg. apart as with a lap winding, but we can chose any convenient position we like for them—*e.g.*, at the top of the commutator—where they are easy to get at for cleaning purposes, etc.

We can, if we like, fit four sets of brushes to a wave winding thus filling up the intermediate commutator bar, A, in Fig. 1; the difference of voltage between it and the other set of brushes of like sign (which we will suppose to be on the commutator bar marked with an asterisk) can only be that due to one armature coil, which will not matter.

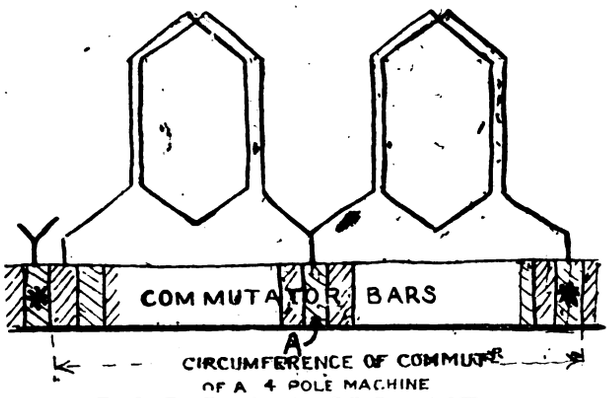

FIG. 1.—Two-Turn Armature Coils Connected Wave.

The only effect of doing this is to reduce the current density in the brushes, the voltage of the machine and everything else remains unaltered. In a wave winding, however, there is no tendency (such as there is in a lap) tending to make the current distribute itself evenly over the two pairs of brushes. We are thus liable at any time to find that one pair of brushes is taking all the current while the other is taking none at all. The use of four sets of brushes is therefore, we see, not of any very obvious advantage, since we must design them so that one pair is large enough to carry the full current. It has, however, been found that commutation is rather better with four sets of brushes than with two. The armature in question may, therefore, either be a wave-wound armature with four sets of brushes or a lap wound. If the former is the case, the two bottom sets of brushes may be removed at once, and the machine will still run as before. If the brushes show signs of undue heating, or the tips of the carbons become red hot, wider brushes should however be substituted.

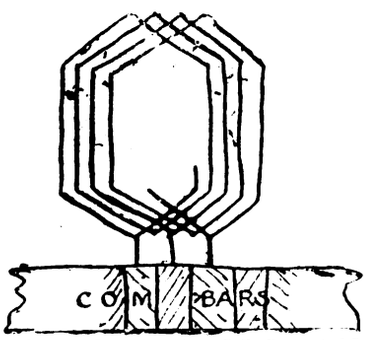

FIG. 2.—Two-Turn Armature Coils Connected Lap.

We can easily determine whether the armature is wave or lap wound by tracing out the connections of the two ends of any one armature coil to the commutator. If the two ends are connected to adjacent commutator parts, it is a lap winding; if to commutator bars 180deg. or two pole pitches, apart it is a wave. If lap-wound, we must disconnect all the armature coils from the commutator, and, after bending their ends into the correct shape, connect them up again as a wave winding. If the brushes of the machine are, when in their working position, nearly under the centres of the poles, the two ends of the armature coils will be of equal length, and, after being bent, will probably be of the right length for connecting up as a wave winding. If the length of the ends be insufficient, pieces must be brazed on, which is a very awkward job, so that it might possibly be cheaper to wind new coils. If it is decided to make new coils, only half the turns per coil should be used, as we have seen above that the wave winding gives twice the volts of a lap for the same number of conductors, the cross-section, therefore, being about twice that of the lap winding. If we can work in the old coils we must connect together the commutator bars in pairs, thus virtually making a double winding of it, or reducing the effective conductors by half, so that the armature still generates the same voltage, or if a motor runs at the same speed.—T. SQUARE.

Answer to No. 589 (*awarded* 5*s.*).—This question results in a discussion on the methods of winding armatures. Multipolar armatures are either parallel or series wound, or some modification of these systems. The parallel-wound armature has so many paths through it and as many sets of brushes as there are poles, and may be adapted to use two sets of brushes only by connecting together the equipotential points on the commutator. There would be as many of these points as there are pairs of poles. The connections could be made by means of insulated connectors (washers provided with lugs) strung on the shaft between the armature and commutator. The arrangement, however, is awkward, and takes up much valuable space on the shaft, besides necessitating a larger commutator, since the whole armature current, which was formerly divided between as many sets of brushes as there are pairs of poles, is now carried by one set, and to get the same brush contact surface as before a commutator of either larger diameter or greater length, or of both, is required. It may be concluded, then, that there is no really practical way of adapting a parallel-wound armature for the use of two sets of brushes other than rewinding as a series armature.

The series-wound armature has only two paths for the current round the armature, irrespective of the number of poles, and the potential across the brushes is the potential produced by half the total number of conductors on the armature, whereas in the parallel-wound armature the pressure across the brushes is the pressure produced by the conductors between any two poles, and hence the wire on a four-pole parallel-wound armature is just half the area of the wire on the same armature-wound series—*i.e.*, assuming same voltage and same speed. The fact that a thicker wire must be used on a series-wound armature is a great advantage in the smaller sizes of motors, whereas for a multipolar design the wire would be too thin for economic handling if the armature were parallel wound. (The series method is also used with moderate sizes of machines, in order that a bar winding may be utilised.) There is another advantage in using a two-circuit winding, which is this: good commutation may be obtained even when the armature is eccentric with respect to the field. This

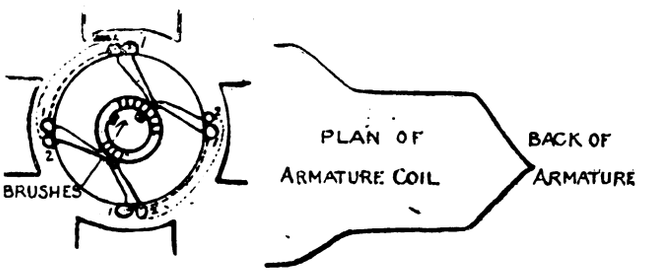

FIG. 1.—Series-Wound Armature, Wave Winding.

eccentricity, which would be produced by wear in the bearings, is disastrous as regards sparkless running in a parallel-wound armature. This, coupled with the fact that the brushes may be placed in an accessible position, is the chief reason for adopting the series type of armature in a tramway motor. But a series-wound armature is often provided with as many sets of brushes as there are poles, as this arrangement reduces the reactance voltage of the sections undergoing commutation, hence lessening the tendency to spark. The motor in the above question may be so arranged (being probably under 50 h.p. and working with a high terminal voltage), and if so, would run almost as well without the two lower sets of brushes as with them.

Fig. 1 is a sketch of a series-wound armature, showing two coils. The dotted lines represent the wire at the back

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of the armature. The end connections are so bent that while the active conductors to which they are joined are 90deg. apart, the commutator sections which are connected to them are 180deg. apart—*i.e.*, for a four-pole machine. The brushes are 90deg. apart, and the number of commutator sections will be odd. Fig. 2 is a sketch of a parallel or lap wound armature, showing three coils. The end connections are bent so that while the active conductors

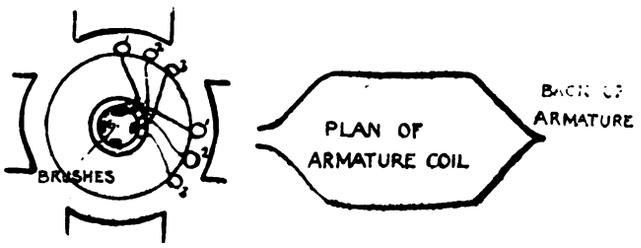
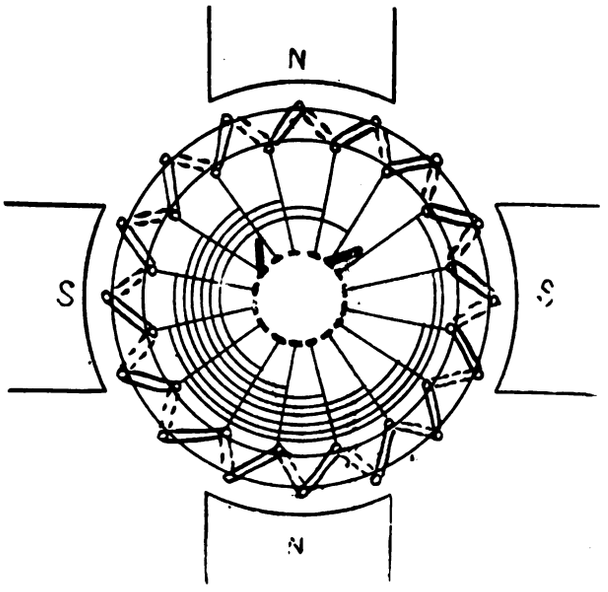


Fig. 2.—Parallel-Wound Armature, Lap Winding.

of a coil are 90deg. apart, their respective segments on the commutator are adjacent.—E. H.

Answer to No. 589 (*awarded* 5*s.*).—If the armature of the motor is a ring it will be possible to run with one pair of brushes, provided opposite parts of the winding are connected as shown in the accompanying diagram. These connections may be at either end of the armature, or, provided, of course, that there is sufficient room for the purpose, within the armature or the commutator. There are several windings for drum armatures in a four-pole field suitable for one pair of brushes. Without having more data than is given in the question it is impossible to give a scheme for rewinding, or to say whether the present winding could be utilised for the desired purpose. In any case it must be remembered that if one pair instead of two pairs of brushes be employed, the amount of current to be carried by each brush will be approximately doubled. This will necessarily entail a longer commutator when only one set of brushes are used, and it is quite possible that the construction of the motor will prevent any appreciable



lengthening of the commutator bars. "R. M." will do well to consider the propriety of fitting a more suitable form of brush-holder, or whether some alteration cannot be made to allow greater accessibility in cleaning and adjusting them than in making such a radical change in the armature. M. M.

Question No. 592.—Give an illustration of the methods adopted for determining the proper sizes of the cables for a three-phase combined lighting and power scheme for a large works, voltage between the phases 350, voltage between neutral point and any one wire 200 volts, length of longest feeder circuit 500 yards, maximum power in one feeder 50 h.p.

Best Answer to No. 592 (*awarded* 10*s.*).—In working out the size of alternating-current feeders, we must first of all know the frequency: for a combined lighting and motor system a frequency of 60 cycles ought to be very satisfactory where the circuits are not too long, remembering that arc lamps will not burn efficiently when the frequency is lower than 40. Having settled this point, the next three most important factors to be considered are: (1) the most economical conductor; (2) the permissible drop in pressure; (3) maximum current density permissible without undue heating.

The most economical feeder is given by Lord Kelvin's law: "The most economical area is that for which the annual cost of the energy lost just equals the annual interest on capital invested." The maximum drop of volts should never exceed 10 per cent. The current density limit is generally taken as 1,000 amperes per square inch of sectional area, or ·87 ampere per circular mil. In the present case the longest circuit is only 500 yards, so that our considerations may be chiefly governed by the maximum current density and the maximum drop of volts allowable. It might be well to mention here that for a three-phase four-wire system the weight of copper necessary is only 33·3 per cent. of the weight required on a single-phase two-wire system at the same minimum voltage.

For calculating sizes of cables for alternating work, the General Electric Company, of Schenectady, have issued some very useful sets of tables which are sufficiently accurate for most practical purposes. Of course, the losses due to induction will greatly depend on the distance between the lead and the return conductors. The following are general formulæ to be used:

$$\text{The area of conductor (circular mils)} = \frac{D\,W\,K}{P\,E^2}.$$

$$\text{Volts loss in line} = \frac{P \times E \times m}{100}.$$

$$\text{Current in main conductors} = \frac{W \times T}{E}.$$

$$\text{Weight of copper in pounds} = \frac{D^2 \times W \times K \times A}{P \times E^2 \times 10^6}.$$

In the above formula—

W = total watts delivered;
D = distance of transmission (one way) in feet;
P = loss in line per cent. of power delivered—*i.e.*, of W;
E = voltage between the main conductors at receiving end.

A, K, T, and *m* are constants given by tables, extracts of which are given below:

System.	Values of A.	Values of K. Per cent. power factor.				Values of T. Per cent. power factor.			
		100	95	85	80	100	95	85	80
Single-phase.....	6·04	2,160	2,400	3,000	3,380	1·00	1·05	1·07	1·25
2-phase 4-wire	12·03	1,080	1,200	1,500	1,690	·58	·53	·59	62
3-phase 3-wire	9·06	1,080	1,200	1,500	1,690	·58	·61	·68	·72

A. W. gauge of wire.	Values of *m* at 60 v. Per cent. power factor.			
	95	90	85	80
0000	1·62	1·84	1·99	2·09
000	1·49	1·66	1·77	1·95
00	1·34	1·52	1·60	1·66
0	1·31	1·40	1·46	1·49
1	1·24	1·30	1·34	1·36
2	1·18	1·23	1·25	1·26
3	1·14	1·17	1·18	1·17
4	1·11	1·12	1·11	1·10
5	1·08	1·08	1·06	1·04

The value of A is based on the fact that ·00000302lb. is the weight of one mil-foot of copper. For direct current K = 2,160, M = 1, T = 1. These calculations hold only for the three main conductors. The neutral wire may be made one-half or one-third of this size, or omitted entirely when the system is well balanced. This is not likely to be the case in the present instance. It is well to note that two wires in parallel have the same resistance and about half the reactance of a single wire of double the cross-section of either. Thus, replacing a No. 0000 wire by two No. 0 wires in parallel, the resistance, weight of copper, etc., is the same, but the reactance is lessened by about one-half. In the present case, line reactance and resistance should not account for more than about 5 per cent. of total power generated.—R. S.

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Answer to No. 592 (*awarded* 5*s.*).—The determination of the correct size of cable for any electrical power transmission scheme, whether alternating or continuous current, comes down primarily, like most other things, to a question of cost. In this case we have two "losses" to consider: (1) the $C^2 R$ loss due to the resistance of the cable; and (2) the interest on the money which has to be sunk in order to buy the cables, and also the money which has to be put away in order to provide a depreciation fund, so that when after a period of years the cable requires renewing there shall be sufficient money in the fund to do it. We can, knowing the average "load curve" of the transmission line, at once calculate out the root mean square current during working hours, and taking this current the average $C^2 R$ watts which will be wasted in any particular size of cable. Knowing, also, the cost of production of electricity per Board of Trade unit at the power station, we can at once turn this loss into pounds per month or year, so as to be directly comparable with the other loss. That size of cable which gives the sum of these two losses a minimum is the correct size to use. Since both the resistance and the cost vary directly as the length, the best size of cable will evidently be independent of the length, but proportional to the current.

Mr. Ellis Crapper gives the following formula for determining the best section of cable to use in any particular case:

$$\text{Section in square inches} = \frac{\text{R.M.S. current in amperes}}{\sqrt{\left(\frac{\text{Working hours}}{\text{per year}}\right) \times \left(\frac{\text{Resistance of 1 mile of}}{\text{copper, 1 sq. in. section}}\right) \times \left(\frac{\text{cost per watt-}}{\text{hour in £}}\right)}{\left(\frac{\text{Wt. tons of cop. conductor 1}}{\text{mile long, 1 sq. in. section}}\right) \times \left(\frac{\text{price of copper}}{\text{cable, ton in £}}\right) \times \left(\frac{\%\ \text{interest}}{100}\right)}}$$

Let h = working hours per day;
n = cost per Board of Trade unit in pence:
σ = resistance of a copper conductor one square inch section and one mile long = ·045 ohm;
m = weight of a copper conductor one square inch section and one mile long, in tons = 9·1;
f = price of copper cable per ton in £;
p = per cent. of interest for capital spent on cables and for depreciation

$$= \frac{p}{100}$$

$$\text{Then section square inch} = C\sqrt{\frac{365 \times \sigma\, h\, n}{1{,}000 \times 240 \times m\, f\, p}},$$

or substituting for σ and m and simplifying

$$= \cdot00274 \times C\sqrt{\frac{h\, n}{f\, p}}.$$

Applying this formula to the example given, assuming that 30 h.p. is the root mean square load and 50 the maximum, we have (the transmission line being evidently a "star" grouping):

Line current per conductor

$$= \frac{\text{power}}{\sqrt{3} \times \text{line volts}} = \frac{30 \times 746}{1{,}732 \times 350} = 37 \text{ amperes.}$$

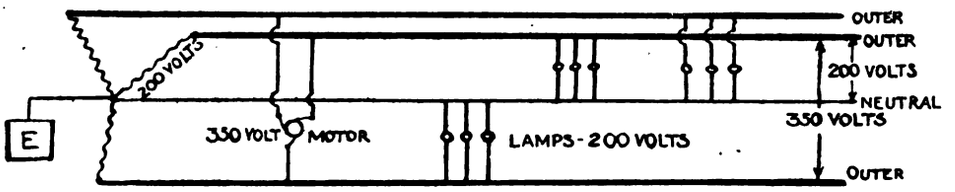
Assuming the line is used for 12 hours per day, that power costs 1d. per Board of Trade unit, that 8 per cent. on the cost of the cable is allowed for interest on capital and depreciation, and that cable costs £150 per ton, we have

$$\text{Section sq. in.} = 37\sqrt{\frac{12 \times 1}{\frac{8}{100} \times 150}} \times \cdot00274 = \cdot1015 \text{ sq. in.}$$

$$\text{Hence current density} = \frac{37}{\cdot1015} = 364 \text{ amperes per sq. in.}$$

This density is quite safe, since for maximum load it will only be $364 \times \frac{5}{3} = 606$ amperes per square inch. Sometimes, however, the density may by this method work out so high as to overheat the cable or cause too great a voltage drop along it for the maximum power. In these cases we must, of course, take a larger cable than that given by the formulæ.—T. SQUARE.

Answer to No. 592 (*awarded* 5*s.*).—The arrangement would be practically a four-wire system, with three outer wires and one neutral wire, this latter being connected to the centre point of the star machine windings and earthed. The motors being three-phase, and connected up between the three outer wires at 350 volts, and the incandescent lamps divided as equally as possible between the three outers and the neutral, the motor load, whatever its size, and however varied, will not then affect the balance of the system. The accompanying diagram shows the connections. It would be cheapest and best, from all points of view, to use four-core cables throughout. In calculating the size of cable, we shall require to know the amperes carried by each outer conductor, and this is found by the following formula:



$$\text{Amperes} = \frac{\text{horse-power carried} \times 746}{\text{volts between phases} \times \sqrt{3}}.$$

In the example given, with 50 h.p. carried and 350 volts between phases, this works out to 61·5 amperes, which a ·062 square inch conductor will safely carry at 1,000 amperes per square inch cross-section.

The question says nothing about the permissible voltage drop in the 500 yards of feeder cable. The loss per 100 yards of single conductor working at 1,000 amperes per square inch is $2\frac{1}{2}$ volts, and, therefore, the drop in the 500 yards of feeder between two-phase wires—*i.e.*, 1,000 yards of conductor—is 25 volts, which means 7 per cent. of 350 volts. The loss due to induction and dielectric hysteresis is negligible. If the drop ought not to exceed 5 per cent.—*i.e.*, $17\frac{1}{2}$ volts—the section would be $\cdot062 \times \frac{25}{17{\cdot}5} = \cdot088$ square inch. This gives the sizes of the three outer conductors, but there is yet the neutral to consider. It will be seen from the diagram that if the incandescent lamps are so arranged as to be equally balanced between the three outers and the neutral, no current would flow in the neutral conductor. This is not possible in practice, but in a small system like that we are considering it should be possible, by careful arrangement of circuits, to balance so far that the out-of-balance current flowing in the neutral would not be more than 25 per cent. of the line current at any time. In this case the neutral need only be one-quarter of the sectional area of the outer conductors—*i.e.*, the four-core feeder cable mentioned would have three conductors, ·062 square inch area ($^{19}/_{16}$ S.W.G.) and the neutral, say, ·017 square inch area ($^{7}/_{17}$ S.W.G.). In town lighting the neutral is generally made the same area as the other conductors.—DUPLICATOR.

FORTHCOMING EVENTS.

Sanitary Institute.—Congress and exhibition, Bradford, July 7-11.

Municipal Electrical Association.—July 15 to 18, annual convention, Sunderland. July 17, Middlesbrough Corporation luncheon. (Programme appeared in our issue of the 12th ult.)

Iron and Steel Institute.—Summer meeting, Barrow-in-Furness, September 1-4.

Municipal and County Engineers.—Meetings: Widnes, July 18 Aberdeen, August 20, 21, and 22; Hastings, September 11 and 12, Detailed programmes will be issued when definite arrangements are made.

Municipal Tramways Association.—July 10, concluding day of conference.

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LONDON TRAFFIC COMMISSION.

The Royal Commission on Locomotion in London sat last Friday, under the presidency of Sir D. Barbour, to hear further evidence by **Mr. E. Harper,** statistical officer of the London County Council.

Examined by the Chairman, the witness described the effect upon the Metropolis of the railway system. He first submitted a table giving the figures of the number of persons entering the central area daily by railway, tramway, and omnibus before half-past 10 o'clock in the morning, and stated that 300,000 came from the north of the river and nearly 200,000 from the south. The congestion in the streets was due to the setting down of large numbers of passengers at particular points, as the railways and tramways did not, as a rule—as the omnibuses did—run through to the far side of the central area. The extension underground of railways and tramways through the central area would relieve both pedestrian and vehicular traffic in the streets. In some cases certain railways conveyed passengers right across the central area.

The **Chairman:** The general tendency of your evidence is this—that to get the working classes to live out of congested districts there is no measure so effective as cheap fares?—Yes. Fares of all kinds have been tried for years past, but none of them have succeeded.

By Sir G. Bartley: There were certain classes connected with certain trades where it is almost impossible for them to live in the country, owing to their having to go backwards and forwards to their workshops.

Examination continued: There were a great number of trades in the neighbourhood of Regent-street and Soho where people were continually going backwards and forwards between the shops and their own dwellings during the day, but he thought that under the existing conditions it would be much better for those people to be working in workrooms open to Government inspection than working, as many there did at present, at home, and if that were so the factories could be removed further out. He thought that a number of radial lines going out considerable distances at cheap fares would greatly relieve the pressure, and he would add that the radial lines should run across the central area so as to distribute the passengers equally over the whole of the central area, instead of dumping them down at one particular spot and so causing congestion.

Mr. J. W. Benn was the next witness. Examined by the Chairman, he said he had been chairman for the past five years of the Highways Committee of the London County Council, which dealt with all matters relating to tramways and electric lighting in the county of London. Two important defects in connection with the unsystematic manner in which tramways had been authorised in London were: (1) in the first place, certain of the undertakings authorised as distinct systems could only be worked satisfactorily as one undertaking, and the result had been the amalgamation of various lines working under different Acts containing a diversity of clauses governing their control and management; (2) owing to this lack of uniformity in the obtaining of legislation, different periods of purchase had been fixed for the same system. The Council, since it was constituted in 1889, had almost uniformly adopted the policy of refusing consent to the tramway proposals of companies on the ground that, as the tramway authority under the Tramways Act, it should itself construct and own all new tramways in the county in order to secure continuity in the tramway system of London, and to ensure the works being carried out in a satisfactory manner as regarded extent of widenings, etc. There had been certain exceptional cases, however, in which the Council had consented to the construction of lines in extension of and supplementing existing systems. In those cases it had required that the date of purchase should coincide with that obtaining with regard to the tramways of which the new lines had formed a part. The witness said that there are about 115 miles of tramways in London, but to be properly served London should have 1,000 miles of street tramways.

The Commission adjourned.

PERSONAL.

We understand that Mr. R. A. Chattock, city electrical engineer, Bradford, has been appointed to a similar position in Birmingham, at a salary of £1,000 per annum.

Mr. H. Webber has been appointed chief assistant engineer at the Hastings Corporation electricity works.

APPOINTMENTS VACANT.

Two Skilled Cable Jointers, Durban Municipality, 15s. a day. Applications, by letter, to be sent to Z.X.Y.Z., care of Deacon's Advertising Offices, Leadenhall-street, London, E.C., by July 27. See advertisement.

Electric Lighting Superintendent, Electricity Works, 27, Osborn-street, Whitechapel, E., July 20. See advertisement.

Assistant Electrical Engineer, Corporation of Torquay, £156 per annum, July 20.

Clerk of Works, generating station, Bath, July, 13.

Assistant, with knowledge of details of overhead "trolley" system, Messrs. Pritchard, Green, and Co., 37, Waterloo-street, Birmingham.

Clerk of Works, London County Council Tramways, 3 to 3½ guineas per week, July 22.

STOCKTON-ON-TEES ELECTRICITY ACCOUNTS.

Herewith are given abstracts of the revenue account and general balance-sheet of the Stockton-on-Tees electricity department for the year ended March 31, 1903, together with the statement of electricity generated, sold, etc.

REVENUE ACCOUNT.

Dr. Expenditure.	£	s.	d.
Generation of electricity	1,824	17	0
Distribution of electricity	177	14	0
Rents, rates, and taxes	273	3	4
Salaries and management expenses	602	14	3
Special charges, insurances, etc.	280	9	3
Balance transferred to net revenue account	1,865	13	2
	£5,024	11	0

Cr. Income.	£	s.	d.
Sale of current by meter	4,083	2	11
Public lamps	806	13	4
Meter rents	130	19	9
Guarantees	3	15	0
	£5,024	11	0

BALANCE-SHEET.

Dr. Liabilities.	£	s.	d.
Sundry mortgages	45,775	14	10
Sundry creditors and deposits as security	2,197	15	7
Excess of assets	3,343	2	2
	£51,316	12	7

Cr. Assets.	£	s.	d.
Amount expended on capital account	47,679	15	11
Sundry debtors	2,442	11	0
Stores on hand	245	10	2
Cash in hand	948	15	6
	£51,316	12	7

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T.U.	344,085
Quantity sold	299,980
Quantity used on works	13,783
Maximum supply demanded (kilowatts)	323

WREXHAM ELECTRICITY ACCOUNTS.

The accounts of the Wrexham electricity department for the year ended March 31, 1903, show a total expenditure on capital account to date of £23,416. Abstracts of the revenue account and general balance-sheet are given herewith.

REVENUE ACCOUNT.

Dr. Expenditure.	£	s.	d.
Generation of electricity	1,133	14	9
Distribution of electricity	10	2	3
Attending and repairs to public lamps	121	16	0
Rents, rates, and taxes	33	7	6
Salaries and management expenses	317	16	8
Fitting and wiring consumers' premises	47	0	3
Gross profit carried to net revenue account	750	3	8
	£2,414	1	1

Cr. Income.	£	s.	d.
Sale of current for private lighting	1,548	2	8
Rental of meters	39	17	10
Current supplied to tramways company	14	5	10
Sale of current for public lighting	720	14	0
Sale of cable, lamps, and repairs	58	8	7
Miscellaneous fees	4	5	6
Pumping, etc., of machinery at public baths	20	0	0
Premium of engineer's pupil	8	6	8
	£2,414	1	1

BALANCE-SHEET.

Dr. Liabilities.	£	s.	d.
Amount outstanding on mortgage	24,855	2	10
Sundry creditors on open account	786	17	10
Surplus	278	14	6
	£25,920	15	2

Cr. Assets.	£	s.	d.
Amount expended on capital account	23,415	16	6
Sundry debtors	946	14	3
Stores on hand	80	13	4
Cash overdrawn and in hand	1,477	11	1
	£25,920	15	2

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CARDIFF ELECTRICITY ACCOUNTS.

From the statement of accounts of the county borough of Cardiff electricity works for the year ended March 31 last it appears that the total expenditure on capital account on that date was £157,561. We give herewith abstracts of the revenue account, general balance-sheet, and statement of electricity generated, sold, etc.

REVENUE ACCOUNT.

Dr.				£	s.	d.
Generation of Electricity.						
Coal or other fuel	£2,932	6	7			
Oil, waste, water, and stores	607	12	4			
Wages at generating stations	1,511	3	1			
Repairs and maintenance	1,014	4	9			
Sundry other expenses	202	4	3			
Energy supplied by Corporation tramways	1,654	8	9			
				7,921	19	9
Distribution of Electricity.						
Wages to linesmen and fitters	111	0	7			
Repairs, etc., of mains	136	0	8			
Repairs, etc., of transformers, etc.	167	17	11			
Repairs, etc., of apparatus	37	16	7			
				452	15	9
Public Street Lamps.						
Attending and repairs	302	12	9			
Renewals of lamps	162	19	9			
				465	12	6
Rents, Rates, and Taxes				911	19	3
Management Expenses.						
Salaries—viz., Engineer's department	514	13	10			
Clerical staff	379	4	4			
Auditor	25	0	0			
Collector	145	0	0			
Printing and stationery	166	8	1			
General establishment charges	185	2	2			
				1,415	8	5
Special Charges.						
Insurances, etc.	73	6	6			
Expenses for certification of meters	30	0	0			
				103	6	6
Total expenditure				11,271	2	2
Amount carried to net revenue account				9,885	12	11
				£21,156	15	1

Cr.	£	s.	d.
Sale of current per meter	18,390	4	5
Sale under contracts	181	1	7
Public street-lighting	2,149	12	11
Rental of meters, etc.	453	18	4
Connections	0	10	0
	21,175	7	3
Less irrecoverables written off	18	12	2
	£21,156	15	1

GENERAL BALANCE-SHEET.

Dr. Liabilities.	£	s.	d.
Capital account, £120,987. 18s. 2d.; less repaid, £1,646. 18s. 10d.	119,340	19	4
Sundry creditors	5,856	19	10
Due to treasurer	39,089	5	7
Due to Corporation tramways account	262	13	10
Due to Corporation waterworks account	82	18	10
Sinking fund and loans fund	11,042	6	0
Balance in hand Ferranti award	763	12	7
Reserve fund	500	0	0
Revenue account credit balance on year's working	3,647	6	9
	£180,586	2	9

Cr. Assets.	£	s.	d.
Capital expenditure	157,561	5	8
Expenses raising stock	4,972	12	6
	162,533	18	2
Less premiums received	1,031	14	3
	161,502	3	11
Stores	1,752	2	10
Sundry debtors	71	11	0
Due from borough fund account	147	15	2
Due from urban authority account	826	8	3
Cash in hands—engineer investments	40	0	0
Redemption fund	9,395	7	2
	£180,586	2	9

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T. units			1,881,548
Quantity sold	Public lamps	213,809	
	By contract	10,863	1,492,470
	Private consumers by meter	1,267,798	
Quantity used on works			62,143
Total quantity accounted for			1,554,613
Quantity not accounted for			326,935
Total maximum supply demanded (kilowatts)			1,372

Number of public lamps: arcs, 224; incandescents, 98.

BARROW-IN-FURNESS ELECTRICITY ACCOUNTS.

We give herewith abstracts of the accounts of the Barrow-in-Furness electricity department for the year ended March 31, 1903.

REVENUE ACCOUNT.

Dr. Expenditure.	£	s.	d.
Generation of electricity	2,391	14	2
Distribution of electricity	262	9	11
Private mains and services	226	2	11
Public lamps—repairs and maintenance	141	18	3
Rents, rates, and taxes	179	1	0
Management expenses	639	2	6
Special charges—insurance	40	14	6
Amount transferred to net revenue account	3,586	1	2
	£7,467	4	5

Cr. Income.	£	s.	d.
Sale of current and meter rents	6,650	18	10
Public lamps	533	19	2
Private mains and services	282	6	5
	£7,467	4	5

BALANCE-SHEET.

Dr. Liabilities.	£	s.	d.
Mortgage loans, less redeemed, March, 1902	54,403	9	6
Loans redeemed to March 31, 1903	4,171	10	6
Cash due to bank on capital account	8,797	11	10
Sundry creditors	575	17	10
Cash due to bank on revenue account	6,466	10	5
	£74,414	0	1

Cr. Assets.	£	s.	d.
Amount expended on works and plant	67,372	11	10
Stores on hand	2,827	14	11
Sundry debtors	2,553	8	3
Balance, being deficiency	1,660	5	1
	£74,414	0	1

BURY ELECTRICITY ACCOUNTS.

From the accounts of the Bury electricity department for the year ended March 31, 1903, it appears that the total expenditure on capital account amounts to £59,240. Abstracts of the revenue account, balance-sheet, and statement of electricity generated, sold, etc., are appended.

REVENUE ACCOUNT.

Dr. Expenditure.	£	s.	d.
Generation of electricity	1,418	13	1
Repairs and maintenance of buildings and plant	236	5	5
Management expenses, salaries, etc.	644	14	0
Distribution of electricity	266	0	1
Attending and repairs to public lamps	107	4	4
Rates and taxes and miscellaneous	681	1	9
Amount carried to net revenue account	2,812	11	1
	£6,166	9	9

Cr. Income.	£	s.	d.
Sale of current—private lighting	5,165	18	7
Ditto, public lighting	599	2	8
Rental of meters, motors, etc.	396	8	6
Incidentals	5	0	0
	£6,166	9	9

BALANCE-SHEET.

Dr. Liabilities.	£	s.	d.
Loans on mortgage	46,729	0	0
Sundry creditors	1,389	19	10
Cash owing bank	7,572	3	0
Sinking fund, less loans paid off	2,571	18	10
Debt extinguished	3,346	0	0
Balance, being income beyond expenditure	21	4	7
	£61,630	6	3

Cr. Assets.	£	s.	d.
Amount expended on capital account	57,448	8	8
Sundry debtors for current supplied	2,381	12	6
Stores on hand	1,800	5	1
	£61,630	6	3

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T.U.			465,832
Quantity sold	Public lamps	55,582	
	By contract	8,286	424,993
	Private consumers by meter	361,125	
Quantity used on works			11,309
Total quantity accounted for			436,302
Quantity not accounted for			29,530
Total maximum supply demanded (kilowatts)			319·7

Number of public lamps: 34 arcs, 17 incandescents.

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LEGAL INTELLIGENCE.

ST. MARYLEBONE ELECTRICITY PURCHASE.

On the 2nd inst. Mr. Justice Buckley had before him the case of the Metropolitan Electric Supply Company, Limited, *v.* the Mayor, etc., of the Metropolitan Borough of St. Marylebone, an action by the plaintiffs to enforce specific performance of a contract for the sale of a portion of the plaintiff's undertaking to the defendants.

Mr. Cripps, K.C., Mr. Astbury, K.C., and Mr. Sarjant appeared for the plaintiffs; and Mr. Fletcher Moulton, K.C., Mr. Buckmaster, K.C., Mr. E. Clayton, and Mr. A. B. Cane for the defendants.

It appeared from the statement of **Mr. Cripps** that the plaintiff company obtained parliamentary powers for the supply of electricity in the districts of St. Marylebone, Paddington, St. Martin's-in-the-Fields, and the Strand districts. Under special statutory powers the company constructed a generating station at Willesden, from which they supplied electric energy to their areas of supply in London. In addition, they had various supply stations, and subsequently they supplied St. Marylebone partly from these supply stations and partly from energy from the Willesden works. In 1901 the defendants obtained parliamentary powers to supply electric energy within their district, on the basis of buying out the plaintiff company. Notice to treat was given on Nov. 1, 1901, and the amount payable as compensation by the defendants to the company was to be settled by arbitration. By the award of Mr. C. A. Russell, K.C., the umpire in the arbitration, the sum awarded to be paid by the defendants to the company for the sale of its undertaking was £1,212,000, Mr. Russell fixing the value as from Dec. 31, 1901, which was, by arrangement between the parties, to be treated as the date of the notice to treat. After this award had been issued, the defendants could not obtain the consent of the London County Council for a loan, and thus could not complete the purchase of the plaintiff company's undertaking at once. Since Dec. 31, 1901, the company had, it was said, incurred an annual capital expenditure of about £50,000 in performing their obligations to the consumers, and the main question in the present case was whether the company could recover this amount from the defendants under the contract. The plaintiffs accordingly asked for a decree of specific performance and an enquiry as to the amount of capital expenditure incurred by the company in meeting their obligations since Dec. 31, 1901.

The defendants' case was that the plaintiffs were bound by the findings of the arbitrator. They further said that the expenditure in question was incurred by the company in respect of their external undertakings at Willesden and elsewhere, and that they had therefore no benefit in it. It was stated that defendants were appealing from the decision of the County Council to the Local Government Board, as to raising a loan for the purpose of completing the purchase, and that the defendants were willing to take and pay for all mains, etc., laid down, which was suitable for the St. Marylebone supply.

In the result, **His Lordship** gave judgment for the plaintiffs for specific performance of the contract, and directed that there should be an enquiry as to the title to certain leasehold and freehold premises included in the contract. He referred it to Mr. C. A. Russell to take, for the purposes of completion, accounts of the capital and other expenditure, and all the receipts of the plaintiff company from Dec. 31, 1901, to the completion of the purchase, and left it to him to determine what part of such capital and other expenditure ought, for the purposes of the accounts, to be allowed as between the plaintiffs and the defendants. His Lordship referred it to Mr. Russell to say, in case the plaintiffs did not show a good title to any freehold or leasehold premises, what sum should be allowed the defendants for compensation. He fixed Dec. 31, 1903, as the date for completion, and directed that the sum of £100,000 should be paid into Court by the defendants, the balance of the purchase money to be paid to the plaintiff company. He gave liberty to apply to extend the time for completing, and reserved the costs. It was arranged that if the parties could not agree on Mr. Russell acting as directed by his Lordship, Mr. Pollock (the official referee) should conduct the enquiry.

FENCING OF ELECTRICAL MACHINERY.

In the Divisional Court, composed of the Lord Chief Justice and Justices Wills and Channell, on Wednesday the Mile End Guardians appealed from the decision of the magistrates of the Thames Police Court fining them 1s. and 10s. costs for not securely fencing a steam-engine at the electricity generating station attached to their workhouse and infirmary in Bancroft-road. The proceedings were instituted at the instance of the factory inspector after a man had been killed while attending to the engine.

On behalf of the appellants **Mr. Danckwerts, K.C.**, contended that as the premises were not used for the carrying on of any trade, and were not a public building in the strict sense of the term, the public having no right of access, the Factory Act did not apply.

Mr. Robertson, on the other hand, submitted that in the sense intended by the Act the workhouse and infirmary were public buildings.

The **Lord Chief Justice**, while admitting that the case raised a difficult question, thought the Act intended to include buildings of this kind used for *a quasi* public purpose.

The other judges concurred, and the appeal was dismissed, with costs.

South Staffordshire Tramways.—This Bill was before Lord Morley's Committee on Tuesday, and the preamble was declared proved. The Bill gives the company power to construct additional tramways, and for working tramways by electrical power.

COMPANIES' MEETINGS AND REPORTS.

BRITISH ELECTRIC TRACTION.

The ordinary general meeting of the shareholders in this Company was held at Hamilton House, Victoria-embankment, on Wednesday, Sir Charles Rivers Wilson presiding.

The **Chairman**, in moving the adoption of the report and accounts (which appeared in our last issue), said he was able again to congratulate the shareholders on the continued expansion of the business, but they had to pay interest and dividends on a much larger capital than last year, so that, although the profits were about £35,000 larger, they were not able to recommend the payment of the same rate of dividend on the ordinary shares as last year without unduly reducing the amount to be carried forward. The reduction of the dividend by 1 per cent. was mainly due to a larger amount of new capital having been expended during the year, which during the period covered by the accounts had not become productive of profit, but, nevertheless, ranked for interest or dividend. An important point for the shareholders to know was that the proportion of profits which came in the form of dividends and interest on the shares and debentures they held in associated companies showed a steady and considerable increase each succeeding year. Giving details of how the main item of £264,000 of gross profits was made up, he said he hoped he had made it clear that a portion of the profit was made in connection with the construction of new works and the establishment of new undertakings; but the important point for the shareholders to appreciate was that the profits which were of a recurring kind, which were not dependent upon the establishment of new undertakings, were increasing very satisfactorily, and now constituted by far the largest proportion of the total profits. Taking all matters into consideration, there should be no cause for surprise or disappointment in the slight reduction of dividends; but, on the contrary, it was a matter for congratulation that, in the circumstances, they were able to pay so high a dividend as 8 per cent. With regard to the proposal to issue second debenture stock, he pointed out that it was important they should raise a larger proportion of their capital at a lower rate of interest than was payable upon the share capital. They, therefore, suggested that the directors should be empowered to borrow up to an amount equal to the share capital, and this would enable the directors to issue second mortgage debenture stock. Further capital would be required from time to time for the conversion to electric traction of several tramways still worked by horses or steam, and for the construction of lines for which they had obtained powers. The issue of second debenture stock would not in any way whatever affect the rights of the holders of the first debenture stock. With regard to the investments, these showed a considerable increase. They were desirous that the reserve fund should be a real one, and £200,000 of it was invested in consols, the rest being employed in the business. The return on these investments was steadily increasing. The Birmingham papers had recently published a series of remarkable misstatements in regard to the Company's objects and methods. As a matter of fact, they had every reason to be satisfied with the progress they had made there. For many years they had worked steadily to consolidate the tramway systems of the Black Country and to convert them to electric traction, and, although the process had been a slow one, it had been eminently successful. Unfortunately, the desire for municipalisation prevailed in Birmingham; but the result of their work had been to get the people of Birmingham and the Corporation a vast amount of information, and he was glad to say that the Corporation of Birmingham was showing a disposition to deal with the matter seriously, and to give the Company, voluntarily, the necessary facilities for through communication and for electrification of the lines, which, until lately, they refused to grant. After referring to the acquisition, in North London, of the Metropolitan Electric Tramways, and to the Auckland Electric Company, the chairman proceeded to refer to their investments in the Brush Electrical Engineering Company and the Electrical Distribution Company, and passed on to refer to some details in the accounts.

Mr. E. Garcke seconded the resolution, which was carried unanimously.

An extraordinary general meeting was afterwards held, at which resolutions were passed, making certain alterations in the articles of association to enable the directors to issue second debentures.

The proceedings closed with the usual vote of thanks.

NEW GENERAL TRACTION.

The annual general meeting was held on Friday at Salisbury House, Baron E. B. d'Erlanger presiding. In moving the adoption of the report, which appeared in our last issue, the **Chairman** said that, considering the bad times through which the Company had passed, and from which it might be said to be only just emerging, he thought that the shareholders would agree with the Board that it would not be prudent to distribute that amount, and that it would be better to carry it forward. The Company had been gradually converted by force of circumstances from a construction company into a trust company. He then proceeded to deal in detail with the various undertakings in which the Company were interested. Their Bill for a railway from Coventry to Arley, which would have placed the former town in direct communication with the Midland Railway, and which received a large amount of local support, was unfortunately thrown out. Terms had been arranged with the Corporation of Coventry granting the Coventry Electric Tramways Company very valuable extensions. The receipts of the Norwich Electric Tramways Company had shown a steady improvement since the autumn. There seemed to be a feeling

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in the town that the tramways there should have been a municipal concern. The Company had a large stake in the Philadelphia, Morton, and Swarthmore Street Railways Company, the completion of which was delayed by legal proceedings. Last year the Company's critics alleged that their capital was too large, but he quoted statistics to disprove this. A sum of £240,000 would be needed for the new extensions and other matters, but the Board hoped that before the money was actually required they would be able to sell in the United States a sufficient number of the bonds of the Philadelphia enterprise to meet the necessity.

The **Hon. A. G. Brand, M.P.**, seconded the motion, which was adopted.

BRITISH ALUMINIUM.

Presiding over the ordinary general meeting of the shareholders at Winchester House on Tuesday, **Mr. J. D. Benner**, in moving the adoption of the report (*vide* last issue), said that it indicated that even at the close of 1902 considerable progress had been made in overcoming the difficulties which beset the Company a year ago. Although the year's trading had had to bear an abnormal expenditure of about £2,000, the profits were about 60 per cent. greater than those of the preceding 12 months. The demand for aluminium continued satisfactory throughout the world. The Company's sales during the year had been very materially in excess of those for the corresponding period of the previous year, and the increase had been well distributed over all sections of the business. There had consequently been a material reduction in the amount of stock. The Board thought that, as a matter of policy, they should always have a considerable reserve of stock. They have therefore decided to increase the production at Foyers as soon as the necessary furnaces could be erected. A material increase in the Company's productive power before the end of the current year was assured. The aluminium and carbon works would have to be extended. The revision of the basic terms of the understanding between the Company and other aluminium producers was arranged at a conference early in the present year. The Board did not consider that they succeeded in obtaining all they were entitled to, but they recognised that there was an evident desire to meet their wishes. They therefore decided to content themselves for the present with the concessions which they accepted. The new arrangement took effect from Jan. 1 last, and the profits for the current year would be favourably affected by it. A considerable reduction in the cost of the manufacture of carbide had been effected, and the Board had resolved to continue its production. Consequently the whole of the present valuable water power would be utilised, and as it was possible that later on further power might be required for the production of aluminium, the Board decided to proceed with the erection of two more dynamos. This step, with the accompanying necessary works, would involve an outlay of nearly £15,000, but the expenditure would be extended over a period of not less than 18 months, which would be required for the completion of the work. All the extensions which he had mentioned would involve an outlay of nearly £240,000, but the Board hoped that the improved position of the business would enable them to provide this sum from the internal resources of the Company.

Mr. H. Wolfenden seconded the motion, which was adopted.

UNITED RIVER PLATE TELEPHONE.

The annual general meeting was held on the 2nd inst. at Winchester House, Mr. J. Irving Courtenay presiding.

The **Chairman**, in submitting the usual motion to the shareholders, reminded them that the report dealt with a period for the most part anterior to the great improvement resulting from the bountiful harvest with which the River Plate had been favoured. The Company had progressed throughout, and the increased prosperity of Argentina must undoubtedly still further improve the prospects of the Company. Unusual expenditure for maintenance and renewals was occasioned in the early part of the year by the removal of their chief central exchange from the location it had occupied for more than 20 years in Calle San Martin to their building in the Avenida de Mayo, and during the latter months by storms of extraordinary severity in the province of Buenos Ayres, which seriously damaged some of their most important lines in many directions. The Company's underground plant, established and being extended in Buenos Ayres and commenced elsewhere, would remedy to a considerable extent the risks from these severe storms, but their pole lines must always be subject to possible injury from this source. The present position of the Company was better and stronger than it had ever been. They now covered to a great extent the city and province of Buenos Ayres, the richest and most populous district in South America, and they also occupied the two most populous cities in Argentina outside this district—Rosario and Cordoba. They might, therefore, confidently look forward to a reliable future for the Company's business and to its increasing importance.

The report was adopted.

ELECTRIC AND GENERAL INVESTMENT.

The ordinary general meeting of the shareholders was held at Winchester House on Wednesday, the 8th inst., Mr. George Herring presiding.

In moving the adoption of the report (which appeared in our last issue), the **Chairman** said the gross profit on the year's transactions of £19,424 was a falling off compared with the figures of the previous year, but the profit varied more or less with the condition of business, and last year was not a very favourable period. He afterwards went through the accounts, and explained the item of loan account, £309,211. With reference to the item of investments at cost, £299,758, he stated that he thought it right on the present occasion to say that they showed a small loss, as on previous occasions he had pointed out that their value was in excess of their cost. He wished again to state that the Company must be considered more or less of a speculative nature as regarded the rate of dividend paid. The shareholders had received dividends of 35 per cent., 45 per cent., and on one occasion 55 per cent., and it must be distinctly understood that the dividends might vary.

Mr. J. B. Braithwaite, jun., seconded the motion, which was unanimously adopted.

URBAN ELECTRIC SUPPLY.

The ordinary general meeting of the shareholders was held on Friday at the offices, Broad Sanctuary-chambers, Westminster.

In their annual report the directors state that the stations at Stamford, Hawick, Twickenham, Weybridge, Godalming, Dartmouth, and Camborne and Redruth, and the tramway between the two latter places were completed and opened during the year. Although these stations were running for an average period of less than six months, the profit derived therefrom amounted to £2,264. After adding interest on loans and deposits and deducting London expenses, including directors' fees and interest on calls paid in advance, there remains a balance of profit of £1,371. Dividends guaranteed by Edmundsons' Electricity Corporation, Limited, under their agreement amounted to £6,697, and after deducting the above profit, the balance of £5,326 has been duly provided by them.

Mr. Francis E. Gripper, who presided, said that during the year seven of the Company's undertakings were opened and commenced work, and the accounts in connection with them had to be audited, not only by their own auditor, but by the official auditor of the Board of Trade. The issued capital of the Company had now all been called up. Practically the whole of the capital that had been provided had been expended. It would be readily understood that the profitable development of such business required further capital from time to time. The Board had arranged with Edmundson's Electricity Corporation to advance any sums which might be required during the year, so that it would not be necessry to make any further capital issue at present. The form which the new capital would take was a matter which he thought the shareholders might safely leave in the Board's hands, as it would depend on the conditions existing at the time of issue. An official quotation on the Stock Exchange had been granted for both the ordinary and the preference shares. Valuable extensions to the Company's Twickenham undertaking had been obtained by agreement with the local authorities of the adjoining districts of Teddington and Hampton. He concluded by moving the adoption of the report.

Mr. W. Page seconded the motion, which was adopted.

CHILI TELEPHONE.

The report of the directors for the year ended March 31 last states that the aggregate number of subscribers at all centres at the end of the year was 5,371 as compared with 4,981 at the beginning, or a gain of 390 for the year. The gross revenue in Chili from all sources was 841,193dol. as compared with 759,139dol. the previous year, an increase of 82,054dol. The expenditure in Chili was 401,519dol. as compared with 365,776dol., an increase of 35,743dol. The net income in Chili from all sources was 439,674dol., as compared with 393,362dol. in 1901-2, an increase of 46,312dol. The average rate of exchange for the year was 15·68d., as compared with 14·85d. in the previous year, giving an increase for the year of 0·83d. Converted into sterling at these rates, the figures given are: in 1902-3, £28,723; in 1901-2, £24,340—an increase of £4,383. The liquid assets and liabilities in Chili on March 31, 1903, were valued at 16¾d., the current rate of exchange on that day, as compared with 13¾d. at which they were valued on the corresponding date of the previous year. The increase in the value of the liquid assets over liabilities in Chili due to this rise in exchange amounts to £1,455, which has been carried to reserve. The balance to the credit of the revenue account, including £2,733 brought from the previous year, is £26,100, of which £11,088 has been carried to reserve for renewal of plant, etc. The directors recommend the payment of a dividend of 6s. per share, less income tax, being at the rate of 6 per cent. per annum, absorbing £12,375, and leaving a balance of £2,637 to be carried forward. The total mileage was on March 31, 1903, 9,205 miles 892 yards; on March 31, 1902, 8,754 miles 527 yards—an increase of 451 miles 365 yards.

NEW COMPANIES REGISTERED.

Robert Atkinson (London), Limited (77,852).—Capital, £12,000. Object: to acquire that part of the business of the Viâ Eastern Code Company, Limited, which is known as the British Engineering Standards Coded Lists. Registered office: 729-730, Salisbury House, London-wall, E.C.

Uddington District Electric Lighting Company, Limited (77,856).—Capital, £1,000. Object: to carry on in Bothwell, co. Lanark, the business of electricians, mechanical engineers, and suppliers of electric light in all its branches. Registered office: 83, Cannon-street, E.C.

Havana Electricity Company, Limited (77,897).—Capital, £300,000. Object: to adopt an agreement with Señor Don Tiburcio Castaneda and La Compania de Electricidad de Cuba; to construct, equip, develop, and control railways, tramways, electric light, tele-

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phone and telegraph works, and other public or private works and conveniences in Cuba or elsewhere.

Nicole Record Company, Limited (77,923).—Capital, £10,000. Object: to acquire the business now carried on at 147-150, Great Saffron-hill, E.C., as Nicole Frères, Limited (New Record Account); to adopt an agreement with Nicole Frères and G. H. Burt, and to carry on the business of manufacturers of and dealers in talking and sound-producing machines, electrical machinery and apparatus, telephones, apparatus for wireless telegraphy, telephony, etc. Registered office: 147 to 150, Great Saffron-hill, E.C.

CONTRACTS FOR ELECTRICAL SUPPLIES.

Lisbon.—The Public Works Department require tenders for the public electric lighting of Macao. Tenders by Oct. 21.

Beszterczebanya, Neusohl (Austria).—The Municipality require tenders for the construction of an electricity station and plant of about 600 h.p. Tenders by Aug. 1.

Hammersmith.—The Borough Council invite tenders for the supply of 40 alternating-current series arc lamps and accessories. Tenders by July 15. See advertisement in last issue.

West Ham.—The Borough Council invite tenders for the supply of high-tension paper-insulated cable for tramway feeders and of multicore telephone and pilot cables. Tenders by July 14.

Barnstaple.—The Corporation invite tenders for wiring, lamps, fittings, switches, etc. Particulars may be obtained from Mr. James Bosson, town clerk, Barnstaple. Tenders by July 16.

Stepney.—The Electrical Committee of the Borough Council invite tenders for the supply of feed, suction, and other pipework, water-softening plant, and storage tanks. Tenders by July 21.

St. Asaph (Flints).—The Guardians invite tenders for lighting the workhouse and the new infirmary by electricity. Particulars may be obtained from the Master of the Workhouse. Tenders by July 16.

Sheffield.—The Electric Light Committee invite tenders for various electricity meters. Particulars may be obtained from Mr. S. E. Fedden, general manager and engineer. Tenders by July 21. See advertisement.

Pietermaritzburg.—The Corporation invite tenders for the supply of electric tramcars. Particulars may be obtained from Messrs. Mordey and Dawbarn, 82, Victoria-street, London, S.W. Tenders by July 29.

Ipswich.—The Corporation invite tenders for the supply and delivery of electricity meters. Particulars may be obtained at the office of Mr. Will Bantoft, town clerk, Town Hall, Ipswich. Tenders by 14th inst.

Pointe-a-Pitre (Guadeloupe).—The Municipality invite offers for a concession for public and private electric lighting for 15 years. Tenders by Aug. 29. Particulars may be obtained from the Colonial Office, Paris.

Manchester.—The Electricity Committee invite tenders for india-rubber matting. Particulars may be obtained on application to Mr. F. E. Hughes, secretary, Electricity Department, Town Hall, Manchester. Tenders by July 17.

Barnstaple.—The Corporation invite tenders for wiring, lamps, fittings, switches, etc. Particulars may be obtained from Mr. W. H. Trentham, 39, Victoria-street, Westminster. Tenders by July 16. See advertisement in last issue.

Lisbon.—The Public Works Department require tenders for the construction of 1m. gauge light railways as follows: (1) Limatal, Vianna-Ponte de Barca; (2) Oberer Minho, Braga-Monçao; (3) Braga-Guimaraes. Tenders by Aug. 1.

Blackburn.—The Town Council invite tenders for one complete main switchboard and accessories. Particulars may be obtained from Messrs. Lacey and Sillar, 2, Queen Anne's-gate, Westminster. Tenders by July 27. See advertisement.

Reigate.—The Town Council invite tenders for electric lighting station extensions. Particulars may be obtained at the office of Mr. Fred. T. Clayton, C.E., borough engineer and surveyor, Municipal Buildings, Reigate. Tenders by July 15.

Christiania.—The Norwegian State Railways invite tenders for telegraph and telephone materials. Conditions of tender may be obtained on application to "Telegrafinspektörens Kontor," No. 8, Stenersgade, Christiania. Tenders by July 15.

Newport (Mon.)—The School Board invite tenders for the installation of electric light at St. Woolos School. Particulars may be obtained at the offices of Messrs. Lansdowne and Griggs, architects, Metropolitan Bank-chambers, Newport. Tenders by July 16.

Shanghai.—The French Colony propose to instal motor-propelled tramways. Tenders may be sent by Oct. 31, 1903, to Secrétariat de la Municipalité Française de Shanghai. Particulars may be obtained from l'Office National du Commerce Extérieur, Rue Feydeau, 3, Paris.

St. Pancras.—The Borough Council invite tenders for the supply of about 350,000 carbons of various lengths and diameters for 12 months. Specifications, etc., can be obtained at the Electricity Department Offices, No. 57, Pratt-street, N.W. Tenders by July 14 at noon.

London, N.W.—The St. Pancras Borough Council invite tenders for supplying about 31 miles of lead-covered and armoured cable. Particulars may be obtained upon application to the Chief Clerk, Electricity Department Offices, 57, Pratt-street, N.W. Tenders by July 14.

Manchester.—The Paving, Sewering, and Highways Committee invite tenders for laying underground telephone pipes, with other appurtenant works. Particulars may be obtained on application at the City Surveyor's Office, Town Hall, Manchester. Tenders by July 20.

Vienna.—The Minister of Commerce requires tenders for the construction of a lift for the Danube-Oder Canal, capable of allowing vessels to negotiate a difference of 35·90 metres. Premiums of 100,000, 75,000, and 50,000 kroner will be given to the three best schemes.

Swindon.—The Corporation invite tenders for seven electric tramcars, with all trucks, motors, and accessories. Particulars may be obtained from Messrs. Lacey and Sillar, 78, King-street, Manchester, and 2, Queen Anne's-gate, Westminster. Tenders by July 23. See advertisement.

Bath.—The Corporation invite tenders for the supply and erection of a jet condensing plant, etc. Particulars may be obtained from the consulting engineers, Messrs. Kincaid, Waller, Manville, and Dawson, 29, Great George-street, Westminster. Tenders by July 17. See advertisement.

Derby.—The Electric Lighting Committee invite tenders for the supply of accumulators, balancers and reversible boosters, and switchboards. Particulars may be obtained from Mr. T. P. Wilmshurst, borough electrical engineer, Full-street, Derby. Tenders by July 13. See advertisement in last issue.

London, N.W.—The St. Pancras Borough Council invite tenders for supplying an electric jenny and grab to their King's-road powerhouse, Camden Town, N.W. Particulars may be obtained upon application to the Chief Clerk, Electricity Department Offices, 57, Pratt-street, N.W. Tenders by July 14.

Preston.—The Corporation invite tenders for the supply and erection of economisers, feed-water heaters, electrically and steam driven pumps, and overhead travelling crane. Particulars may be obtained from Mr. Walter H. Tittensor, consulting and resident electrical engineer, 25, Burrow-road, Preston. Tenders by July 22.

Launceston (Tasmania).—The Mayor and Aldermen invite tenders for the supply of 500 or more electric meters. Particulars may be obtained on application to Mr. William Corin, city electrical engineer, Launceston, Tasmania, or to Messrs. John Terry and Co., 7, Great Winchester-street, London, E.C. Tenders by Sept. 28.

Heston and Isleworth.—The Urban District Council invite tenders for the supply of steam-engines, dynamos, boosters, etc., storage batteries, cables, and arc lamps and glow lamps. Particulars may be obtained from the Council's engineers, Messrs. J. and J. S. Enright, 47, Victoria-street, S.W. Tenders by 23rd inst. See advertisement in last issue.

Cheadle (Cheshire).—The Urban District Council invite tenders for the supply and delivery of about 350 tons of grooved steel girder tramway rails, eight tons of tie-bars, 13½ tons of fishplates, and three tons of bolts and nuts; also for 17 sets of points and crossings. Particulars may be obtained from Mr. Charles R. Brady, A.M.I.C.E., 13, Warren-street, Stockport. Tenders by June 27.

Weymouth and Melcombe Regis.—The Corporation invite tenders for the supply, delivery, and erection of the following in connection with the electric lighting of the town: Lancashire boilers, engines and dynamos, overhead travelling crane, switchboard and battery boosters, storage battery, arc lamps and arc lamp posts, pipework, feed pumps, economiser, ejector condensers, etc., distributing mains and feeders, by July 19.

RESULTS OF TENDERS.

Felixstowe.—The Urban District Council have accepted the tender of Johnson and Phillips, for cables, at £945.

Rochdale.—The Tramways Committee have accepted the tender of W. A. Peters and Son, Crossfield, Rochdale, for the erection of a car-shed.

Colchester.—The Tramways Committee recommend the acceptance of Messrs. J. G. White's tenders for the construction of the Colchester tramways at £35,035.

Crewe.—The Town Council have resolved to accept the tender of the British Thomson-Houston Company to supply lamps of 5, 8, 16, and 25 c.p., 130-250 volts, at 9½d.

Marylebone.—The Council have accepted the tender of Messrs. A. W. Penrose and Co., 109, Farringdon-road, for electric light installation at the town hall, at £73. 9s. 6d.

Bradford.—The Guardians have accepted the tender of Messrs. Smith and Croft, Bradford, at £1,020. 3s., for a complete electric light installation at their sanatorium for consumptives at Eastby, near Skipton.

Middlesbrough.—The Electric Lighting Committee have accepted the tender of Messrs. Callender, London, for the carrying out of the electric lighting extension scheme to Grove Hill and Linthorpe, at £2,733.

Ilford.—The Urban District Council have accepted the tender of W. Newbold and Co., Pearl-buildings, London Bridge, S.E., at £384. 5s., for supply of machinery and tools in connection with their electric tramways.

Colchester.—The Electric Light Committee recommend the Council to accept the tender of the Henley Telegraph Works Company, Limited, to supply the required lengths of cable for North-hill, North Station-road, and Bergholt-road extension, at £1,635; and for raising main switchboard, etc., at £56.

Spennymoor.—The Urban District Council have accepted the tender of the Electricity Company at £2. 10s. per lamp for the

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district now lighted by Spennymoor Gas Company, £2. 11s. 6d. per lamp for the Blocks, and £2. 9s. 6d. per lamp for the Tunnel and Merrington-lane footpath.

Engine Contracts.—Messrs. J. Howden and Co. have recently booked the following orders: One 100-kw. engine and generator for the Scottish Co-operative Wholesale Society, Limited (Leith branch); one 300-h.p. compound engine, for Messrs. A. M. Bruce Peebles and Sons, Limited, Rishton Paper Mills; one 300 h.p. compound engine, for Messrs. Mather and Platt, Limited, Manchester.

Battersea.—The Lighting Committee recommend the following tenders for acceptance: Messrs. H. and G. Messures for carrying out necessary works of repair, etc., to the blow-down tank at the central electric generating station, £37. 10s.; W. T. Glovers, Limited, for supp'ying cable, etc., required for the purpose of connecting the new dynamo with the switchboard at the central station, £38. 1s. 7d.; Callender's Cable and Construction Company for supplying materials as may be required in connection with the extension of electric mains, the estimated cost of such articles and materials amounting to £1,148.

Rochdale.—The following tenders have been accepted in connection with the tramways: J. G. White and Co., Limited, London, for overhead line equipment of the remainder of the tramway system, at £21,619. 13s. 10d.; Lorain Steel Company, for points and crossings and for the entrance to the car-shed, including rails and fishplates, at £2,587; Hadfield's Steelfoundry Company, Limited, Sheffield, for the supply of points and crossings for the general track, at £5,322; W. Scott, Limited, Leeds Steelworks, Leeds, tramrails and fishplates: Bayliss, Jones, and Bayliss, Victoria Works, Monmore-green, Wolverhampton, tiebars, bolts, and nuts; L. Cooper, jun., Leeds, soleplates.

Paisley.—The following tenders are recommended for acceptance for the work to be carried out at the electricity works:

J. Porter and Sons, Jeanfield Brickworks, London-road, Glasgow, bricklayers and masons	£2,267	13	6
D. Clerk and Son, Limited, 92, Wellington-street, Glasgow, steelwork	358	13	1
G. and T. Houston, 5, Maxwellton-street, carpenters, ironmongers, etc.	521	13	9
A. Shaw and Sons, 51, High-street, slaters	135	5	0
A. Forsyth and Son, 46, Broomlands-street, plumbers	154	1	2
D. T. Hutchison and Son, 25, Gauze-street, plasterers, concretors, etc.	99	3	9
Cherry and Co., Limited, 100, Bath-street, Glasgow, tilework	94	0	6

Maidenhead.—The following tenders have been received for extensions to the central station buildings:

Peerless, Dennis, and Co., Eastbourne	£1,242	0	0
Thompsett and Co., Farnham	1,221	0	0
W. J. Bloxham, Banbury	1,174	0	0
H. Flint, High Wycombe	1,127	12	6
C. W. Cox and Sons, Maidenhead	1,110	0	0
A. J. Colborne, Swindon	1,099	19	6
F. W. Edwards, Maidenhead	1,080	0	0
F. Bissley, Maidenhead	1,020	0	0
W. E. Theaker, Maidenhead (accepted)	874	0	0

The following tenders have been accepted: Messrs Aiton and Co., extension of steam, exhaust, feed and other pipes, feed-pump, etc., £490. 5s.; Messrs. Johnson and Phillips, extensions to switchboard, connections to new dynamo, etc., £236.

London County Council Tramways.—The following tenders have been received for the erection of the second portion of the Clapham car-shed:

Kirk and Randall, Woolwich (recommended for acceptance)	£29,434	0	0
H. Lovatt, London and Wolverhampton	29,844	0	0
W. Pattinson and Sons, Westminster	29,852	0	0
C. Wall, Chelsea	30,047	0	0
W. Jones and Sons, Bow	30,240	5	2
F. Morton and Co., London	30,355	0	0
Holloway Bros., Limited, Lambeth	30,875	0	0
F. and H. J. Higgs, Loughborough Junction	31,000	0	0
Grays Steel Construction Company, London and Grays	31,202	0	0
B. E. Nightingale, Lambeth	31,552	0	0
Perry and Co., Bow	31,700	0	0
H. L. Holloway, Deptford	31,900	0	0
M. T. Shaw and Co., London	32,277	0	0
W. Norton, Chelsea	32,878	0	0
J. Westwood and Co., Millwall	33,071	6	1
F. G. Minter, Westminster	33,612	0	0
J. Jackson, London	34,541	10	0
Peirson and Co, London	39,941	0	0
C. B. Roberts and Co., Redhill	36,528	0	0

BUSINESS NOTES.

TRACTION.

Prestwich.—Bury Old-road is to be widened for tramway purposes.

Clydebank.—A demand is being made for special car facilities for working men.

Reading.—The formal opening of the electric tramway system has been fixed for the 22nd inst.

Bexley.—The District Council are taking up £20,000 of the loan of £30,000 for tramway purposes.

Branksome.—The local authority have withdrawn their opposition to the Bournemouth Tramways Bill.

Ashton.—The electric cars will probably be running through from Manchester in about a month's time.

Blackburn.—The Town Council have again rejected a proposal for the extension of the tramways to Revidge.

Central Wilts.—A meeting in support of the proposed Central Wilts light railway was held at Calne on Friday.

Lizard Light Railway.—It is proposed that work shall be started on the construction of this railway in the autumn.

Brampton.—The Parish Council are considering a scheme of electric tramways which has been submitted to them for approval.

Tipton.—A start is to be made with the work of equipping the tramway from Dudley to Wednesbury through this district for electric traction.

Airdrie.—With the intervention of the Board of Trade an agreement is being come to between the Corporation and the tramways company.

St. Marylebone.—The Borough Council are recommended to oppose the construction of the proposed tramway along Tottenham Court-road and Edgware-road.

Sheffield.—A proposal to defer the question of accepting advertisements for the tramcars for 12 months was defeated at this week's meeting of the Council.

Birkenhead.—The Tramways Committee have transferred £3,595, the amount of income over expenditure on revenue account for the past year, to a renewal fund.

Fraserburgh.—The new light railway, which connects the villages of St. Combs, Inverallochy, and Cairnbulg, with Fraserburgh, has been opened for passenger traffic.

Paisley.—It is announced that contracts have been placed in connection with Mr. Murphy's tramway scheme, and the work of construction will be commenced forthwith.

Crewe.—Terms of agreement are being arranged between the Town Council and the company which proposes to lay down a system of light railways for the town and district.

Brighton.—Lord Hatherton's Committee of the House of Lords has passed the preamble of the Bill promoted by the Corporation to extend the tramways in various directions.

Camberwell.—The Borough Council have agreed to contribute one-third of the cost of the necessary street widenings in connection with the County Council's tramway scheme.

Great Orme's Head Tramway.—The upper section of the Great Orme's Head tramway was opened for traffic on Wednesday after satisfying the requirements of the Board of Trade.

Newcastle.—The Tramways Committee have decided to request Mr. Rossignol to prepare an estimate of the cost of laying an extra line of rails from the centre of the city to Gosforth.

Hanwell.—Land at Hanwell has been sold at the rate of £15,000 an acre, which before the advent of the "tube" and the electric tramways was disposed of at about £1,000 per acre.

Ilkeston.—Mr. Pilcher, engineer and manager, has been instructed to draw up the necessary plans and specifications for substituting double track in place of the existing single-track tramways.

Wallasey.—It was stated at the monthly meeting of the District Council that there is a prospect of an early extension of the tramways to Wallasey village, nearly all the surveys having been completed.

Aberdeen Suburban Tramways.—A meeting of the Aberdeen Suburban Tramways Company has resolved that the directors be now authorised to issue the total share capital of the company, £72,000.

Ipswich.—A memorial from tradesmen of Tavern-street has been sent to the Town Council protesting against "the long-continued stoppage of traffic owing to the reconstruction of the tramways."

Stepney.—The Borough Council have decided not to consent to the London County Council's proposal to adopt overhead traction on the projected electric tramways on the Mile End, Burdett, and other roads in East London.

Bromley (Kent).—The Urban District Council have decided to organise "effective opposition" to the application by the British Electric Traction Company for tramway powers in this and neighbouring districts, referred to in our last issue.

Bournemouth.—The Town Council have decided by 29 votes to 6 not to run tramcars on Sundays. The Corporation will shortly take over the Poole and Branksome tramway, and, according to agreement, will have to run Sunday trams in those districts.

Derby.—The Tramways Committee have arranged to pay to the Electric Lighting Committee £150 per annum for the next three years in consideration of the services rendered by Mr. Wilmshurst, the electrical engineer, in connection with the electric tramway scheme.

St. Pancras.—A letter from the London County Council has been referred to the Electricity Committee of the Borough Council asking if the Council are prepared to give their statutory consent to the construction of the suggested tramway along Tottenham Court-road.

Cathays.—In view of the continued agitation in Cathays for the lowering of Salisbury-road Bridge, which would enable the ordinary double-decked tramcars to be run, the members for the ward have arranged for a *plébiscite* of the inhabitants to be taken on the question.

Lewisham.—The Borough Council are approaching the London County Council on the subject of their proposal to construct electric tramways through the borough, asking for information which, when obtained, will doubtless be very valuable and assist towards the solving of the problem.

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Irvine.—At the monthly meeting of the Irvine Town Council this week it was unanimously agreed to open negotiations with the County Council of Ayrshire and the town councils of the neighbouring burghs with a view to obtaining their opinions on the formation of a joint electric traction scheme for the district.

Rochdale.—The tramway company's lines will be taken over by the Corporation on the 31st inst., and it is intended to begin the reconstruction of the tramways for electric traction forthwith, so as to have the electric cars running in the centre of the town and on the best paying sections as soon as possible.

Bury.—The section from Blackford Bridge to the boundary of Unsworth and Whitefield is to be laid with a double track in place of the single line originally contemplated. The tramways in Radcliffe, when constructed, are to be taken over by the Corporation under an agreement with the Urban District Council.

Ilford.—The District Council, by way of experiment, have decided to equip one of the electric cars with a covered top, after the fashion adopted at Liverpool, Leeds, etc. The electric cars are now running on the section from the Broadway to Rodingbridge, within a few yards yards of the East Ham electric car terminus.

Wednesbury.—The difficulties between the Corporation and the South Staffordshire Tramways (Lessee) Company, Limited, are now settled, and the Town Council at their next meeting will be recommended to sanction the sealing of the necessary agreement for an improved system of traction in the borough.

Lowestoft.—The question of running the electric trams on Sundays, which evoked considerable opposition on the part of the members of the religious bodies in the town, has been decided by the Corporation. The cars will not commence to run until noon, a compromise which, it is hoped, will meet the wishes of the townspeople.

Chester.—A movement is on foot with a view to securing the extension of the electric tramways from City-road to Great Boughton. Numerous residents are discussing the advisability of selecting two candidates for the November contest, irrespective of party, who, if returned to the Council, would use very effort to obtain the extension.

Southend.—On Friday, whilst an electric car was proceeding down London-road at Southend-on-Sea, the trolley boom broke and fell on to the top of the car. A lady passenger was cut about the face and head, and was removed to the nearest surgery. Other passengers had narrow escapes, whilst a number of seats were smashed. Traffic was interfered with for a considerable time.

Baker-street and Waterloo Railway.—Lord Morley's Committee had before them on Tuesday the transfer Bill which transfers the above undertaking to the Underground Electric Railways Company, Limited. There was no opposition, and the preamble of the Bill was declared proved. In the Commons the Baker-street and Waterloo Railway (Extension of Time) Bill has been read a third time.

Leeds.—The Board of Trade is examining the details of the working of the Leeds tramway system with a view to authorising an acceleration of speed. At the request of the Board of Trade the Leeds authorities have prepared particulars as to gradients, speeds, etc., on the routes over which they run cars, and it is hoped that as a result a revision of the maximum speed allowed may be made.

West London.—As an example of the popularity of the London United Electric Tramways system, it is interesting to know that during the past week considerably over a million passengers have been carried, the receipts being £7,654, thus comparing very favourably with other metropolitan lines, such as the Central London, the receipts for the same period being £6,788, and the Metropolitan District Railway £7,079.

Maidstone.—The Board of Trade have determined to confirm the order of the Light Railway Commissioners as to Railway No. 1 (from High-street to the borough boundary), but not as to Railway No. 2 (from the borough boundary to the Bull Inn, Barming. It is stated that this decision is quite agreeable to the Corporation, who have no ulterior motive in view, such as extending the borough boundaries, so as to include Barming.

Bradford.—Major Pringle, Board of Trade inspector, on Friday, travelled over and inspected the Drighlington and Buttershaw extensions of the Bradford city tramways. He was accompanied by the general manager (Mr. C. J. Spencer), the city surveyor (Mr. J. H. Cox), the tramways engineer (Mr. Taylor), the traffic superintendent (Mr. Schofield), and the rolling-stock superintendent (Mr. Edwards). Major Pringle was understood to be fully satisfied with the lines.

Leith.—Mr. James More has presented his report to the Town Council as to the value of the tramways undertaking in the burgh, and the conversion of the present lines to electric traction on the overhead system. He estimates the undertaking as worth £78,512, and the cost of reconstruction at £77,000, giving a total capital expenditure of £157,000. The new system worked by the Corporation, and with the terminus at Pilrig as at present, would, he considers, result in a net annual profit of £3,444.

Darlaston.—The Urban District Council have decided to offer no objection to the proposed transfer of the undertakings authorised by the Dudley, Sedgley, and Wolverhampton Tramways Order, 1880 and 1884, the Dudley and Wolverhampton Tramways Order, 1899, the South Staffordshire Light Railways Order, 1900, and the South Staffordshire Light Railways (Extensions) Order, 1900, from the British Electric Traction Company, Limited, to the Wolverhampton and District Electric Tramways, Limited.

Turton.—The delay of the Board of Trade in giving their decision on the application of the Lancashire Light Railway Company for powers to construct light railways in the district, under the Bolton, Turton, and Darwen order, was discussed at the last District Council meeting, and the chairman and clerk were authorised to interview the Board of Trade and urge that the order should be confirmed or rejected forthwith, as the withholding of the decision was preventing other schemes from being submitted.

Halesowen.—The Light Railways Committee have resolved to empower a representative to settle for the transfer of the electric lighting order and light railways orders upon the following terms—viz.: (1) the costs of and in connection with the orders to be paid back as quickly as possible after the execution of the agreement; (2) the Lye to Halesowen line to be put down at an early date; (3) the Halesowen to Old Hill length to be carried out at an early date; (4) the Halesowen to Birmingham line to be put down as early as possible.

Bromsgrove Light Railway.—The promoters of this light railway scheme are applying to the Board of Trade for an extension of time for the completion of the works sanctioned under a parliamentary order some years ago. The delay that has occurred in the carrying out of the scheme is attributed to the obtaining of a lighting order, and to the failure of negotiations for amalgamating the scheme with the proposed Redditch undertaking. The project has now, however, been revived in another form, and the promoters are hopeful that the work will be proceeded with shortly.

Hammersmith.—At the last meeting of the Borough Council the Law and Parliamentary Committee recommended that the London County Council be informed that, subject to details being arranged, the Borough Council will be prepared to consent to the construction of the proposed tramway from Shepherd's Bush to the Marble Arch, and to make a contribution of one-third of the cost of the necessary street widenings, not exceeding £9,260, provided that the tramway is continued either along Uxbridge-road to Bayswater or along Latimer-road. The recommendation was carried.

Stroud.—The following resolution has been passed by the Urban District Council: "That the Council consider that the Stroud District and Cheltenham Tramways Bill will if passed be of great benefit to the district, and they therefore strongly approve of the Bill, and hereby resolve to give it their hearty support. The Council respectfully urge the Great Western Railway Company to withdraw their opposition, and the Council appoint their vice-chairman, Mr. C. P. Allen, M.P., and Mr. J. H. Tratt to attend, if necessary, before the committee and give evidence in support of the Bill on behalf of the Council."

Walsall.—The permanent way for the tramway extensions in Walsall and district is rapidly approaching completion, and the erection of the overhead electrical equipment is being pushed forward. It is proposed to have the whole of the new lines in readiness for the cars to commence running on Jan. 1, the date upon which the Corporation take over the lines in the borough. At a meeting of the Town Council on Monday the Tramways Committee will present a special report with respect to the arrangements to be made for working the Corporation tramways, as amended and approved by the General Purposes Committee.

Additional Traffic Returns.—Anglo-Argentine, £1,610 increase; Barcelona Ensanche y Gracia, £205 increase; Barcelona, £8 decrease; Brisbane, £43 decrease (month of June, £9,575, decrease £612); British Columbia Electric (month of March), gross earnings £10,352, net income £2,658; Buenos Ayres and Belgrano Electric, £298 increase (month of April, £12,995, increase £1,125); Calcutta, £423 increase; Cape Town (month of April), receipts £16,003, expenditure £8,313; Isle of Thanet Electric, £205 increase; Mexico Electric (month of March), receipts £46,200, expenditure £26,400; Perth Electric, £18 increase; Port Elizabeth (month of April), receipts £4,292, expenditure £2,281.

Ruabon.—Several memorials have been sent to the company who recently commenced running electric cars between Johnstown (Ruabon) and Wrexham, asking them to discontinue running the cars on Sundays, as the practice led to a great deal of drunkenness in the district. At a meeting of Rhos Council, a letter was read from the secretary to the company, who said that in view of the large number of residents in the district who had availed themselves of the facilities offered by the trams on Sunday, the company could not see their way to discontinue the service. The company had made enquiries locally, and found that the little drunkenness which there was in the district had in no way been increased by reason of the service of cars on Sundays.

Wolverhampton.—A balance-sheet on the past year's working of the Corporation tramways has been issued by Mr. Howell, borough accountant. It shows that the working of the horse tramway section cost £5,478, and the income amounted to £94,654, the loss being £824, without taking into account anything for interest and sinking fund on borrowed capital. On the electric traction system there was spent last year £12,670, and the income was £21,352, the gross profit being £8,682. The interest and sinking fund on both the horse and electric traction had been charged against the income from the electric section. The deficit of £824 upon the horse trams had been wiped off, £2,000 had been set against depreciation, and the total loss on the year's working of the two systems was £256.

District Railway.—Last Wednesday week the electrically-equipped section of the District Railway from Harrow to Ealing broke down by reason of failure of current from the temporary generating station at Alperton. A single coach drawn by ordinary steam-engine brought the belated passengers from the City on Wednesday night. By the following day repairs had been made and traffic was resumed. Mr. Bonar Law, replying to Mr. Weir in the House of Commons on Wednesday, said that the company informed him that the railway between Mill Hill Park and South Harrow—about six miles—had been regularly worked by electric traction since June 28. The company added that the working of the main line by electric traction depended on the date of the completion of the power house at Lot's-road, Chelsea, which was being pushed forward with the greatest possible speed.

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Birmingham.—At the meeting of the City Council on Tuesday it was unanimously decided to appoint at once a tramway manager, and, in order to secure the best possible man for the position, it was decided not to advertise in the ordinary way or to fix a salary, but to leave the selection entirely in the hands of Alderman Beale and his colleagues on the Tramways Committee. The Council also decided to give notice to the City Tramways Company to surrender certain lines in a portion of Birmingham which was not within the city when the lines were constructed; and Alderman Beale foreshadowed the electrical equipment of the whole of the lines within the next two years, and a workable agreement with the tramways company, the British Electric Traction Company, and the outside authorities. Probably the first section to be reconstructed will be the Aston-road section.

York.—The City Council have had two proposals submitted to them by the tramways company as to the electrification and extension of the tramways in the city, and have decided not to entertain either. The committee, in recommending this course, were unanimous that it would be unwise for them to lose control of the streets, and to come to any arrangement or agreement with the tramways company which would cause that. It was stated at the meeting that the Council had a mandate from the citizens a comparatively short time ago in which they refused leave to the Corporation to take over the tramways, and some of them thought it too soon to approach the matter again. Very great changes were also looming in the future with regard to electric traction and the introduction of motor 'buses, and it would not be wise for them, even if they had an agreement with the tramways company, to incur a large expense in pulling down corners of streets so as to improve them for electric traction. They therefore thought that it would be well to delay the matter a little while longer.

Hampstead.—At the last meeting of the Borough Council it was decided to comply with the request of the London County Council on the subject of the suggested reconstruction for electrical traction of their northern tramways, to give directions that any electric lighting mains laid in the carriageway of thoroughfares where there are tramways, or which are likely to form part of tramway routes in future, shall be placed as near as possible to the kerb, and that mains crossing the carriageway be laid at a depth of not less than 3ft. 6in. below the surface. The General Purposes Committee recommended that, with reference to the letter from the clerk to the London County Council, stating that the Improvement Committee had again under consideration the suggested widening of Edgware-road, High-road, Kilburn, and Shoot-up-hill, in connection with the proposal to construct a tramway from Marble Arch to Cricklewood, and asking this Council to contribute a third (amounting to about £15,213) of the net cost of the necessary street wideningș, the London County Council be informed in reply that this Council are not prepared to contribute towards the cost of the proposed scheme. The recommendation was adopted.

Hull.—From the report of the city treasurer (Mr. Milner) for the year ending March 31 last, it appears that the expenditure for the electric tramways on capital account during the 12 months has been £30,490. 15s. 9d., making a total to date of £341,042. 8s. 5d., subject to the addition of the proportion of cost of paving works in course of progress. The sinking fund has been increased by instalments charged to revenue and interest on accumulations, making together £9,622. 10s. The income from fares has been £91,491. 16s. 10d., against which the working expenses and maintenance have been £48,088. 2s. 3d., leaving a net revenue of £43,403. 14s. 7d. Out of this have been met charges for interest, £9,082. 15s. 6d.; sinking fund, £9,147. 14s. 3d.; and £10,673. 4s. 10d. has been carried to the reserve fund. The remaining £14,500 will be carried to the city fund for the relief of the rates. The working expenses have been 52·56 per cent. of the receipts, compared with 53·42d. per cent. the previous year. The number of passengers carried was 22,062,703, the highest number in one day being 172,521 on Aug. 9 last. The amount to the credit of the reserve fund is now £36,572. 18s. 9s., being 10·7 per cent. of the outlay on works.

Southport.—A big fight is being waged here on the question of a Sunday tram service. On Saturday a *plébiscite* of the ratepayers was taken, and nine wards out of ten returned majorities against, the total figures being 1,843 for and 3,639 against—majority against, 1,796. All the clergy and minsters have taken a decided stand in opposition to the proposal. Their victory, however, is only a prelude to a campaign. On Sunday the whole town was astonished by the Southport Tramway Company, in which the British Electric Traction Company have a controlling interest, running a service in Lord-street, the principal thoroughfare. A clause in their lease says they cannot ply for hire on Sundays without the sanction of the Corporation. Accordingly, passengers were granted free tickets for the Southport portion of the journey, and treated as "guests" of the company. On arrival at the Birkdale boundary they pay their fares. A Gilbertian situation could be created by passengers travelling half way without paying, but the conductors could reserve to themselves the right of saying who will be guests. Last year the company lost over £2,000 on the undertaking, while the Corporation system lost £1,200. Before the poll was taken much amusement was caused by the company profusely placarding their cars with lists of churches and chapels along the route which would be benefited by a Sunday service. The chairman of the Corporation Electricity Committee declined on Saturday night to supply current, and the company have connected wires with the Birkdale system.

District Railway (Various Powers) Bill.—The Select Committee of the House of Lords presided over by Lord Ribblesdale concluded its consideration of this Bill on the 3rd inst. In the case of the petition of Messrs. Van Noorden and Co., ivory cutters, whose premises adjoined the proposed new railways between Mark-lane Station and Minories Station, and who feared damage arising from increased vibration, the committee, after hearing Mr. Brereton, engineer to the District Railway Company, and Sir A. Binnie, declined to grant the request of the petitioners for the insertion in the Bill of a vibration clause, but agreed to a clause to the effect that the company should not take any portion of their premises. Several outstanding points on the petition of the London County Council were then discussed. The most important of these had reference to the construction of certain station works proposed to be executed by the District Railway Company under Whitechapel-road. The County Council expressed a fear that these works would interfere with, and possibly prevent, the electrification of their existing tramways on the conduit system, and they asked for protection in this respect. Mr. Pember, K.C., on behalf of the District Railway Company, brought up a clause undertaking that these station works should not be constructed at a level higher than their existing works. The committee agreed to this clause. The committee found the preamble of the Bill proved. The clauses were gone through and adjusted, and the Bill, which has already passed through the House of Commons, was ordered to be reported for third reading.

Municipal Trading.—The parliamentary enquiry into the question of municipal trading was resumed in the Houses of Parliament on Monday, the Earl of Crewe presiding. Mr. James Dalrymple, accountant to the Glasgow Corporation tramways, said all moneys required for capital purposes were borrowed under the provisions of the Glasgow Tramway Acts, 1872 to 1901. Their net borrowing powers authorised were £2,043,197. To May 31, 1903, the total tramway revenue was £656,572, of which £653,199 was derived from passengers. The average total revenue per car mile was 11·25d. The working expenses amounted to 7·40d. per car mile. A sum was charged for the renewal of the track calculated at the rate of £450 per mile. This sum was carried to a renewal fund, to which all sums actually expended in renewals were charged. This fund now stood at £136,789. In addition to this a further sum of £74,038 was charged to revenue to meet the year's depreciation on plant and equipment. After deducting every item of expenditure there remained a credit balance of £224,702. The balance of £100,276 still remaining was regarded as the net surplus of the year's working. Street improvements had not been carried out to benefit the tramways as suggested. The Tramway Committee kept up the centre of all streets in which tramways were laid to a width of 17ft., and was quite prepared to pay the proper proportion of the cost of street improvements. Last year the tramways department was the fifth largest ratepayer in the city. This year the department would be the second largest ratepayer. The principle adopted by the Corporation in regard to depreciation was to provide out of revenue annually a sum sufficient to reinstate the subject at the end of its estimated life. This sum was always charged against revenue as a working expense. The amounts formed a deduction from the capital cost, and was applied in the reduction of debt. The annual sinking fund formed a charge against net revenue, and was charged to meet depreciation. The result would be that at the end of the period for the repayment of the debt the Corporation would have a tramway system in perfect condition and free from debt. The committee adjourned.

Aberdeen.—The tramway accounts for the year ended May 31 last have just been issued, showing a very healthy and promising state of affairs. The revenue amounts to £50,986. 0s. 7d., as compared with £37.035. 17s. 10d., an increase of £13,950. 2s. 9d. over the revenue of last year. The average income per mile is put at 12·66. Then, against the income of £50,986. 0s. 7d., there has to be put the working expenses, totalling £27,571. 4s. 6d., compared with £26,577 last year, leaving a profit on the actual working of £23,414. 16s. 1d. to be carried to the net revenue account, an increase of £12,059. 19s. 11d. over, and more than double, last year's profit. The working expenses include: traffic expenses, £10,642. 9s. 1d. (2·647d. per mile); electric current, £7,644. 19s. 11d. (1·898d.); maintenance and repairs, £5,183. 7s. 2d. (1·287d.); general charges, £2,910. 11s. 5d. (·721d.); and depreciation on cars, plant, office furniture, and buildings, £1,189. 16s. 11d. (·295d.). The average working expenses per mile works out at 6·85d. The balance of £23,414. 16s. 1d. carried to net revenue account is disposed of thus: interest on mortgages and loans, bank interest, and commissions and stamp duty, £7,666. 8s. 6d. (last year, £6,111. 11s. 1d.); amount written off preliminary and parliamentary expenses, £734. 3s. 4d. (£734. 3s. 4d.); carried to credit of sinking fund, £1,884. 5s. 2d. (£1,201. 2s. 2d.); carried to credit renewal account, £8,458. 18s. 9d. (£1,708. 1s. 6d.; capital account, written off value of old horse cars, harness, and horses, £4,671. 0s. 4d. Turning to the capital account, the amount debited for the year is £38,849. 18s. 9d. The amount of capital account carried to balance account is £259,597. 0s. 5d. The liabilities fully met by assets in the balance account amount to £271,162. 3s. 3d. An interesting table embodied in the report gives the details of the traffic returns week by week for the year to May 31 last. The best week was that ending July 19 of last year (the exceptional week on which the Highland and Agricultural Show was held on the Links), when £1,647. 16s. 1d. was drawn, representing 380,953 passengers carried. Leaving that week out of account for the sake of comparison, we take the next best week, ending Aug. 2 last year, when the sum drawn was £1,299. 10s. 7d., representing 292,597 passengers carried. In the previous year the high-water mark was reached on July 27, when the weekly receipts amounted to £1,064. 8s. 8d., representing 245,621 passengers carried. The total mileage covered in the year was 966,859 miles, the average number of passengers per car mile being 12·57, and average receipts per passenger 0·99. It is proposed to erect a new car depôt at an estimated cost of £4,800, and workshops and stores at £4,200.

London County Council.—At the meeting of the London County Council on Tuesday a long debate took place with reference to the relative merits of the conduit and overhead systems of electric traction as applied to tramways generally, and to the lines in North London in particular. Mr. Sidney Low opened the discussion by adducing a number of objections which he said could be urged against the conduit system. Its construction involved an enormous disturb-

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ance of traffic, and in every case it required a much longer time than any other system. They had had some experience of rain, but they did not know what snow would do. Mr. Benn, added Mr. Low, thought there should be a thousand miles of electric tramways in London, and this carried out on the conduit system would mean an expenditure of 12 millions of money. He admitted that London was behind other cities in the matter of tramways, but he objected to spending large sums on a scheme which in 10 or 15 years' time might be rendered obsolete by the motorcar or the trolley omnibus. Mr. Allen Baker defended the conduit system. He admitted that it took longer in construction, but, once made, it involved no further disturbance for years, and as for the difficulties with railway bridges, these could be overcome. As far as South London was concerned, the authorities at Greenwich absolutely prohibited the Council from using the overhead system within a radius of three or four miles, and this referred also to the Commercial-road line. Mr. John Burns, M.P., adduced the experience of two months in South London as evidence in favour of the conduit system, and thought the Council made a mistake in following the main roads so closely, instead of having a single line down one street and a return line up another. Mr. Benn, replying on the discussion, said it had been asked in North London many times why they had had to wait so long for electric trams, but the reason lay with the company, which had refused to surrender its lease at any price, and with the borough councils, which objected to the overhead system. The committee had looked at the question from every point of view, but they could not do as they would like. The report was a compromise, and if any member on the other side could suggest a way out of the difficulty he (Mr. Benn) would be glad to give all the assistance in his power. After further discussion the report was received, and the recommendations of the committee as to the reconstruction of the northern lines (set out in a previous issue) came under debate. In the case of 18 routes the committee recommended that they should be reconstructed on the conduit system, and after Mr. Sidney Low had moved and withdrawn an amendment for reference back the recommendation was adopted. There were 19 other recommendations as to routes which should be reconstructed on the overhead system. Mr. Howell Williams moved as an amendment that the conduit system should be substituted, and, in deference to an appeal from Sir William Collins, Mr. Benn agreed to an adjournment of the debate, repeating his hopes that the Moderates would come forward with some practical suggestion as to the whole matter. At the same meeting the Highways Committee presented a report stating that the reconstruction, for electrical traction, of the tramways (*a*) in Camberwell New-road, between Camberwell-green and Brixton-road, (*b*) in Brixton-road, between Camberwell New-road and Kennington Park-road, and (*c*) in Westminster Bridge-road, from its junction with Kennington-road to St. George-circus, has been completed, and the Board of Trade has consented to, and approved of, the use of electrical power on these lines. The Board has also certified that the tramway in Camberwell New-road, which has been reconstructed as a double line under the powers conferred upon the Council by the Act of 1901, and not under the Electrical Power Act as is the case with the other two lines, is fit for public traffic. The Board has forwarded, with its consent, a copy of a report by Lieutenant-Colonel Yorke, R.E., who inspected the tramways on its behalf on June 24. In his report Colonel Yorke has made certain recommendations, to which effect has been given, as to the method of working the lines. These tramways have been opened to the public, and in order to relieve the traffic in Walworth-road, where the tramways are being reconstructed, arrangements have been made for a through service of electrical cars between Camberwell-green and Blackfriars Bridge, *via* Camberwell New-road.

LIGHTING AND GENERAL.

Maidenhead.—The suggested electric light extension in Ray Park-avenue has been agreed to.

Long Eaton.—The Urban District Council are raising £1,600 in respect of electric lighting expenses.

Bruce Peebles and Co.—Letters of allotment of shares in Bruce Peebles and Co., Limited, have been posted.

Kent and Canterbury Hospital.—Electric lighting is to be installed throughout this hospital at a cost of £300.

Ramsgate.—The Town Council have accepted the terms of the tramway company for the electric lighting of the town.

Sleaford.—The Urban District Council have obtained sanction to a loan of £1,925 in connection with the electric lighting.

Batley.—Sanction has been received to borrow £5,308 for the provision of a refuse destructor near to the electricity works.

Tonyrefail.—It has been decided to form an electric light company, with £1,000 capital, for public lighting and private supply.

London County Council.—The Council on Tuesday agreed to lend the Battersea Borough Council £3,019 for electric light installation.

Watford.—Electricity consumers now number 270, and owing to the increasing demand the Council are compelled to extend the works.

Benwell.—The offer of the Newcastle and District Electric Lighting Company to supply the district with electricity has been accepted.

Southwick.—The Empire Electric Lighting Company intend to make application for a provisional order to supply electricity in the district.

Main Trunk Telephone.—The wires have been put up between Shrewsbury and Aberystwyth, and conversation has been carried on between these points.

Stourbridge.—The Council have decided to apply to the Board of Trade with a view to assuring the non-revocation of their electric lighting provisional order.

Clayton.—The Empire Electric Lighting and Power Company intend to make application for a provisional order to supply electricity for use within the Council's area.

Edinburgh.—The Electric Lighting Committee on Tuesday decided to recommend that the price of energy for each public lamp should be reduced from £13 to £12. 10s. per annum.

Electric and General Investment Co.—Warrants for the half-year's dividend, payable July 1, on the 6 per cent. cumulative preference shares of the Company have been posted.

Erith.—The Erith Education Committee are considering the subject of the electric lighting of all the Council's schools. The St. Augustine's-road new schools are to be first taken in hand.

Kingston (Surrey).—Colonel W. R. Slacke has held an enquiry into the application of the Town Council for sanction to borrow £7,784 for purposes of their electric light undertaking.

Bath.—The Corporation propose to apply to the Board of Trade for a provisional order to supply electricity for public or private purposes in the area of the Rural District Council.

Irvine.—Royal assent has been given to the Electric Lighting Bill promoted by the Corporation. The order provides, *inter alia*, for the lighting of the streets in the burgh by electricity.

Thornhill.—The General Purposes Committee of the District Council have approved the final plans for the erection of a generating station for the Yorkshire Electric Power Company.

Devizes.—The Town Council have decided to apply for an electric lighting order with the intention of, in two or three years' time at the outside, setting up plant for the manufacture of electrical power.

Crewe.—The electrical engineer's last report stated that 7,083 units had been used by consumers and 11,729 in public lighting. The engineer has been instructed to prepare a report as to the cost of placing arc lamps into the main streets.

Overhead Wires.—The London County Council have been asked to insert a clause in their General Powers Bill to prohibit electric current being supplied to consumers within the area of a local authority from an outside source by means of overhead wires.

East Dereham.—The Southern District Electricity Company intend to apply for a provisional order for supplying electricity in the district. This question and the consideration of the provision of a telephone system has been referred to committee.

Clydebank.—The Electric Lighting Committee are negotiating with the Clyde Valley Electric Power Company in regard to certain proposals to supply the street lamps and municipal buildings with electricity, and also to treat the burgh refuse at their works at Yoker.

Willesden Polytechnic Electrical Engineering Society.—On Saturday an interesting paper was read by Mr. H. German on the subject of the society's recent visit to Messrs. Martin and Co.'s electric lighting station. Mr. F. H. Taylor, A.M.I.E.E., occupied the chair.

Stockton.—The Electricity Committee in their last report state that the additions made during the month were equivalent to 1,769 8-c.p. lamps, and on their recommendation it was decided to apply for sanction to borrow £1,000 for the purchase of motors to be let out on hire.

Exmouth.—The District Council have approved of a site for an electric lighting station, and the surveyor is about to interview Messrs. Crompton and Co. and ascertain from them the terms upon which they would take steam from the Council for the purpose of generating electricity.

Stock Exchange Settlements.—Applications have been made to the Stock Exchange Committee to appoint a special settling day in and to grant a quotation to the County of London and Brush Provincial Electric Lighting Company, Limited, £250,000 4½ per cent. second debenture stock.

Cheltenham.—The borough electrical engineer in his last report states that all work, both of extensions and ordinary running, has progressed satisfactorily. There are 700 customers, with the equivalent of about 42,600 8-c.p. lamps, connected to the private supply mains, and applications for supply to about 600 more 8-c.p. lamps are in hand.

Wallasey.—In our last issue we gave some particulars in reference to the proposed alteration of charges for electrical energy in Wallasey, in the course of which it was stated that the price was to be altered from 5d. to 6d. per unit, instead of the other way about—*i.e.*, the price is to be reduced from 6d. per unit to 5d., subject to a reduction of 2d. for all supply above two units per quarter for each 8-c.p. lamp, etc.

National Electrical Contractors' Association.—Successful meetings of the Northern Section of the National Electrical Contractors' Association were held at the Grand Hotel, Manchester, on the 4th inst. Members were present from all parts of the North of England, and many important matters, including registration and training of workmen, municipal trading, etc., were discussed. It was reported that good work was being done by all the local associations. The hon. secretary is Mr. W. Cross, 4, St. Nicholas-buildings, Newcastle.

New Palace Steamers.—Last week "La Marguerite" commenced her cross-Channel trips for this season, taking a large number of passengers from Tilbury to Ostend and back. The vessel performed the journey in her usual good style, doing the 220 miles (the distance for the return journey) in just over 10 hours, including a call at Margate. On Monday the "La Marguerite" made a special trip to the English Channel to meet the fleets escorting the President, and accompany them to Dover, and the passengers thus had an opportunity of joining in the welcome to M. Loubet. The popular husbands' boat trip to Margate was resumed on Saturday by the Palace steamer "Koh-i-Noor," enabling City business men to take the fresh-air route to the seaside after the usual Saturday office hours.

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Dublin.—At the last meeting of the City Council the suspension of the standing orders was proposed with the view of taking up the consideration of the report of the Lighting Committee. The result of the voting was 41 for and 18 against, which was not sufficient, as the motion required a majority of three-fourths.

Buralem.—At the last meeting of the Town Council a scheme for lighting the town by electricity was provisionally adopted. The cost, it was stated, would be about £20,000. It was decided to withdraw all opposition to the North-Western Electricity and Power Gas Bill, as amended in the House of Commons Committee.

St. Pancras.—Nearly 40 tenders have been received by the Guardians for lighting the Highgate Infirmary by electricity. The whole matter is before the Infirmary Committee for report and recommendation. The committee have been given power to consult Mr. Baynes, electrical engineer to the Borough Council in its consideration of the tenders.

Dewsbury.—The electrical engineer in his last statement reported the consumption of 7,457 units of electricity for lighting purposes and 15,031 units for the tramways during the fortnight ended June 20. For a similar period last year 5,894 units had been used for lighting, and in the preceding fortnight 17,494 units had been used by the tramways.

Winchester.—At the Rural District Council meeting on Saturday a letter was read from the secretary of the Inland Waterways Company, Limited, giving notice of their intention to apply to the Board of Trade for a provisional order to supply electricity within this district. It is intended to utilise the water power of the Itchin and its tributaries.

Pudsey.—The Corporation have only till August to execute their electric lighting order. The Council have approved of a £7,000 scheme, but later a new scheme, involving an outlay of £17,000, has been discussed. Now an electric supply company have given notice that they intend to apply for powers to supply electricity in the Pudsey district.

Sports.—On Saturday the B. E. T. Club held their third annual sports at Wormholt Farm, and, favoured by splendid weather, managed to pull off a large number of well-contested prizes which had been presented by the directors of the company. The excellent T Division police band, under the conductorship of Mr. J. Stewart King, played on the lawn.

Canadian Cables.—The Canadian Minister of Finance has announced his willingness to offer a subsidy of 15,000dol. for the institution of a cable news service to provide the Canadian newspapers with the news, opinions, and comments of Europe as viewed from a Canadian standpoint. At present most of these reports are received through the United States.

Blaydon.—The question of the electric supply is still under discussion. The County of Durham Electric Power Distribution Company intend to apply to the Board of Trade for a provisional order to supply the district. Arrangements have also been made to form a company called the Priestman Power Company, Limited, for the same purpose, and Mr. C. H. Merz, of Newcastle, has been appointed consulting engineer.

London Gazette.—At an extraordinary general meeting of the Electrical "Lumiscriptor" Company, Limited, held at 33, Henrietta-street, Covent Garden, London, W.C., on July 2, it was decided that the company be wound up voluntarily, and that Mr. R. Warner, 10, Walbrook, E.C., be appointed liquidator. A receiving order has been made out in the estate of H. J. Furniss, electrician, 5A, Queen-street, Derby, on debtor's petition.

Newport (Mon.).—A considerable extension of the Orb Works, Newport, owned by Messrs. Lysaghts, Limited, is in contemplation, and the proprietary are negotiating with the Corporation for the supply of a large amount of electric power from the Corporation station, which is situated near the works. The installation of the new electric plant at the workhouse was switched on by Major D. E. Williams, chairman of the Board of Guardians, at the union last week.

Arbroath.—The Electric Lighting Committee recently reported to the Town Council that the cost of laying the electric light in the compulsory area under the provisional order would be £20,000, and that at the end of two years it would be optional on the part of anybody outside the compulsory area to apply for its extension, which would make the cost £40,000. It has now been decided that for financial reasons, and in the prospect of the introduction of a large scheme of water supply, the best possible terms be arranged with a company for carrying through the work.

Pontypool.—On Thursday Messrs. R. Algar and Sons, Dock-street. Newport, gave a dinner of the members and officials of the Pontypool Board of Guardians in celebration of the completion of the laying down of the electric lighting installation in the workhouse at Griffithstown. The contract was for £755, and the plant consists of 345 lamps, incandescent lamps throughout, high-speed vertical engine (directly coupled to a generator) of 45 b.h.p., making 350 revolutions per minute. The mains are all laid underground, and the different buildings are controlled from the switchboard in the engine-house.

Luton.—The electrical engineer in his last report states that since May 22 last 5,026 units had been generated, an equivalent to 135 8-c.p. lamps connected, making a total of 103 consumers with 7,402 lamps and 16 motors of 48 h.p., and that at the present time over 900 additional lamps and 12 motors of 29 h.p. were being wired. He also reported that the number of units generated shows an increase of 116 per cent. over the number generated during the corresponding period of last year. Extensions of mains at an estimated expenditure of about £400 have been agreed to, and the Finance Committee will take up the sum of £2,500, being one-half of the amount for which sanction has been obtained.

Reading.—The Highways and Lighting Committee, after considering the offer of the Reading Electric Supply Company, Limited, stating the terms upon which the company would be prepared to light certain of the streets in the town by electricity, have resolved that it is desirable that the tramway routes in which "ducts" for electric lighting have been laid should be lighted by electricity if favourable terms can be arranged with the Reading Electric Supply Company, Limited, for the purpose, and that it be referred to a sub-committee consisting of the chairman of the committee and Councillors Bonny, Cox, and Venner to confer with the company on the subject and to report thereon to the committee at their next meeting.

Electrical Transmission for Slate Quarries.—The Park and Croesor Quarry Company are now putting down an electrical generating plant for supplying power throughout their quarry at Penrhyndeudraeth, North Wales. Messrs. Gilbert Gilkes are supplying the turbines, the whole of the electrical work being carried out by Messrs. Witting, Eborall, and Co., Limited, of Temple Bar House, E.C. The generating station is equipped with a turbine-driven three-phase alternator, capable of giving 200 kw. at a pressure of 2,750 volts. The exciters are separately driven, and the installation includes a high-tension power transmission line for supplying power to the quarry for driving motors, haulage and pumping gear, and one locomotive, all of which are being supplied by Messrs. Witting, Eborall, and Co., Limited. The whole of the work is being carried out to the specification of the quarry company's engineer, Mr. M. Kellow.

Tipton.—At the last meeting of the Urban District Council Mr. W. O. Foster, solicitor to the Council, reported the satisfactory issue of the negotiations between the Council and the Midland Electric Corporation, which had been going on during the past three years. They differed as to the construction of the agreement of 1898, and they had had to promote a provisional order and to appeal to a Board of Trade enquiry. The verdict of the latter was entirely in their favour, and thanks to the mediation of Mr. W. W. Doughty an agreement had been come to. The Midland Electric Corporation would pay the whole of the costs connected with the provisional order and antecedent thereto, and also the costs of the enquiry. They would pay a lump sum of £600, a sum of £50 for the year next ensuing, £150 in each of the next two years, and £200 a year for the remainder of the 21 years, in addition to 30s. a week for a meter inspector. The agreement was sealed.

Dudley.—From the report of the municipal electrical undertaking for the year ended March 31 last, it appears that the loans sanctioned and borrowed since June, 1899, amount to £63,500, of which £2,701 had been repaid. The total expenditure had been £67,392, comprising £22,567 for the year ended March 31 last and £44,825 for 1902. The following are the principal items of expenditure on the capital account for the year ended March last: buildings, £1,503; machinery, £90,941; mains and services, £7,717; motors, £312; arc lamps for pubic lighting, £1,049; engineer's fees, £940. On the supply account for last year the expenditure had been £4,409 and the income £8,929, leaving a gross profit of £4,519. The income included £7,781 for sale of current, £649 for public lighting, £325 claim from the General Electric Company *re* meters. Of the £4,519 gross profit, £1,429 had been absorbed by interest on mortgage loans, £1,375 repayment of loans, £526 bankers' charges, leaving a net profit for the year of £1,186.

Primitiva Gas and Electric Lighting Co.—The *Financial Times* says it is reported that the undertaking of the Primitiva Gas and Electric Lighting Company of Buenos Ayres is about to pass into the hands of the Germans, who, not content with carrying on a large electric lighting undertaking at Buenos Ayres, recently absorbed their French competitor in that city, and now propose to extinguish their English and sole remaining rival in the Argentine capital. Acting on behalf of the German Transmarine Electricity Company, representatives of the Allgemeine Electricity Company of Berlin have been, it is said, engaged during the past few days in London in bringing negotiations with the Primitiva Company to a conclusion, and it is stated that an arrangement has now been arrived at. One report declares that the English undertaking is to be bought outright for £600,000, but another asserts that the enterprise is not to be sold, but is to be leased to the German Transmarine Electricity Company for a long period of years. The latter company's capital is largely held by the Berlin Allgemeine Company and the Union Electricity Company, which will be remembered as having recently established a community of interests for 35 years.

New Issues.—The Oriental Telephone and Electric Company are making a new issue of 50 000 6 per cent. cumulative preference shares of £1 each. The company was originally formed in 1881 to work the telephone patents of Thomas Elva Edison and Alexander Graham Bell, in the East. In 1892 that company took powers to undertake electric lighting, and the name was altered to the Oriental Telephone and Electric Company, Limited. In 1894, in order to effectuate an arrangement between the holders of vendors' shares and the holders of ordinary shares the company transferred its undertaking to the present company. The company possesses telephone exchanges in Madras, Rangoon, Moulmein, Singapore, and Mauritius, and being the successor of the parent company of the following companies, which were formed over 20 years ago, is very largely interested in them: the Telephone Company of Egypt, Limited, the China and Japan Telephone and Electric Company, Limited, the Bengal Telephone Company, Limited, and the Bombay Telephone Company, Limited. The company has also an electric lighting branch established in Calcutta, and carries on electrical business in connection with each of the above-mentioned exchanges. The company and its subsidiary companies in India have recently obtained from the Government of India renewals of their telephone licenses from April 1, 1903, for a period of 60 years, subject to certain equitable conditions of optional purchase by the Government after a lapse of 20 years. The companies have under-

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taken in consideration of these licenses to metallic circuit their systems. The Telephone Company of Egypt, Limited, has just completed the underground cabling of its systems in Cairo and Alexandria.

Fulham.—The following report has been received from the borough electrical engineer: "I beg to report that we have had serious trouble with certain switch boxes which are at present installed on our mains. These switches are of two kinds—one for use in brick pits in the streets, for sub-dividing the high-tension circuits; the other switch is used in the sub-station for controlling the high-tension side of the transformers. On Friday last, one of the street switches, at the corner of Kingwood-road, broke down completely, setting fire to the material in the box. We were notified of this by a police constable. Owing to the nature of the damage, we were compelled to cut out the section and reconnect it temporarily. I am glad to say this did not affect the supply very considerably. On looking up the books I found that the same switches had given trouble on three other occasions, which had caused a complete shut-down of the circuit to which attached. Three of these switches have been taken out and replaced, including the one which broke down last week. There still remains in the streets five or six others of the same type. I now wish your instructions for me to take these out and replace them by others of a more suitable type. I believe the cost of these switches was originally £18 each. The ones which I propose to fix would cost about £8 each. The second switch which is used in the sub-station broke down on May 26 last, and was completely destroyed. This caused a shut-down on the circuit for over an hour. Previous to this I find that this switch had several times given trouble, and on March last one of them broke down at Hurlingham, and was so damaged that it was necessary to take it out and replace it with temporary apparatus. I strongly advise the replacing of these switches by others of a more up-to-date type, and which could be more safely handled. As the matter was most pressing I have already put in hand a set for the Claybrooke-road sub-station, at a cost of £8 each. We have eight sub-stations on circuit, each containing two of these switches. All these would need to come out and be refitted. It is essential that this be done immediately, before the winter load comes on, and I trust you will not hesitate to pass my requirements immediately, as it takes a considerable time to get these delivered." It has been decided that accordingly 16 sub-station switch boxes be obtained at a cost of £8 each, and six street switch boxes at an estimated cost of £10 each.

COLONIAL NOTES.

Melbourne.—Electric lifts are making steady progress and the demand for small motor power greater than present supply is able to meet.

Ballarat.—Works of proposed electric tramways and improved and extended system of lighting in the city of Ballarat are still at a standstill, but it is expected to start the tramway plant erection very shortly.

Geelong.—Extension of private lighting and motor power in this city is steadily going ahead. The lock-up and gaol are lighted by electricity. About 250 5-c.p and 16-c.p lamps are installed in latter, giving every satisfaction as regards uses and economy.

Wireless Telegraphy.—Great interest is shown in this matter in Australia, but beyond a few feeble attempts with unsuitable apparatus, which as a result have given poor effects, there has been nothing seriously attempted to prove the suitability of adopting the system along the coasts and between the islands. In this direction there is a great future for wireless telegraphy in Australasia.

Meeloort (Charlotte Plains, Victoria).—The system installed here is high tension of 6,600 volts, three-phase, transforming down to 440 volts for motors and 110 for lighting. There are motors at present pumping for two mines—viz., New Havilah and Pioneer—shifting 6,000,000 gallons of water per day, pumping 24 hours. The electrical weekly output is about 79,000 units. American Buckeye engines are used, and alternators of the General Electrical Company.

Bendigo.—The tramways are giving great success. There is a double line from View-street to High-street, Eaglehawk, and from there a single line to Bernard and View streets, Bendigo. In the town of Bendigo there is a double track in View and Mitchell streets and in portion of Pall-mall. Fares are 1d., 2d., and 6d. on the Eaglehawk line. Extensions are to be made to Golden-square and White Hills. A single track to cemetery is just being completed. Steel poles are used in the town to carry the trolley wires. These were supplied by Messrs. Prescott and Co., of Manchester. Obtside of the town belts wooden poles are used. Track rails are fixed in concrete and granite blocks, and is undoubtedly one of the best laid down in Australia. At the electric power station Browett-Lindley engines are used with Silvertown dynamos. Tension about 550 volts (about 500 used on tramway). The switchboard, cars, sheds, offices, and all parts that go to form the whole system are very complete and in every way up to date. All feeders are laid underground, both for trams and lighting. The voltage is 500 for trams and 440 for lighting and motor purposes. Public lighting is now being changed over to new Crompton lamps of 1,200 c.p. placed on suitable arms on the trolley poles in centre of track; the lamps are in series of nine across the 440-volt cables.

Cable Communications.—The Eastern Extension Company has secured a Federal Government agreement. This means that what is known as the "Adelaide agreement," and which Canada objected so much to, will now operate throughout Australia. The agreement is subject to ratification by the Federal Parliament. There, however, is no doubt that such will be easily given, as there is now a great reaction in favour of the company. The public have secured all they require in the cheapening of cable rates, and though the battle against the company has been a severe one, they deserve all they have won owing to the generous manner in which they have met the public demands. This agreement permits the company to open their own public offices throughout the States of the Commonwealth, and thus deal direct with their customers; but, in addition, it allows them to have their own land lines between the capitals of the States—a valuable concession, by which the public as well as the company will greatly benefit. The Pacific cable has had and lost its opportunity, the chances of which were flitted away through want of proper management. Feeling is bitter against such indifference, and it has been suggested to take away the control from a board and place the management and control of the cable amongst the postmasters-general of the self-governing States interested in the venture. Something will have to be done, and that very soon, as Australia cannot afford to lose over £30,000 a year and grin and bear the loss.

PROVISIONAL PATENTS, 1903.

JUNE 29.

14380. Improvements in or relating to contact breakers for induction coils. Herman Willem van Raden and Carey Burt Robinson, 18, Hertford-street, Coventry.

14476. Improvements in or connected with arc lamps. John Llewellyn Davies, 40, Chancery-lane, London.

JUNE 30.

14500. Improvements in overhead equipment for electric traction, applicable also for use with other exposed conductors. Herbert Smithson and Edgar Ravenhill Sharpe, 6, Bank-street, Manchester.

14537. A new or improved electrically-lighted club for theatrical and like displays. Thomas Hamblet Davies and George Bert Davies, 7, Staple-inn, London.

14539. Improvements in armature coils for dynamo-electric machines. The British Westinghouse Electric and Manufacturing Company, Limited, Westinghouse-building, Norfolk-street, Strand, London. (The Westinghouse Electric and Manufacturing Company, United States.)

14541. Improvements in galvanic dry cells. Georges Schauli and Wolf Loewenstein, 16, Devonshire-square, Bishopsgate-street, London.

14542. Improvements in controlling devices for electric motors. David Leonard Lindquist, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

14543. Improvements in holders for telephone directory cards and the like. Charles Elmer Napp, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

14550. Improvement in lifeguards for electric cars and other vehicles. John Farrer Mason and Harry Kremnitz, 8, Quality-court, Chancery-lane, London.

14551. Improvements in electric controllers for motors and the like. August Sundh, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

14555. Improvements in controlling devices for electric motors. David Leonard Lindquist, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

14555. Improvements in and relating to electromagnets. David Leonard Lindquist, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

14560. Improvements in oil switches. Henry Price Ball, 18, Buckingham-street, Strand, London. (Complete specification.)

14561. Improvements in automatic circuit breakers. Henry Price Ball, 18, Buckingham-street, Strand, London. (Complete specification.)

14562. Improvements in circuit breakers. Henry Price Ball, 18, Buckingham-street, Strand, London. (Complete specification.)

14568. Improvements in electric switches. Henry Price Ball, 18, Buckingham-street, Strand, London. (Complete specification.)

14566. Improvements in means for electrically driving centrifugal engines. Herbert John Haddan, 18, Buckingham-street, Strand, London. (The American Tool and Machinery Company, United States.) (Complete specification.)

14575. Improvements in holders for electric incandescent lamps. Peter Kleber, 65, Chancery-lane, London. (Complete specification.)

14597. Improvements in machines for making bases for electric lamps. Edgar Alfred Carolan, 83, Cannon-street, London. (The General Electric Company, United States.)

14596. Improvement in electric motor-driven machine tools. Edgar Alfred Carolan, 83, Cannon-street, London. (The General Electric Company, United States.)

14601. Improvements in coin mechanism specially applicable for electricity and other meters. Edward Du Bois, Norfolk House, Norfolk-street, Strand, London.

14602. Improvements in coin mechanism specially applicable for electricity and other meters. Edward Du Bois Norfolk House, Norfolk-street, Strand, London.

JULY 1.

14610. A dynamo-electric generator for the production of high-voltage continuous currents without commutation. Frederick Hamer, Anchor Bridge House, Hayes, Middlesex.

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14654. **Mode of and apparatus for converting the energy of fuel into electric energy.** Hugo Jone, 36, Chancery-lane, London.

14655. **Regenerative voltaic cells and mode of operating the same.** Hugo Jone, 36, Chancery-lane, London.

14656. **Mode of and apparatus for heating voltaic cells and restoring the battery products thereof to the original state.** Hugo Jone, 36, Chancery-lane, London.

14671. **Improvements in electrical shot-firing or like apparatus.** Robert Charles William Wood and George Clifton, 111, Hatton-garden, London.

14697. **Improved manufacture of frames for dynamo-electric machines.** Siemens Bros. and Co., Limited, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Siemens und Halske Actiengesellschaft, Germany.)

JULY 2.

14721. **Improvements in and appertaining to holders for electric incandescent lamps.** Charles Harold Jones, 9, Tempest Hey, Liverpool.

14728. **Improvements in or connected with primary electric batteries.** John Crisp Fuller, 33, Chancery-lane, London.

14731. **Improvements in electrolytic separation of copper and nickel from matts or ores.** Percy Richard Julius Willis, Fife House, Kingston-on-Thames. (C. S. Shields, Canada.)

14754. **An improved electric lamp.** Charles Clare Regnart, 29, Anson-road, Cricklewood, London. (Complete specification.)

14770. **Improvements in electric motors or dynamos.** William Ernest Burnand, 124, Oakbrook-road, Sheffield.

JULY 3.

14814. **Improvements in or connected with electrical resistances or rheostats applicable as a regulator, motor-starting switch, or the like.** Sydney George Brounger and William George Haywood, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

14823. **Improved construction of apparatus for telegraphing or signalling through space.** Anthony Bernard Tubini, 173, Fleet-street, London.

JULY 4.

14877. **Mounting electrical fittings on or in metal bases, frames, and cases.** August Eckstein and William White, Peel Works, Adelphi, Salford, Manchester.

14888. **Improvements relating to electric motors.** Rudolf Klemm and Felix Reiss, 72, Cannon-street, London. (Complete specification.)

14908. **Improvements in or relating to electric contacts.** Ernest Edgley Prestwich and Ernest Charles Lea, 70, Chancery-lane, London.

COMPLETE SPECIFICATIONS ACCEPTED.

To be published July 23, 1903.

1902.

12463. **Electrical measuring instruments.** Weston and Benecke.

15119. **Method of providing copper cables intended for use as electrical conductors with solid ends.** Hardingham. (Felten und Guilleaume Carlswerk Actiengesellschaft.)

16941. **Electrical resistances.** Reyrolle.

16972. **Electric motors for ceiling fans.** Rollo. (Swan.)

16985. **Contact fingers for electric controllers.** Lake. (General Electric Company.)

16988. **Apparatus for electric transmission, more particularly adapted for operating and controlling automatic type-setting and composing machines.** Lagarde.

16994. **Electrodes for secondary batteries.** Gouin.

17384. **Dynamo-electric machines.** Lake. (General Electric Company.)

17385. **Means for regulating electric circuits.** Lake. (General Electric Company.)

17389. **Insulation of high potential electrical apparatus.** Lake. (General Electric Company.)

17794. **Apparatus for actuating the electrical controlling appliances of the motors of electric railway cars.** Siemens Bros. and Co., Limited. (Siemens und Halske Actiengesellschaft.)

18328. **Electric switches.** Lake. (General Electric Company.)

18329. **Controllers for electric motors.** British Thomson-Houston Company, Limited. (Dutton.)

18332. **Fuseless rosettes for electric circuits.** British Thomson-Houston Company, Limited. (Wirt.)

18328. **Systems of electric motor control.** British Thomson-Houston Company, Limited. (Case.)

18336. **Armatures for dynamo-electric machines.** British Thomson-Houston Company, Limited. (Reist.)

18331. **Means for regulating dynamo-electric machines.** British Thomson-Houston Company, Limited. (McKay.)

18786. **Electric arc lamps.** Bremer.

18922. **Electric meters.** Lake. (General Electric Company.)

18926. **Electrical transformers.** Lake. (General Electric Company.)

18933. **Safety appliances or trolley catchers for electric cars.** Milnes.

19286. **Trolleys for electric traction.** Roberts.

19428. **Electromagnetic brakes.** Childs.

20340. **Form and construction of wire used for the transmission of electrical energy.** Hopkinson.

23353. **Electrolysing processes and appliances.** Wetter. (Elektricitäts-Aktiengesellschaft, vorm Schuckert und Co.)

1903.

4234. **Electric batteries.** Piqueur.

6366. **Casings and globe holders for electric lamps.** Kusebuch. (Date applied for under International Convention, March 21, 1902.)

7980. **Self-registering electrically-operated sectional targets.** Peters.

8389. **Electric accumulators.** R. Trüb und Co. (Date applied for under International Convention, April 19, 1902.)

8512. **Electric arc lamps.** Gore.

10080. **Insulated joints for the rail sections of electric railways.** Page. (Weber Railway Joint Manufacturing Company.)

11698. **Self-regulating systems for electric light and power.** Page. (Adler.)

11840. **Field magnets and like electrical apparatus.** Bláthy

12078. **Electric pocket lanterns.** Gloerfeld.

12119. **Method of receiving electrical vibrations with the use of electrolytic cells.** Evans. (Allgemeine Elektricitäts-Gesellschaft.)

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.		Last price
Commercial and Industrial.—	£		£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1	..	½-¾
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1	..	¾-⅞
British Insulated and Helsby Cables, Ord., 1-100,000	5	..	6⅞-7¼
—— 6 per cent. Cum. Pref., 1-100,000	5	..	5¾-6
—— 4½ per cent. Mortgage Debentures	100	..	101-105 xd
British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red.	100	..	104-106
British Westinghouse Elec. and Manuf., 6 per cent. Pref.	5	..	5¾-6
—— 275,001-375,000	5	..	—
—— 4 per cent. Mortgage Debenture Stock	100	..	100-102
Brush Electrical Engineering, Ordinary, Nos. 1-105,751	2	..	¾-1¼
—— Non. Cum., 6 per cent. Pref.	2	..	1¼-1⅝
—— 4½ per cent. 1st Debenture Stock	100	..	98-102
—— 4½ per cent. 2nd Debenture Stock	100	..	87-92 xd
Callender's Cable, Debentures	100	..	106-110
—— Ordinary	5	..	11½-12½
—— 5 per cent. Pref.	5	..	5¼-5 xd
Crompton and Co.	5	..	2-2½
—— 5 per cent. Debentures	100	..	101-105 xd
Edison and Swan United, "A" Shares, 1-98,261	5	..	¼
—— "A" Shares, 01-017,139	5	..	1½-2¼
—— 5 per cent. Debentures	100	..	75-80
—— 4 per cent. Deb. Stock, Red.	100	..	71-75 xd
Electric Construction, Limited, Nos. 1 to 112,100	2	..	1¾-1⅞
—— 7 per cent. Cumulative Pref.	2	..	2½-3
—— 4 per cent. Perp. 1st Mort. Deb.	100	..	100-103
Ferranti Limited, 5 per cent. 1st Mort. Deb. Stock, Red.	100	..	90-95 xd
General Electric Company (1900), 5 per cent. Cum. Pref.	10	..	9¼-10 xd
—— 4 per cent. 1st Mort. Deb. Stock	100	..	99-102
W. T. Henley's Telegraph Works, Ordinary	5	..	14-15
—— 4½ per cent. Preference	5	..	5-5½
—— 4½ per cent. Debentures	100	..	108-112
India Rubber, Gutta Percha, and Telegraph Works	10	..	18½-19½
—— 4 per cent. Debentures	100	..	100-103
Parker, Thos., Limited, Ordinary	10	..	14½-15½
Telegraph Construction and Maintenance	12	..	33-36
—— 5 per cent. Bonds	100	..	102-103 xd
Electric Lighting and Supply.—			
Blackheath & Greenwich District Ordinary 1,201-101,200	1	..	⅝-¾
—— 4½ per cent. Deb. Stk. Certs., Red. and Conv.	100	..	118-121
Bournemouth and Poole, Ordinary	10	..	12½-13½
—— 4½ per cent. Cum. Pref., 7,501-15,000	10	..	10-11
—— 6 per cent. Cum. Second Pref., 15,001-22,500	10	..	10½-11½
—— 4½ per cent. Debenture Stock, Red.	100	..	102-105 xd
Bromley (Kent) Electric Light and Power Co., 4½ per cent. 1st Debenture Stock, Red.	100	..	102-105
Brompton and Kensington, Ordinary	5	..	10½-11
—— 7 per cent. Preference	5	..	10½-10⅝
Calcutta Electric Supply Corp., Ordinary, Nos. 1-40,000	5	..	6¼-7⅛
—— Nos. 20,001-30,000	5	..	7-8⅛
Cambridge Electric Supply Company, Ltd., £10 Ord.	8	..	14¼
—— £10 Ord.	6	..	10⅜
Central Electric Supply, Ltd., 4 per cent. Guar Deb. Stock	100	..	106-109
Charing Cross and Strand, Nos. 1-70,000	5	..	9-9½
—— 4½ per cent. Cum. Pref.	5	..	5¼-5
—— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000	5	..	4¾-5 xd
—— 4 per cent. Debenture Stock, Red. (Prov. Certs.)	100	..	104-106
Chelsea Electricity Supply	5	..	6-6¼
—— 4½ per cent. Debentures	100	..	107-110
City of London, Ordinary	10	..	11¾-12¼
—— 6 per cent. Cumulative Pref.	10	..	13-14
—— 5 per cent. Debenture Stock	100	..	121-126 xd
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100	..	102-105
County of London and Brush Provincial, Ordinary	10	..	8-9
—— 6 per cent. Cum. Pref.	10	..	12-13
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	100	..	109-112
Edmundsons' Electricity Corporation, Ordinary, 1-50,000	5	..	6¼-7
—— 6 per cent. Cum. Pref.	5	..	6-6¼
—— 4½ per cent. First Mort. Deb.	100	..	108-111
Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-30,000	5	..	3¼-4¼
—— 5 per cent. Debenture Stock, Red.	100	..	95-98 xd
Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000	5	..	6-6¼
—— 4½ per cent. First Deb. Stock, Red.	100	..	102-105
Hove Electric Lighting, Limited, Ord., 1-13,000	5	..	8-9
Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000	5	..	11-12
—— 4 per cent. Debenture Stock Red.	100	..	103-106

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Name.	Amount paid.	Last price.
	£	£
Kensington and Knightsbridge and Notting Hill	100	103-106
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	9½-10½
London Electric, Ordinary	3	2-2½
—— 6 per cent. Pref.	5	5½-6
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	100-102
Metropolitan, Ordinary	10	17½-18½
——4½ per cent. First Mortgage Debenture Stock	100	108-112
——3½ per cent. Mortgage Debenture, Red.	100	97-100
Newcastle-upon-Tyne Electric Supply, Ordinary	5	100-103
—— Preference	4	102-105
Notting Hill Electric Lighting	10	13½-14½ xd
—— 4 per cent. First Mort. Debs., Nos. 1-500 (Reg.)	100	99-102
Oxford Electric, Ordinary, 1-96 and 407-14,310	5	5-6
—— 4 per cent. Debenture Stock	100	93-101
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100	100-102
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5	3-3½
—— 4 per cent. Debenture Stock	100	88-93
South London, Ordinary	5	3½-4
St. James's and Pall Mall, Ordinary, 101-20,080	5	15½-16½
—— 7 per cent. Pref.	5	8½-9½
—— 3½ per cent. Deb.	100	98-101 xd
Urban Electric Supply Co., Ordinary, 8-30,007	5	5-5½
—— 5 per cent. Cumulative Preference, 50,001-80,000	5	5-5½
Westminster, Ordinary	5	12-13
—— 5 per cent. Cum. Pref., 110,101-138,251	5	6½-6¾ xd

Electric Railways.—

Central London, Ordinary	100	104-107
—— 4 per cent. Pref.	100	101-104
—— ,, ,, deferred	100	107-110
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100	117-120
City and South London, Consolidated Ordinary	100	70-72
—— 4 per cent. Debenture Stock	100	116-119
—— 5 per cent. Pref. Stock '91	100	130-133
—— ,, ,, ,, '96	100	129-132
—— ,, ,, ,, '01	100	128-131
Liverpool Overhead, 5 per cent. Pref.	—	13-13½
—— Ordinary, 1-50,000	—	7½-8
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	—	102-104
Waterloo and City, Ordinary	100	98-101

Electric Tramways.—

Anglo-Argentine, 1-260,007	5	4¾-4⅝
—— Permanent 6 per cent. Debenture Stock, 1888	100	124-129 xd
Blackpool and Fleetwood Tramroad	10	13½-14½
Brisbane Tramway Invest., Lim., Ord., 1-75,000	5	2¾-3½
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5	4¼-4¾
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100	100-103 xd
British Columbia Electric Railway Co., Ord., Nos. 1-20,000	100	69-72
—— Non.Cum. 5 per cent. Pref., Nos. 25,001-38,600	100	92-96
—— 4½ per cent. 1st Mt. Debs., Nos. 1-6,250, of £40 each	40	104-106 p.c

Name.	Amount paid.	Last price.
	£	£
British Electric Traction, Ord., 1-300,000 & 60,001-80,000	10	13-13½
—— 6 per cent. Cm. Pf., 30,001-60,000	10	11¾-12½
—— 5 per cent. Perpetual Debenture Stock	100	122-125
Buenos Ayres and Belgrano Tram., Ord., 1-100,000	5	2¾-3
—— "A" 6 per cent. Cm. Pf., 1-40,000	5	5¾-5¾
—— "B" 6 per cent. Cm. Pf., 1-27,500	5	4¾-5¼
—— 5 per cent. Deb. Stock, Red.	100	105-108 xd
—— Prov. Cert., all paid	100	97-100
Cape Electric Tramways, Nos. 1-480,000	1	2¼-2⅜
City of Birmingham Tramways, 5 per cent. Cum. Pref.	10	5-5¼
—— 4 per cent. 1st Mortgage Deb., 1-3,000 (1917)	100	99-102
Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red.	100	103-105
Cork Electric Tramways and Lighting Co., Ordinary	10	13-14
—— 5 per cent. Cum. Pref.	10	11-12
—— Debentures	100	96-99
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10	13½-14½
—— 6 per cent. Pref., Nos. within 1-60,000	10	15-16
—— 3½ per cent. Mort. Debs., 1-3,000, Red.	100	94-97
Imperial Tramways, Ordinary	all	22-22½
—— 6 per cent. Cum. Pref.	all	14½-15½
—— 4½ per cent. Deb. Stock	100	112-114
Isle of Thanet Electric Tramways and Lighting, 5 per cent. Cum. Pref., Nos. 30,001-60,000	5	4-4½
—— 4 per cent. Debenture Stock	100	92-95
Kidderminster and District Lighting and Traction, Pref.	5	3½-4
London United Trys. (1901), 5 per cent. Cum. Pref.	10	11½-12 xd
—— 4 per cent. 1st Mt. Db. Stock, Red.	100	105-108
Metropolitan Electric Trams., Deferred, 1,000,001-1,314,016	1	¼-⅜
—— 5 per cent. Cum. Pref., 500,001-814,016	1	½-1½
New General Traction, Ordinary	5	¾-1½
—— 6 per cent. Cum. Pref.	5	2-3
—— 5 per cent. Mortgage Debentures, 1-1,713 (Regd.)	100	91-96
Oldham, Aston, and Hyde Tramway, Ordinary	10	10½-10¾
—— 5 per cent. Cum. Pref.	10	11½-12½
Perth Elec. Tramways (W.A.) 5 per cent. 1 Mort. Deb. Stk.	100	99-102 xd
Potteries Electric Traction, Ordinary, 20,001-40,000	10	9½-10½
—— 5 per cent. Cum. Pref., 1-20,000	10	9½-10½
—— 4½ per cent. Debenture Stock	100	102-105
South Lancashire Electric Traction and Power Company—		
—— £250,000 Ordinary	1	1
—— £101,132 6 per cent. Preference	1	1
—— £528,093 4½ per cent. Debenture Stock	100 p.c.	100 p.c.

Telephones.—

National Telephone, Preferred	100	102-104
—— Deferred Stock	100	82-84
—— 6 per cent. Cum. First Pref.	10	13-14
—— 6 per cent. Cum. Second Pref.	10	12-13
—— 5 per cent. Non. Cum. Third Pref.	5	5-5½
—— 3½ per cent. Deb. Stock, Red.	100	96-98 xd
—— 4 per cent. Deb. Stock, Red.	100	101-103
Oriental Telephone and Electric Company	1	13/16-15/16

TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line	Traffic Returns for week			Increase or decrease.		Miles of single track open.		Accounts for past year.						Cost per car mile.
	Ending	1903.	1902.	Week.	Current year.	1903.	1902.	Ending	Total receipts	Passengers carried.	Car miles run.	Receipts per Pas-s'nger	Car mile.	Mile of track.	
		£	£	£	£				£			d.	d.	£	d.
Aberdeen Corporation	June27	1,247	1,295	− 48	+ 4,863	19¼	17¼	May 31	37,931	9,099,715	794,641	0·98	13·02	1,970	6·14
Ayr Corporation	—	—	—	—	—	8	6	Sept. 25	12,503	2,979,276	290,099	1·00	10·34	1,560	4·7
Birmingham Tramways	July 4	5,335	4,833	+ 562	+ 6,576	6¼	6¼	—	—	—	—	—	—	—	—
Blackburn Corporation	June26	909	1,193	− 236	+ 674	24	24	March 25*g*	40,964	7,234,105	826,558	1·36	11·87	1,705	7·44
Blackpool Corporation	July 2	954	1,491	− 537	+ 1,152	17½	16½	,, 31	211,168	6,169,121	784,443	1·52	10·8	—	—
Blackpool-Fleetwood Tramways	June30	839	763	+ 136	+ 1,059	16½	16½	Dec. 31	30,923	2,043,677	584,989	3·62	12·68	1,932	6·99
Bolton Corporation	July 5	1,926	1,664	+ 251	+ 3,423	25	25	March 31	85,704	17,761,605	1,896,247	1·15	10·75	3,430	5·87
Bournemouth Corporation	,, 1	1,001	—	—	—	10½	—	—	—	—	—	—	—	—	—
Bradford Corporation	,, 5	4,061	3,591	+ 470	+ 5,770	39	—	—	—	—	—	—	—	—	—
Brighton Corporation	,, 5	981	933	+ 48	+ 5,238	6½	—	,, 31	—	10,432,508	1,031,928	1·00	10·10	—	—
Bristol Tramways Company	,, 3	5,375	5,065	+ 310	—	51½	51½	Dec. 31	223,480	41,192,899	5,724,114	1·30	9·38	4,348	—
Burnley Corporation	,, 4	795	730	+ 65	—	—	—	—	—	—	—	—	—	—	—
Cardiff Corporation	June27	2,060	2,294	− 233	+ 9,135	—	—	—	—	—	—	—	—	—	—
Carlisle Tramways Company	—	—	—	—	—	—	—	,, 31	—	2,216,583	320,129*h*	—	—	—	—
Central London Railway	July 4	6,788	7,196	− 403	— *h*	6	—	,, 31	367,225	45,305,110	1,276,971*a*	1·87	66·6 *a*	59,076	35·6 *a*
City and South London Railway	,, 5	2,465	2,821	− 366	—	6⅜	—	,, 31	165,003*a*	19,069,319*a*	—	—	—	—	—
Cork E. T. and L. Company	,, 2	628	803	− 177	+ 61	—	—	—	—	—	—	—	—	—	—
Darwen Corporation	,, 3	228	270	− 42	− 90	7·23	—	March 31*g*	12,341	2,360,735	254,279	1·25	11·65	1,707	9·36
Dover Corporation	—	—	—	—	—	3	—	—	—	—	—	—	—	—	—
Dublin & Lucan Electric Railway	,, 5	94	119	− 25	− 206*h*	—	—	Dec. 31	5,796	364,796	102,087	3·81	13·62	859	7·68
Dublin U. T., electric cars	,, 3	2,212	2,071	+ 140	—	46	46	March 31	126,121	24,553,133	3,429,356	1·23	8·82	2,741	5·06*h*
Dublin S. District, Electric	—	—	—	—											
Dundee City Tramways	,, 1	861	819	+ 42	—	22	22	May 15	35,874	9,084,522	752,814	0·93	11·276	1,630	—
East Ham Corporation	,, 4	773	488	+ 285	+ 3,002	10·75	7·52	March 31	25,341	9,971,337	650,224	0·61	9·35	2,357	—
Farnworth U.D.C.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Glasgow Corporation	,, 4	14,136	12,410	+1,725	+ 8,823	124	101	May 3	653,200	177,179,549	14,008,750	—	—	—	—
Halifax Corporation	—	—	—	—	—	30½	27⅔	—	—	—	—	—	—	—	—
Huddersfield Corporation	,, 6	1,406	1,045	+ 361	—	34	35	March 31	56,631*h*	9,738,213	1,218,539	1·4	11·14	1,618	6·38
Hull Corporation, E. S.	,, 4	1,924	1,789	+ 134	+ 1,520	19	19	,, 31	87,707*h*	21,065,999	2,218,696	1·00	9·49	5,004	5·07
Ilkeston Corporation	,, 2	219	—	—	—	—	—	—	—	—	—	—	—	—	—
Kirkcaldy Corporation	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Leeds Corporation	,, 4	6,083	6,120	− 37	+ 5,725	77	—	March 25	262,656	57,239,779	5,773,651	1·11	10·91	3,283	—
Liverpool Corporation	June27	10,774	15,032	−4,258	+ 9,725	101	95	Dec. 31	504,304	108,906,472	11,705,425	1·11	10·34	5,000	6·88
Liverpool Overhead Railway	July 5	1,672	1,595	+ 77	—	15½	15½	June 30	79,252	10,466,726	986,185*a*	1·82	19·30*a*	5,110	— *a*
Newcastle-on-Tyne Corporation	,, 4	3,243	2,635	+ 608	—	36	36	Dec. 15	127,852	28,411,899	2,767,444	1·08	11·09	3,551	—
Portsmouth Corporation	—	—	—	—	—	29	29	Sept. 30	47,651	9,168,137	868,157	1·24	13·17	1,643	—
Rochdale Corporation	,, 6	149	139	+ 10	—	4½	--	March 31	5,416	925,281	127,456	1·38	10·27	—	7·66
Salford Corporation	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Sheffield Corporation	,, 5	4,796	—	—	—	46½	46¼	Mar. 25	1,31,837	49,176,631	3,791,993	0·93	12·01	4,140	7·82 *f*
Southampton Corporation	,, 2	1,163	1,569	− 405	—	11	11	,, 31	35,874	9,034,522	752,814	0·946	11·436	3,760	—
Sunderland Corporation	,, 5	1,368	1,320	+ 48	+ 589	18·48	17·18	,, 31	59,930	13,987,121	1,270,957	1·03	11·3	3,243	6·43
Wallasey U.D.C.	,, 4	811	682	+ 126	+ 1,371	10·5	10·5	,, 31*g*	31,307	5,690,378	654,553	1·32	11·47	2,981	6·97

Includes maintenance of permanent way and proportion of profits paid to the tramway companies for term of unexpired lease. *a* Train mile.
h Half-year's figures. *e* Include rail and tram. *f* Including one section of horse traction. *g* 1903.

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UNIVERSITY

NOTES.

Society of Arts.—Notice is given in the *Journal* of the above society that on Monday, the 6th inst., at their first meeting, the council elected Sir Wm. Abney, K.C.B., D.C.L., F.R.S., as chairman for the ensuing year. The various committees were also reappointed.

Literary Notice.—Messrs. Spon, of London and New York, are about to publish a new work by Mr. William R. Bowker, M.I.E.E., entitled "Practical Construction of Electric Tramways." Mr. Bowker, besides being a civil engineer, is lecturer on physics and electrical engineering at the Halifax Municipal Technical School.

Automobilism in Ireland.—The members of the Automobile Club have all but completed their engagements in connection with their fortnight's tour in Ireland. At the end of last week Cork was made the centre of attraction, and some interesting speed trials were successfully carried out over a two-mile straight and level course in the western suburbs of the city. The competitions again excited keen enthusiasm, and the same may be said of the trials which have taken place during the present week They included a motor boatrace at Cork and further hill-climbing contests at Killarney. Some 60 cars are taking part in the tour through the South of Ireland.

Emanations of Radium.—Researches are being made by Sir Wm. Crookes and Prof. Dewar into the effect of extreme cold on the emanations from radium. To detect the emanations, the experimenters allowed them to scintillate on a blende screen. It was observed that cold produced by liquid air stopped the emanations, but this was found to be owing to the effect on the screen, not on the radium. Sir William and Prof. Dewar have also observed in the course of the experiments that the property possessed by radium emanations of rendering the air a better conductor of electricity is not lost at the low temperature of liquid hydrogen. An electroscope charged with electricity leaked into the air when radium in a tube of liquid hydrogen was brought near to it.

Electricity in Train-Lighting.—Speaking of electricity in a report on the railways of India, prepared at the instructions of Lord Curzon, Mr. Robertson regards it as specially adapted for lighting trains in India on account of the absence of heat. He remarks with truth that the electric lighting of trains has passed beyond the experimental stage. It effects considerable saving in upkeep and working expenses, and Mr. Robertson emphasises the fact that English and Continental railways are now adopting the system very extensively. Its introduction on the Indian railways would also permit of fans being provided in carriages during the hot weather at comparatively little cost. The report makes no mention of electricity in its application to railway working, but perhaps the time is not yet ripe for this more recent adaptation so far as India is concerned.

Institution Journal.—Vol. xxxii., Part 1, of the *Journal* of the Institution of Electrical Engineers has been published. It contains the following papers, with the discussions thereon: "A Study of the Phenomenon of Resonance in Electric Circuits by the Aid of Oscillograms," by Mr. M. B. Field, before the Glasgow Section, also abstract of same before the London main section; "Distribution Losses in Electric Supply Systems," by Messrs. A. D. Constable and E. Fawssett; "Divided Multiple Switchboards," by Mr. W. Aitken; "Methods of Supporting and Protecting Inside Conductors," by Mr. O. L. Falconar; "Some Notes on Continental Power-House Equipment," by Mr. H. L. Riseley; "Network Tests and Station Earthing," by Mr. A. N. Taylor; and "Arrangement and Control of Long-Distance Transmission Lines," by Mr. E. W. Cowan.

Telephone Competition at Swansea.—The National Telephone Company are pursuing their usual tactics at Swansea. As was the case at Glasgow, Tunbridge Wells, and elsewhere, they have been forced to lower their tariff in face of the formidable competition which will shortly be offered by the municipal exchange in the provision of an efficient telephone service in the town. The Corporation's system will be opened on Oct. 1, but the company have not waited till then, and are already bringing out a new scheme of charges by which subscribers may have a certain number of free calls for £5 per annum—the same charge as the Corporation propose to make for an unlimited service. The advantage is then on the side of the municipal exchange, even if the natural feeling of gratitude on the part of the citizens to the Corporation for providing them with an efficient and up-to-date service at reasonable rates, were not enough to ensure the popularity and ultimate success of the new enterprise.

Steam-Turbine Installation.—A case has arisen in the States in which trouble is sometimes experienced in a hydro-electric plant by the failure of the water power. It has therefore been decided to instal a steam-turbine, which will be used for relay purposes. Electric power is utilised almost entirely for driving the machinery in the factory, but a small steam-power plant is also employed, which will supply steam for driving the turbine. It is a 540-h.p. machine, taking steam at 165lb. pressure, after it has traversed the distance of 350ft. separating the boiler-house from the engine-house. Before entering the turbine the steam will be superheated about 100deg. F. by means of an independent superheater, fired by waste hydrogen gas rising from electrolytic baths used in the process of manufacturing at the factory. The gas has heretofore been a waste by-product. The steam economy is estimated at about 13·5lb. per electrical horse-power hour, which means about 11lb. per indicated horse-power hour.

Tramway Subways.—Under this heading last week we announced the decision of the London County Council to send its chief engineer to the States this summer to enquire into the methods of construction of tramway subways in that country. By an unfortunate slip we referred to Mr. J. Rider, the Council's electrical engineer, as being the gentleman in question. It should, of course, have been Mr. Maurice Fitzmaurice, who is charged with the construction of the authorised tramway subway under the new thoroughfare from Holborn to the Strand. Mr. Rider has, as our readers know, already been to America to familiarise himself with tramway matters as conducted over there, and the experience he gained two years ago will hold him in good stead in carrying out the electrical work connected with the Council's new venture. We wish Mr. Fitzmaurice all success in his impending visit to New York and other American cities, and trust the information he may gather will prove of value to him in carrying out the important scheme with which he has been entrusted.

Post by Electric Trams.—The system of posting and collecting letters by electric trams, which has been successfully tried in some of the northern towns, is being adopted on the electric tramway system of Sydney, in New South Wales, but on a more extensive scale. The scheme includes the erection of a small clearance office at one of the important termini, and letters as they are cleared will be sent off by messengers to the General Post Office

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every 15 minutes. In this way, it is believed, communication between the suburbs and the city will be greatly expedited, and this has certainly been the experience of those places which have adopted the system in this country. It is also proposed to arrange for boxes to be put on cars running to the railway station, so that letters too late for the general mail at the Post Office may be posted on any car reaching the station before the departure of the mail train. There is some difference of opinion at present as to the rates to be paid by the Post Office for these privileges, but it is hoped that a fair agreement may be come to which will allow the scheme to be put into operation.

The Telephone in South Africa.—As in most things, South Africa is making good progress in matters telephonic. A long-distance telephone line has lately been put in operation between Johannesburg and Pretoria, and is likely to lead to other extensions. The tariff adopted is fairly liberal in the circumstances. A three minutes' conversation for distances up to five miles costs 1s.; between five and thirty miles, 2s. 6d.; between 30 and 50 miles, 3s.; and between 50 and 70 miles the charge is 3s. 6d. Among the towns in South Africa which are proposing to establish telephone exchanges is Aliwal North, on the border of Cape Colony. Johannesburg, too, is planning a telephone system, or, rather, an extension of the existing system, sufficient to accommodate 10,000 subscribers. The proposal is to put the mines in telephonic communication with the city, which is an undoubtedly enterprising scheme. We understand that the first instalment of the material for the underground work has been ordered from this country, and the work of building up the system will be undertaken in sections extending over a period of two years. Additions to the equipment of the central exchange are also in progress, and arrangements are rapidly being made for an early inauguration of the first portions of the new system.

A Shock of 5,500 Volts.—A Continental exchange describes an extraordinary case in which a workman was subjected to a discharge from a 5,500-volt three-phase circuit for the space of five minutes and survived. He appears to have suffered no permanent injury except to his hands, which were so severely burnt that it was considered that amputation might be necessary. The upper skin of the front and back of the hand, and of the left forearm, was entirely detached from the lower skin, and was completely charred and dried up. The under-skin looked as if it were cooked, and had lost all sensation. The sole of the left shoe was perforated and torn away in places. The unfortunate man was suspended for five minutes from the live wire, and bystanders assert that flames were seen proceeding from his hands and feet Dr. Jellinek, who delivered a lecture on this case to an Austrian medical society, came to the conclusion that 10 h.p. to 12 h.p. raged for five minutes in the body of the unfortunate workman, but, in making this calculation, it is doubtful whether he made sufficient allowance for the very high resistance of the charred skin and the leather soles of the boots. It is, however, a remarkable fact that a human being should suffer such a shock under the most favourable conditions and survive.

Institution of Mechanical Engineers. — This institution will hold its summer meeting this year in Leeds, opening on the 28th inst., under the presidency of Mr. J. Hartley Wicksteed. Conference business begins on the morning of that day at the Leeds Philosophical Hall, and will be continued the following day, opportunity being afforded at the same time for visits to a large number of works in the city and district. On the 30th expeditions are planned to Doncaster and Frodingham, to Farnley Ironworks, to Normanton, and to Wakefield; while Friday, the following and last day of the meeting, is to be devoted to pleasure excursions to Ripon and York. One or two social functions in connection with the municipality have also been arranged. On the programme of serious business five subjects are down for consideration. Mr. Henry McLaren will introduce a discussion on "Economy of Fuel in Electric Generating Stations." Mr. H. Ade Clark will contribute a paper on "The Diesel Engine," and Mr. Arthur Greenwood one on the "De Laval Steam-Turbine." Mr. R. H. Fowler will deal with the question of "Roofing Existing Shops while Work is proceeding," and Prof. Hele-Shaw is to describe a "New Form of Friction Clutch." Mr. E. Kitson Clark and Mr. Christopher W. James are acting as joint hon. local secretaries to the conference.

Electrical Separation of Metals.—In a note communicated to the Paris Academy of Science, D. Negreano suggests a novel process for separating metallic powders from inert matters. On an insulated metal plate the pulverised mixture is placed, the plate being connected to the negative terminal of a Wimshurst machine. On bringing up to the plate a metal disc connected to the positive terminal of the machine and projecting the pulverised substance in a vertical direction by means of a special blowing machine, the metallic powder is found to be repelled and partly deposited on the upper part of the disc. The separation will occur readily when operating with sand and metal grains; experiments with sand grains and very small copper and bronze grains have shown nearly the whole of the metal to be deposited on the disc. This phenomenon is explained as follows: in the space between the metal plate and disc, the combination of which constitutes an air condenser, the field being uniform, the flux will be perpendicular to the disc; in the neighbourhood of the edges of the disc the lines of force will undergo a bending effect, so that the lines parting from the plate beyond of the surface facing the disc will be curved in towards and made to terminate on the latter, this being the path followed by the metallic particles deposited. The above process may serve in some cases to separate a mixture of finely divided metals. When applied to a mixture of brass and copper particles, for example, experiment shows that the brass will be repelled and deposited on the metal disc. The process may, as well, be applied to separating the metallic part of an ore from the gangue.

Lighting Our Coasts.—The Prince of Wales had some interesting subjects to dilate on when, in his capacity of Master of that ancient corporation, Trinity House, he presided over the annual dinner at the latter end of last week. One of these was the lighting of our coasts, and his Royal Highness truly remarked that scientific discoveries, engineering skill, and mechanical appliances have all contributed to the development of the coast-marking system as it now exists. As the wood and coal fires of the earliest days gave way to candles and smoky oil lamps, so these in their turn have been superseded by very powerful burners with elaborate combinations of lenses, through which blaze beams of light—electric oil, or gas. As the Prince observed, during the last few years much has been accomplished in the development of the lighthouse service, and we may add for ourselves that much of this is due to the improved conditions of lighting obtained through the medium of electricity. His Royal Highness also touched on the question of fog signals, and referred to the experiments which are continually being made with a view to the production of a

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trustworthy instrument. With reference to wireless telegraphy, the Prince merely repeated the intention of Trinity House to utilise it for communicating between some half a dozen lightships and their respective stations on shore. There is no doubt that wireless telegraphy has an extensive field of application in this direction.

Street-Lighting.—We do not blame the advocates of gas-lighting for making the most of the little material at their disposal in their efforts to discount in the eyes of the public the benefits of street-lighting by electric arcs. There is, however, a limit to all things, and it has surely been reached in the case of Stepney, the facts of which have been brought to our notice. In their energetic campaign in favour of the incandescent gas mantle, these gentlemen have carried the war into the enemy's land. A report has been put in circulation that a petition, largely signed by the inhabitants of Stepney, has been presented to the Borough Council complaining that the arc lighting "is inefficient and a source of danger to the public," and asking that the lamps should be replaced by incandescent gas lamps. We are authorised to contradict this statement absolutely. We strongly suspect the source from which this and such-like reports come, and as they are calculated to prejudice the interests of electric street-lighting generally if allowed to pass uncontradicted, we are happy to be in a position to state the actual facts in this case. The petition referred to was signed by the inhabitants of two small streets in which 13 ordinary gas columns had been converted to incandescent electric lighting, each containing two lamps of 16 c.p. each, and the petitioners asked that these incandescent electric lamps should be replaced by incandescent gas lamps having Welsbach mantles of from 50 c.p. to 100 c.p. As we are informed, the petition had no reference whatever to the arc lighting of the main streets, which are admittedly as well lighted as any part of the Metropolis. In deference to the representations of the petitioners, the Council have decided to try the interesting experiment of lighting one of the two streets referred to by Nernst lamps instead of the ordinary incandescent, and are raising a loan of nearly £3,000 for that purpose.

Tramway Trolley and Guard Wires.—This is not a new subject in this country, but it is now occupying the serious attention of the authorities in New South Wales, chief among whom are the Railway and Tramway Commissioners and the Postal Department. The position in Australia is accentuated by a conflict between these two authorities, and the fact that the Postal Department has power to do as it pleases with postal equipments in the State, irrespective of other authorities. The case for the Railway Commissioners is that, so far as telephone and telegraph wires are concerned, they should be underground, and that the Commissioners should not be forced to put up guard wires over the electric trolley system where the Post Office wires cross. It has been conceded by the tramway authorities that the course proposed by the Postal Department—that of adopting guard wires—might be favourably considered if it could be shown that it removed all element of danger in connection with falling wires, or did not introduce additional dangers. Guard wires, however, are regarded by them as an evil, and an unnecessary one, and it is held that the removal of the causes rests with the postal authorities. In this country the position is very similar. It is practically owing to the attitude of the Post Office that the Board of Trade insists upon the maintenance of some form of guard wire over the trolley wires where the unprotected Post Office wires cross the tramway track. The undoubted disposition of the Board of Trade in this country is in favour of the abolition of guard wires, which are admittedly dangerous things, but, unfortunately, the Board has no control over the erection of Post Office wires. And so matters remain as they are, although in New South Wales the position is being fought out with spirit, and with the one exception of the Postal Department, all the responsible authorities in the State are opposing the introduction of guard wires as a source of danger and accident.

International Exhibition, Manchester, 1905.—It is proposed to hold an international exhibition at Manchester in 1905, and the committee appointed to take the requisite preliminary steps have issued a circular containing the proposals. It will be the first international exhibition held in Manchester, and no other international exhibition is yet announced for 1905. Among the various reasons urged for holding the exhibition are that electric traction has now completely superseded horses on many tramways, automobiles are rapidly growing in favour, and the railways have increased in number and efficiency. Several plots of land quite suitable in size and position are available. The scope of the exhibition will comprise all that is best in industries, arts, and sciences, home, Colonial, and foreign. The classification will not be too general in the industrial section, but due regard will be given to the products of the district, and imported articles which are required and used in the locality. Automobiles will have a special department and a track provided for displays. Endurance and reliability trials will be started from the exhibition throughout the surrounding country. Aerial navigation and submarine boats, in their latest developments, will be fully displayed, together with such novelties as may be discovered in the meantime. In addition to the above, one predominant feature, such as the electric illuminated fountain at the Royal Jubilee Exhibition in 1887, or the Eiffel Tower at Paris in 1889, will be introduced, and several projects are under consideration, but for manifest reasons cannot be mentioned here. The cordial support of the Colonies and foreign nations may be confidently relied upon; informal communications have already taken place with prominent exhibitors and others which leave no doubt on this point. These opportunities properly availed of, and under good management, can only result in substantial benefit to Manchester and district, and also in material advantage to the whole community, and to the consolidation of friendship between the Empire and all other nations.

Electricity in Mines.—A number of members of the South Wales Institute of Engineers have visited the Tredegar Iron and Coal Company's mines and collieries to inspect a recent electrical installation which has been made at the Pochin and Ty-Tryst pits in the Sirhowy Valley. Electrical power is at present being used in these mines underground both for hauling and pumping, but eventually its application will be extended to surface work. The central station has been built about a mile away from the pits at Bedwellty, and three-phase electrical currents are transmitted to the mines at a pressure of 2,000 volts. In the mines themselves three-phase alternating current is used at 40 periods and 500 volts. At the central station the engines are of the horizontal slow-speed type, and are supplied with steam from a range of six high-pressure Lancashire boilers. The generators are of the revolving-field type, excited by a small four-pole shunt dynamo, the engines being coupled by means of grooved pulleys and cotton ropes. The main switchboard is divided up into three dynamo and three exciter panels, and one transformer panel for the Bedwellty pit. Underground cables are laid along the intake roads in steel semi-tubes, filled with solid bitumen, which is compound in all swampy places. But the chief point about the installation, which was laid

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down by Messrs. Mountain and Scott, is the economical results of its working. At Pochin the plant has been in full use for 12 months, and during this period a saving of £1,500 has been shown in fuel. There was also a saving in repairs of roads, tramways, etc., and altogether the year's experience has more than warranted the adoption of electrical methods at the collieries. With regard to the steelworks, most of the machines are electrically operated, the generating plant consisting of two Westinghouse horizontal compound engines, with a generator mounted on a shaft between the cranks. There are two Babcock and Wilcox boilers, with the Meldrum system of forced draught, and by this means the company are able to con sume waste product in the shape of coke, which previously found its way on to the tips. The electricity is generated at under $\frac{3}{16}$d. per unit, and large economies are resulting from its use, the cost of production in the steelworks being correspondingly reduced.

Electrical Safeguards.—From an electrical point of view there were one or two papers of considerable interest presented at the concluding meetings of the International Fire Prevention Congress in London last week. That which particularly commends itself to our attention was submitted by Mr. E. C. de Segundo and entitled "Electrical Wiring and Fire Risks." The question raised by the author in this paper is one which is always with us, but can hardly yet be said to have found a final solution. Summarising the essential features of a properly-erected wiring installation, Mr. Segundo stated that the first mportant condition consisted in providing that the electric current should be kept within its prescribed bounds, and that if by any unforeseen contingency a way should be opened for the current to trail in any unauthorised direction, the supply should be cut off automatically and instantly. No absolutely trustworthy means had as yet been devised whereby possible trouble due to electricity "out of bounds" could be guarded against, and the efforts of those who were working in the cause of fire prevention should be directed towards bringing about the adoption of the best kind of insulation and the most suitable kind of mechanical protection for the wires. For safety against risk of fire one must, he remarked, depend entirely upon the means adopted for keeping the electric current within its designed sphere of action—namely, the character of the insulation of the wires or the means adopted to prevent contact between wires of opposite polarity. This included the insulation on the wire and the means adopted to guard against mechanical injury and damp. Up to the present nothing had been found to touch best-quality rubber specially prepared to resist the oxidising action of the atmosphere and the deleterious influence of any rise in temperature of the conductor. It was possible, however, that before long a new form of insulator might be introduced upon the English market which, while possessing all the useful properties of guttapercha, was practically indifferent to the action of light and air, and was very much harder than guttapercha. Large quantities of wires insulated with this material had already been used on the Continent with excellent results. The ideal method of wiring a building, in his opinion, was to use the highest class of vulcanised or other suitable rubber insulation with some suitable form of mechanical protection in the way of braiding. Further, to enclose the wires in a continuous system of cold-drawn steel tubes specially selected for smoothness of bore, with joint-boxes inserted at all points necessary to enable the drawing in of the wires to be carried out without injury to their protective covering and to facilitate inspection, withdrawal of any wires for the purpose, if need be, of increasing their size, etc., the whole system of steel tube and joint-boxes being connected to earth. Another informing paper was presented by Mr. Alfred Hands, who took up the subject of "Necessary Safeguards against Fires caused by Lightning." He showed that from the number of lightning discharges accompanying thunderstorms, damage would be very much more frequent but for the lightning conductors in use. Conductors, however, were not always successful. There was a tendency to regard protection from lightning too much as being the mere putting up of lightning conductors True protection from lightning often consisted of a good deal more than the mere erection of conductors. The part that often made the difference between efficiency and non-efficiency was the making of the various connections to bridge over sparking gaps, as well as keeping a safe distance away from metals that it would be dangerous to connect to. For general purposes the system to be adopted must be evolved only after an intelligent consideration of the conditions that might exist in the structure to be protected.

Utilisation of Free Nitrogen of Atmosphere.—At the recent International Congress for Applied Chemistry at Berlin, Dr. A. Frank read a paper on the industrial utilisation of free atmospherical nitrogen. This element, as is known, is an indispensable factor in agriculture, particularly with highly exhausted soil, the annual importation of Chile saltpetre having been as high as 592,568 tons in Germany for the year 1901. As, however, the Chilene saltpetre mines are likely to become exhausted, the price of this so far indispensable material has been unceasingly rising for some years. Now, the same amount of nitrogen as contained in the above quantity of Chile saltpetre may be found in the air column about 100,000 tons in weight, as resting on one hectare of the surface of the earth. The raw material for manufacturing nitrogen compounds has therefore always been present, but the passive behaviour of atmospheric nitrogen opposed a serious drawback to any attempts made in this field. In the latter part of last century, the opinion was generally adopted that nitrogen could not be made to combine with other elements but by electrical means. Berthelot, in 1869, obtained hydrogen cyanide by passing electric sparks through a mixture of acetylene and nitrogen. A commercial operation of these processes, however, became possible only by the modern possibilities afforded for electrical energy being produced on a large scale. The firm of Siemens and Halske, as well as the Americans, Lovejoy and Bradley, would oxidise the nitrogen of the atmosphere to nitric acid by means of large electrical contrivances; whereas Dr. Frank and Dr. Caro, using the carbides obtained as well by electrical means, would convert the nitrogen derived from air into amides and cyano compounds, affording in turn the raw material for manufacturing ammoniacal salts, red prussiate of potash, etc. After having been tested and placed on a scientific basis by many years' work, this process was taken up by Messrs. Siemens and Halske, a great trial plant being installed with the assistance of Dr. Frank and others. The results there obtained, besides fully confirming the outcome of the laboratory tests, led to the manufacture of a novel nitrogen manure, the so-called "lime nitrogen," being a nearly perfect equivalent for both saltpetre and sulphuric ammonia as to its effects as a manure, and particularly suitable for our northern soils. It is now contemplated to manufacture this new manure on a large scale, it being anticipated that the inexhaustible sources of nitrogen thus placed at the disposal of agriculture will make it independent of foreign markets. On the other hand, the electrochemical industry is sure to profit highly by the new

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process, a novel field for utilising large amounts of power being opened.

Electricity Supply in London.—When in the House of Commons the Government obtained the rejection of the Bill introduced by the London County Council for the purchase of electric supply undertakings and for the supply of electricity in bulk, a promise was given that the Government itself would promote legislation on the subject. This promise would seem to have been fulfilled in the letter if not in the spirit, for the Bill introduced by the Government this session appears to be framed on very different lines from that of the London County Council. From a municipal point of view, the Government's proposals are regarded as being likely to have the effect of placing both the consumer and the local authority more in the hands of the companies than they are at present, while the object of the County Council's Bill was quite in the opposite direction. The situation has been closely enquired into by the Camberwell Borough Council, who, it will be admitted, are probably more nearly concerned than any other metropolitan borough, in view of the recent decision of the Board of Trade giving the County of London and Brush Provincial Electric Lighting Company a monopoly in the Camberwell borough against the wishes of the local authority. The town clerk, acting on instructions, has prepared a report showing the chief proposals of the Government Bill, amongst which are these: compulsory acquisition of land for generating stations, supply in bulk, provisions as to the right of local authorities to purchase, exercise of electric lighting by authorities jointly, provision as to consents of local authorities to grant provisional orders, revision of maximum price, electric light accounts, and supply of electricity to premises having separate supply. With regard to the question of supply in bulk, the Government's proposals seem to satisfy the views of the local authorities, but serious exception is taken to Clause 3, which it is contended seriously interferes with the purchase clause in the Electric Lighting Acts. By this new clause the present provisions of those Acts relating to purchase, and any subsequent Acts authorising special purchase, may, by a provisional order of the Board of Trade, be annulled, and this is regarded as putting it in the power of the companies by such provisional order, if obtained, to destroy all the powers the local authorities now have to acquire the companies' undertakings; all the large London companies may be exempted altogether from purchase, and the monopoly thus indefinitely continued. Another clause in the new Bill permits the Board of Trade to dispense with the consent of the local authority, and this clause repeals the clause requiring such consent to be obtained. Again, Clause 10 is a stand-by clause, which it is argued from the municipal point of view might be used by a company in a very arbitrary manner, and for the protection of large consumers should be carefully modified and re-drafted in the interests of the consumers, and not the company or persons authorised to supply. Summing up the position, it is contended that the general effect of the Bill is to deprive the local authority and the consumer of much of the protection they now have under the general Electric Lighting Acts; and the company, if able to convince the Board of Trade, is enabled, practically, to come into the area of a local authority and conduct business without the local authority having any power of control as at present. The metropolitan boroughs are very naturally alarmed at the position thus presented, and some stiff parliamentary fighting may be expected over the question of the introduction of protecting clauses. The Camberwell Borough Council have so far taken the lead, and are calling to their aid the weight and authority of the other metropolitan borough councils, the London County Council, and the Municipal Corporations Association in an attempt to organise an effective opposition to the Government Bill.

Motorcar Logislation.—Those who have ventured the hope that the Bill for amending the Light Locomotives Act in regard to motorcars will have an easy passage through Parliament will probably have changed their views by this time. Already there are unmistakable signs that the Government's new proposals for regulating motor traffic on the public highways will be met with a considerable show of hostility both in Parliament and among the general community. One of the principal bones of contention would appear to be the question of licensing. The Government's proposal as to this is that only those who drive a car "for hire, fee, or reward" shall be compelled to take out a license. Those who drive for the mere pleasure of the thing are exempted from this condition. For ourselves, we fail to see the distinction. It is admitted that the granting of a license is no guarantee of skill on the part of the licensee, nor could it be argued otherwise; so that the fact that a professional chauffeur plying for hire is the holder of a license is no security to the public against the perils of furious driving, except that on conviction the offender's license may be "suspended, endorsed, or forfeited at the discretion of the court." But even so the public is only partially protected by this limited system of granting licenses, as the greater bulk of automobilists — those moneyed classes who drive for pleasure, and, as evidenced by the proceedings in the police courts, are often the worst offenders in the matter of furious and dangerous driving— are to remain unlicensed, and are only subject to the increased penalties on conviction provided by the Bill. But a fine of £20 is not calculated to have much effect upon the class of men who own cars, and who have the rate of speed absolutely within their discretion, except in such districts as the present 14-mile limit may be retained by order of the Local Government Board. An exception to the argument that all motors should be licensed may perhaps be made in favour of electric broughams, such as are in daily use in London, which are known to have only a limited radius, and are not constructed for high speeds. The question of licensing is, therefore, one which may be expected to arouse considerable feeling and dissension between motorists and the general public. In proposing to place the speed of motorcars in the discretion of the drivers the Government has done a wise thing. It is obviously impossible to fix a hard-and-fast rule which will meet the varying conditions which govern automobilism in different parts of the country. At the same time, if a local authority is of opinion that the present limit should be retained in its particular area, owing to the presence of dangerous conditions, the Local Government Board, on such representations being made to it, may order the enforcement of the limit by the local authority. This condition certainly invests the local authorities with much power, and the Local Government Board will have its hands full if every local authority is to be allowed to apply for special speed limits and to have an official enquiry thereon. On Tuesday the Bill was discussed in a business-like manner in the House of Lords on the motion for the second reading. As foreshadowed above, the chief debate centred round the licensing question, the general feeling being that all motorcar drivers, whether amateur or professional, should be required to take out a license. Indeed, the feeling on this point was so strong that Lord Balfour undertook to amend the clause in dispute so as to extend its operation to owners and other amateur drivers. The Bill was then able to be read a second time without a division.

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MUNICIPAL TRAMWAYS ASSOCIATION.

ANNUAL CONFERENCE.

The annual conference of the Municipal Tramways Association of Great Britain was held in Glasgow last week, commencing on Wednesday and extending over three days. On the opening day the members and delegates were formally received by the Lord Provost (Sir John Ure Primrose) and the Corporation of Glasgow in the City Chambers.

The LORD PROVOST said he had great pleasure in welcoming the association on behalf of the Corporation of Glasgow, which occupied a very prominent place in the development of municipal enterprise. They were probably the first to municipalise tramways on a large scale, and were very fortunate in having as their general manager Mr. John Young, whose reputation extended even beyond the limits of these islands, and whose whole record was one of capable and careful administration. Being the pioneers, had they achieved only a qualified success, other municipalities might have hesitated, but having, on the contrary, achieved what he might honestly describe as a magnificent success, other municipalities had followed in their wake.

Mr. JOHN YOUNG said it usually fell to the president of the association to reply on such an occasion, but as he (Mr. Young) was at home, he would call upon Councillor Smithson, chairman of the Tramways Committee, Leeds, to say a few words.

Councillor SMITHSON thereupon thanked his lordship on behalf of the members of the Municipal Tramways Association and others present for the hearty welcome which had been extended to them. He also thanked the members of the Glasgow Tramways Committee, especially Councillor Walter Paton, their convener, for the opportunity which had been offered of examining the tramway undertaking generally as regarded its equipment.

In acknowledging these latter thanks, Councillor WALTER PATON said his committee had had very great pleasure in making arangements for the conference. He was glad that the members of the association were going to visit Pinkston power station, which was, perhaps, the most complete power station in this country.

The business of the conference was then entered upon in the Council Hall, Mr. John Young, the president, occuping the chair. In the course of his address, the PRESIDENT said that, although their association was founded only a year ago, almost all the corporations eligible had joined it, and had sent the chairman or deputy chairman of their respective tramway committees to represent them at the conference. The membership now numbered 93, and they might fairly enough describe themselves as an association of municipal tramway experts and specialists. They had now within themselves not only the expert knowledge and experience necessary to initiate, but also moving power to carry into effect. Although they were a Municipal Tramways Association, they recognised that most of the questions and problems which they would have to consider and discuss would apply to all tramways, whether operated by municipal corporations or by companies, and to tramway practice generally. They had therefore taken the liberty of inviting the Street Railways Association and the Street Railway Accountants' Association of America, the Union Internationale de Tramways, and the Tramways and Light Railways Association to send representatives to their present conference, and were delighted to see some of those associations represented. The field which lay open to their association was a very wide one. It was coextensive with the great and growing interests of tramways in this country, and those interests now touched the great bulk of our urban and suburban populations. In this country, although we were slower than our friends in America and on the Continent in adopting electric traction, progress had been rapid during the past few years. He supposed we now had about 2,000 miles of electric tramways, while four or five years ago there were only a few miles. The duties and responsibilities of municipalities, especially of the larger ones, were year by year growing in importance. In every department of civil and municipal life higher ideals were being formed as our scientific knowledge increased, and higher standards of efficiency were being demanded all round. That, of course, meant progress; not reckless change or adventure, but solid advancement on lines which were necessarily broadening, but must still be well defined. It was not the time to discuss what these lines should embrace, but they could not help seeing what had come to pass. As a general rule, municipalities in this country had already taken into their own hands such monopolies or public utilities as the supply of water and artificial light and the operation of the street tramways. They also jealously exercised full control of the public streets and highways; they provided public parks, public baths, public markets, and abattoirs; also fire brigades, and hospitals for infectious diseases; they also undertook works of cleansing and sanitation, which had a direct bearing on the comfort and health of the people. Since this was all done with the approval of the community generally, they might take it that the citizens considered it right and proper, and in the public interest, that it should be so. He thought that the object lesson on the operation of tramways on the best commercial lines which the municipalities were now giving to the country, might well make Parliament feel disposed to lighten their own hands, and those of their public departments at Westminster and Whitehall, by throwing more direct responsibility upon the local authorities in connection with their respective undertakings. Perhaps it was the success of municipalised tramways which had of late caused a few people to get up a scare against them. In any case, it had been taken so seriously at Westminster that a Joint Select Committee of the two Houses of Parliament had been appointed to enquire into what was called municipal trading. Municipal tramways formed one of the chief points of the enquiry. He was strongly in favour of enquiry whenever there was a case for it. The municipalities could only come out of the present enquiry with their hands strengthened. It was desirable that there should be the best possible understanding between Government departments and municipal corporations, and he was sure the association would be pleased to render any assistance or in any way make itself useful in that direction. If the association could, by encouraging mutual assistance and co-operation among its members, help to maintain municipal tramway undertakings at the highest point of efficiency in every respect; if they could continue to show how tramways could be operated so as to serve the greatest good of the community by transporting them cheaply, comfortably, and speedily from point to point within the area in which they lived and worked, the Government would be bound to recognise it sooner or later, and to encourage it in their own time and way. Districts could, however, be over-tramwayed, and tramways over-capitalised. He thought it was admitted that the first duty of municipalities operating tramways was not so much to show a large profit as to give the best and cheapest possible facilities of transit consistent with safe business and sound finance. If they erred, it must be on the safe side. It would be observed that the subjects to be brought before the conference were of general interest to all tramway men, and he hoped they would have a full and frank expression of opinion upon all of them from gentlemen who had given one or other of them their special attention and study. The first report was on the "Standardisation of Accounts," which subject he considered of primary importance. It was obviously by making friendly comparisons that they could be helpful to each other, and in a position to fulfil the objects of their association. But such comparisons were impossible at present, simply because no two statements of accounts were made up on the same basis. He therefore looked upon standardisation of municipal tramway accounts as the very foundation of their usefulness as an association. The President then called upon Mr. J. Dalrymple, C.A., accountant of Glasgow Corporation tramways, to submit his report on the "Standardisation of Tramway Accounts."

In submitting his report and suggested standard form of accounts, Mr. DALRYMPLE said it was important that they should, if possible, come to an agreement as to the various heads under which they should classify their expenditure,

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because that side of tramway accounts was the more important. It would be seen that he had confined himself to the form of the annual financial statement, including revenue and expenditure account, capital account and balance-sheet, with an appendix giving a complete classification of construction and equipment accounts and operating expense accounts. He had endeavoured to draw out a form which could be adopted by all municipal tramway managers and borough accountants in stating their annual tramway accounts. He thought that tramway managers should be entrusted with power to have their expenditure classified in a particular way. In America they were very advanced in this respect, and had adopted a standard form of accounts very similar to that now proposed for acceptance in this country. In dealing with details, he had observed that some municipalities spent twice as much on repairing cars as Glasgow, while the latter town spent a great deal more on permanent way than any other city. There might be good reasons for these differences. It would be useful to know them. Referring to the suggested standard form, the permanent-way renewal fund—folio 4—was calculated on the basis of complete renewal at the end of the life of the track. As to depreciation, that should be charged first of all against revenue, and after that the sinking fund should be fully charged against net revenue, the result being that at the end of the borrowing period—31 or 40 years as the case might be—the Corporation would have their loan debt totally extinguished, and a complete tramway to hand over to their successors. That, however, was not a point which they could now discuss. On folio 7—capital account—the amounts deducted under each depreciation were shown. No notice was to be taken of the amounts given, as these were not intended for criticism, the main point being to agree upon a standard form of accounts. More or less detail might be given under the various headings. In that respect the form was not intended to be binding.

A vote of thanks was accorded to Mr. Dalrymple for his report, and the PRESIDENT, in opening the discussion on same, remarked that they were not there to discuss the question of depreciation and sinking fund, which was a matter of policy for corporations to deal with.

The discussion which ensued emphasised the desirability of adopting such a standard form of accounts as that suggested by Mr. Dalrymple. At the same time the difficulty of instituting a fair comparison between self-contained systems and systems depending upon an independent source for their power was pointed out. There was a consensus of opinion that all expenses rightly chargeable to power should be concentrated under one heading. Ultimately the following resolution was moved by the secretary of the association (Mr. J. M. M'Elroy, Manchester) and carried: "That the association is of the opinion that it is desirable that a standard form of tramway accounts should be adopted; that a communication be sent to the Burgh Treasurers' Association requesting them to appoint a number of their members to join with members of this association to form a joint committee to fully consider and recommend a standard system of tramway accounts suitable for adoption by the various municipalities; and that pending consideration of the matter each corporation represented be requested to consider the draft form of accounts submitted by Mr. Dalrymple, and to report."

Messrs. John Young, R. C. Bellamy, J. Dalrymple, G. Swainson, and J. M. M'Elroy, were appointed to represent the association on the joint committee.

Next in order came a report by Mr. A. Baker, chief officer, London County Council tramways, on the "Hours of Labour and Rates of Pay obtaining in Various Municipal Undertakings in Great Britain." In this report the author gave some interesting figures and information relating to the conditions under which tramway men are employed in different towns. In 1897 the tramway undertakings in the United Kingdom numbered 159, of which 42 only belonged to local authorities, while by June, 1902, no less than 74 new undertakings had come into existence, the total number then being 233, of which more than half—viz., 118—belonged to local authorities. The figures given in the report related to 34 different towns in Great Britain. An examination of the figures, the author pointed out, did not disclose any very considerable difference in the rates paid to the various classes of employés in different towns. It would be seen that, with only one or two exceptions, every town had adopted a graduated scale of pay for drivers and conductors, new men starting at the lowest rate and rising to the maximum by length of service varying from six months to three years. He (the author) had more than once heard this system bitterly attacked, it being argued that one man might become as proficient as another after about a month's service. Those who were engaged in the actual operation of tramways were fully aware of the fallacy of that argument. They knew that the percentage of accidents of one kind or another with which they had constantly to deal was considerably higher where new men were concerned than where the men had been in the service, say, two years and upwards. That fact alone was, he thought, sufficient justification for the method almost universally adopted. He found, taking the maximum rate of pay in all cases for motormen and conductors, that the average over the whole country was as follows: motormen, 6¼d. per hour; conductors, 5¼d. per hour. That worked out, taking 60 hours a week as the standard, at 31s. 3d. for motormen and 26s. 3d. for conductors. It was to be observed that out of 33 towns only two—viz., London and Glasgow—paid motormen and conductors equal wages. In the remaining 31 towns motormen were paid at higher rates than conductors. For his own part he could not see any legitimate reason why the driver of an electric car should receive more pay than the conductor who was in charge of everything except the driving, unless it were in some rural district, with a sparse population and light traffic, where boys or youths might well be employed. Placing the towns in order according to the wages paid, he found that the London County Council paid their motormen 7½d. per hour—thus heading the list—while three towns paid 7d., three 6¾d., seven 6½d., three 6¼d., ten 6d., and the others slightly less per hour. With regard to conductors, the towns came out in slightly different order, although the London County Council still headed the list with 7½d. per hour, while of the other authorities two paid 6¾d., four 5¾d., eight 5½d, two 5¼d., and ten 5d. per hour. He had often heard it argued that there should be a standard rate of pay for tramway employés all over the country, those who supported the arguments asserting that the work of "lifting" pence from passengers or manipulating the controller or brake handles was equally arduous whether in London, Glasgow, or the urban district of X For his own part, he had never been able to see any force in the argument that because A and B paid its men so much per day or week C must do likewise. Of course, there were some towns of about equal size and alike in some other respects where the wages paid in one might well serve as a guide to the other, but, generally speaking, each corporation must fix rates according to local conditions, and regardless of what is being done in other places. The advocates of a standard rate of pay were in this dilemma: they must either fix the standard equal to the highest rate in the country—which would be a very nice thing for tramway men in rural districts—or they must strike an average. The average for motormen was 31s. 3d. per week. If, therefore, that was to be taken as the standard, motormen in London would have to submit to a reduction of 6s. 3d. per week. That, he ventured to think, exposed the ridiculous nature of the argument. With regard to hours of labour, the position was different. It was a much easier thing to establish a standard day's work for the outside staff than to standardise the pay, and in that respect he thought it was remarkable how generally the 10 hours' day, six days a week, admitting the blessed principle of one day's rest in seven, had been adopted in this country. Glasgow, Doncaster, Cardiff, Plymouth, Halifax, and Manchester had adopted a nine hours' day, 54 per week; Warrington and Darwen following next with 56 and 57 hours per week respectively, while all the remainder, with the exception of three, had set up the 60 hours' standard. With regard to the three towns where a 60 hours' week was exceeded, it was only fair to say that considerable reductions in the hours of labour had been made as compared with the companies who worked the

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undertakings previous to the corporations obtaining possession. In one case the men worked under the company as much as 91 hours a week; this had been reduced to 65. In another, 95 hours a week were worked; this was reduced to 63; while in the third case, 81 hours had been reduced to 64½. Notwithstanding the variations referred to, it might be taken that a 60 hours' week was the standard, and, considering the nature of the work, he was not one of those who considered 60 hours a week on a tramcar outrageously long. During the last five years, under municipal control, and largely by the aid of electric traction, tramway men's hours had been reduced by 48 per cent., and at the same time their wages increased by not less than 42 per cent. In London it had cost the Council upwards of £40,000 a year to give its servants a 60 hours' week and a decent living wage. The opponents of municipal tramways treated this extra expense, as compared with company management, as loss in working, and gravely stated that corporations could not manage their concerns as economically as those controlled by private enterprise. He believed no gentleman present was anxious to emulate private enterprise in effecting economies at the expense of human beings by sweating them in the same way they were sweated a few years ago. Many of the corporation tramways, however, were experiencing the first flush of success, and while it was the obvious duty of the municipalities to put labour on a proper basis, yet the meting out of any preferential treatment to tramway servants should be strictly guarded against. Having regard to the peculiar nature of the work tramway men should be generously treated, but there were limits, and as soon as those limits were passed so soon would the work in which they were all engaged be seriously prejudiced. A danger to municipal tramways lurked in attempts which had been made in some towns, immediately the municipality had acquired the tramway undertaking, to place the employés under conditions altogether out of proportion to the duties performed. Such attempts, which were fortunately rare, simply armed those who were bitterly opposed to what was called municipal trading with a weapon which was unhesitatingly used against every corporation, quite regardless of whether the undertakings in which it was engaged were conducted on sound business principles or not. The remainder of Mr. Baker's report was devoted chiefly to the question of encouraging friendly societies for the benefit of the men. The author instanced the societies connected with the tramways in Liverpool and Glasgow as being especially worthy of imitation.

An adjournment was then made for lunch.

In the course of the discussion on Mr. Baker's report, which ensued after lunch, the question of Sunday labour claimed principal attention. It appeared that no difficulty had been experienced or objections raised in the towns where the men are allowed to work only six days per week, and take their share of Sunday work in rotation without extra pay. The policy of giving the men additional remuneration for Sunday labour was generally disapproved. Several speakers also emphasised the responsibility of the motormen as compared with that of the conductors, and sought to justify the prevailing higher rate of pay in favour of the former by that line of argument, thereby disagreeing with Mr. Baker's contention that the rate of pay for motormen and conductors should be equal.

Mr. Baker having made a brief reply to the discussion,

A voluminous and highly instructive "Report on Permanent-Way Construction and Maintenance" was submitted by the president, Mr. John Young. Being in the form of a tabular statement, the interest in the report was great enhanced by an admirable summary prepared by Mr. C. A. King, permanent-way engineer, Glasgow Corporation tramways, and read by that gentleman. Pressure on our space prevents us from dealing with the report now, but we hope to do so in a subsequent issue.

The discussion on the report terminated the first day's business.

In the evening the members of the association were entertained at dinner by the Lord Provost, convener, and members of the Tramways Committee of the Corporation of Glasgow in the banquetting hall of the City Chambers. Thus ended a full and instructive day's proceedings.

MUNICIPAL ELECTRICAL ASSOCIATION.

The eighth annual convention of the above association was opened in Sunderland on Tuesday last. The MAYOR (Councillor H. J. Turnbull, J.P.), having been introduced by Mr. Snell, extended a cordial welcome to the members and their guests. He hoped that the meeting would be intellectually profitable to the members. Owing to there being few skilled electrical engineers on councils, the corporations had to depend for the success of their electrical undertakings on their engineers. He was sure that these engineers would derive great assistance from the association. In Sunderland they had spent half a million of money on their electric lighting, tramways, and power scheme, under the able management of the association's president, Mr. J. F. C. Snell. He could assure those present that in Sunderland they highly appreciated the honour done to Mr. Snell in electing him as president.

Mr. J. F. C. SNELL, after thanking the Mayor for his kind words of welcome, proceeded to read the following address:

Presidential Address.

BY MR. JOHN F. C. SNELL, PRESIDENT.

GENTLEMEN,—I feel very deeply the honour which you have done me and this town in conferring upon me the office of president. In these days so many presidential addresses are written that it is difficult to select a wise and useful subject, and particularly so when the utterance of the president to some extent involves the association he represents; though, of course, members cannot be really held responsible for the president's vagaries. As the opportunity comes but once, I have determined to speak boldly on some of the subjects which I feel are seriously menacing the progress of municipal undertakings. On more than one occasion I have been told that our association is feeble in its organisation, and has done little of importance during its existence. To such criticism I have retorted that if nothing further had resulted, the fact that the municipal engineers and chairmen of committees of most of the principal towns in the United Kingdom are annually brought into close communication, and are thus enabled to have an interchange of opinion, this alone has proved the association to be of the utmost value to its members. It has given an impetus to municipal electrical industry, and through this co-operation of its members has not improbably saved many towns unnecessary expenditure. For my own part I must freely admit that I have received much help from these annual conventions, not only from the papers, but particularly from private discussions and visits to various works throughout the country. The *esprit de corps* and good feeling which is so noticeable at these conventions is a particularly pleasant phase of our association. I believe that there is much work for which this body may prove to be a useful instrument. The municipalisation of certain public necessaries—whatever may be the opposition offered by private interests—has become a settled policy of the present day. Among these is the supply of electricity, and it must be acknowledged that municipal electrical supply must be allowed free and wide expansion, and that unnecessary restrictions must be removed.

Let us consider for a moment the wider question of the general spread of electrical applications. The natural law of the survival of the fittest is at work in every department of life. We shall agree, I think, that of all known means of transmitting energy electricity has the right, *par excellence*, to the fittest position, and its wider use will help us to use the natural wealth of our land with increasing efficiency. The coal stores of Great Britain are not inexhaustible. If the antiquated steam-engines, useless shafting, and indirect means of applying power were done away with, and in place of them works of every class were electrically driven, the annual consumption of coal would be enormously reduced. It is to me a melancholy reflection that the accumulated energy of past ages should be so prodigally wasted, and wasted beyond recall, through this delay in adopting the most economical and efficient means of its transformation for our manufacturing requirements. When conveyed to countries where these natural riches do not exist, and where, therefore, manufacturers cannot afford to be so wanton, competition has demanded an increased efficiency in workshop methods, which we ourselves, I regret to say, have been too slow and conservative in following. I believe, however, that at last English people have awakened from their lethargy, and it may be a surprise to many to see the evidence of rapid electrical developments on the Wear, Tyne, and Tees; and more surprising still when they are told that this has all sprung into being during the last two or three years. The effect upon trade output, I am convinced, will soon be noticed, and this will mean a new era of prosperity to our manufacturers.

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But it is more particularly on the supply of electricity by municipalities that I wish to speak. During the last year there has been an outburst from a section of the community against municipalisation, and there can be no question that Parliament apparently intends to restrict us to narrower bounds. I am not going to enter into the field of politics, with which neither I, nor we, have anything to do. We are the public servants of municipalities, and our duty is clearly to do our best in that service; but I want to take this opportunity of putting before you seriously some of the disabilities with which we are fettered. To remove a false idea which has been circulated—viz., that electrical supply companies are much more progressive and are managed in a more businesslike way than municipal departments—let me briefly recite what was the actual comparison for 1902 between these two classes of undertakings. The total capital outlay on company undertakings in the Metropolis in 1902 was £9,299,000, and on undertakings owned by local authorities £1,448,000. The average capital expenditure per kilowatt installed in the former was £115, and in the latter £96·5. The average price per unit sold in the former was 4·72d., and in the latter 3·58d.; whereas the cost per unit sold was 2·59d. in the former, and 2·38d. in the latter—which means that metropolitan companies spend 19 per cent. more on plant, charged 32 per cent. more for each unit sold, and their costs were nearly 9 per cent. more than the local authorities. And the same is true of the provincial undertakings. In the provinces the companies had spent £2,963,000, and the local authorities £13,404,570. The average capital expenditure per kilowatt installed in the former was £98·5, and in the latter £78·5; and the average price per unit sold in the former was 4·45d., and in the latter 3·15d. The companies spent 25 per cent. more on plant, charged 41 per cent. more per unit, and their costs were nearly 34 per cent. in excess of the costs of the municipal undertakings. This, surely, sufficiently answers the attacks which have been made upon municipal electrical undertakings during the last year.

The most important and most debated question at the present moment is that of depreciation of municipal electrical undertakings. There is a class of critics which affirms that municipalities are not working on a financially sound basis because the majority of them do not form any depreciation fund, or at least have not yet commenced to form one. These critics state that in order to be sound we ought to pay off our capital by sinking fund as at present, and in addition, to form a sufficient and separate depreciation fund. In 1901 this association, in conjunction with the Borough Treasurers' Association, passed resolutions which affirmed that when the term of repayment does not exceed 30 years, and provided the plant be kept up to its proper capacity from revenue, a further depreciation fund is unnecessary and uncalled for. A great deal of this controversy about depreciation arises from the wilful neglect of our critics to make a *just* comparison between companies and municipalities, and also I think by a confusion between "wear and tear" and "antiquation." I think it better to at once make this point clear. For example: a boiler will require certain repairs from year to year; new tubes, new parts of certain fittings, new furnace tubes, perhaps, or other renewals dependent on the type. This I call "wear and tear," and such renewals are properly paid for from revenue. But in addition there is a gradual deterioration of the boiler itself right through—a process of decay, as it were—and, like ourselves, it has a life dependent on two things: its original manufacture and its usage during life! This deterioration I call "antiquation," or true depreciation. There is yet a third factor not to be forgotten, but I think easily disposed of—viz., the possibility of certain details of plant becoming obsolete. I do not call the replacement of small sets—rendered necessary during the pioneering stages of any concern—by larger and more economical sets "obsolescence," for the smaller sets will fetch their present value when sold, and thus no waste of capital takes place—at least this is my personal experience, from which I generalise. Nor do I consider such a case as the supercession of the 100-volt lamp by the 200-volt such a case, for the earning capacity of cables was thereby much increased, and the cost of the change was charged to revenue in most cases. Newer methods of distribution, or improvements in gas-engines, for example, might introduce economies which would make present-day plant comparatively inefficient. But one might speculate on possible improvements and frighten oneself into a state of imbecile passivity, so I really do not think that this factor is one to be seriously taken into account. We were left then with two other factors—viz., "wear and tear" and "antiquation" (or true depreciation). The first is met by revenue, and is thus safely dismissed from this argument; but antiquation remains. We must look squarely at this fact. Some of the plant in both electricity and tramway concerns has a shorter life than the 25 or 30 years allowed by the Local Government Board—some a much longer. The period for the repayment of these loans is one which requires alteration. I will first recite some of the anomalies which exist. The London County Council is enabled to grant periods of 42 years to the borough councils. The Commissioners for Scotland allow a period of 30 years for municipal undertakings within their province. There are isolated cases of even longer periods—such as Glasgow, where an old Act gives that city 62 years in which to repay its debt—while we in provincial England are allowed by the Local Government Board a period of only 25 years. If application be made to Parliament by way of Bill for extensions of electrical works, the undertakers are granted 25 years only, it is true, but are given a remission of the sinking fund instalments for one, two, or three years, a point which was strongly sympathised with by the Committee on Repayment of Loans in 1902. The Local Government Board, however, is unable to do this, and thus those who proceed by the less costly method of provisional order have to pay this sinking fund on all extensions and new loans before it is possible for the new capital to have earned any revenue. Another case: if a council apply to Parliament for a Bill to construct and work its tramways and to build the necessary power-house, a period of 30 years is granted for the repayment of the whole loan (in some cases, of course, longer periods being given for land, and the usual period of five years for the costs of the Act); but if the same corporation provide [the necessary power-house through *an extension of its electric lighting undertaking and instal identically the same plant as in the former instance*, the loan must be repaid in 25 years. If plant which runs at 17 hours a day, and subject to the severe conditions of tramways supply, can be given the longer period, why should not electrical undertakings be given at least the same extended period, especially when the plant is subjected to less severe conditions; and if 42 years is the legitimate period for repayment of loans in London, why should provincial undertakings be called upon to repay theirs in 25 years? Everyone points to the general excellence of management in the second city of the Empire. If 62 years is proved to be a legitimate and not unduly long time there, why cannot the rest of us be given similar privileges? A curious anomaly to me is that electric lighting undertakings are only allowed 25 and the tramway undertakings 30 years, when I am of opinion that the reversal of these periods would bear a more real proportion to the lives of the undertakings.

Now, the point which I wish to emphasise is this: the financial regulations of the Local Government Board, to which we are subjected, require a very drastic alteration. Some of our plant (such as accumulators) has a natural life of only 10 or 11 years, some 25 to 30 years, and some 50, 80, or 100 years. A sinking fund which repays a debt in 25 years is a clumsy and unsound instrument for writing off plant which is non-existent in the eleventh year under existing conditions, although the 25 years is supposed to represent the "equated" life of the whole of the installation. The present method of the Board in such a case is to grant a further loan for the replacement of this portion of the plant, for which they grant a period of 10 years. The result is that from the eleventh to the twenty-first year a two-fold sinking fund on this particular plant has to be paid, and then in the twenty-first year the plant again is non-existent, and a third loan has to be applied for. This, of course, is nonsensical. That is one extreme view of the question. On the other hand, buildings, stoneware casings, cast-iron pipes, roadwork for mains, and land will have depreciated but very slightly in 25 years, and if Parliament has safely been able to grant 60 years to gas and water undertakings for their pipe lines, reservoirs, etc.—subjected as they are to much more serious depreciating action than those I have enumerated—I say that we have every right to take this extended period as the natural life of *those portions* of our undertakings. I do not want to argue from false premises, as a critic might say that one has no right to assume that the 60 years for gas and water undertakings *is* a legitimate period; but basing one's estimate of the life of these items from other engineering sources within one's experience, I cannot come (nor I am sure can anyone else) to any other conclusion. Under the Public Health Act, 60 years is the maximum period allowable. In 1901 a table was laid before the association by Mr. Newington, of Edinburgh, in which the life of all the details of a representative electrical undertaking was set forth, and this received the unanimous support of the council. That table made out that at any rate the equated life was well over 30 years. I have most carefully applied the like reasoning to several undertakings in very great detail (including that of which I am the chief officer) and I cannot make the figure less than 42·8 years. I presume that the shareholders of electrical companies will expect to get this life from their own undertakings—in fact, there are companies which have been in existence for very nearly half this period already, and show very little signs of collapse; on the contrary, they become more remunerative each succeeding year. Clause 52 of the model provisional order sets forth that undertakers may set aside annually from their profits a reserve fund up to a limit of 10 per cent. of the aggregate capital expenditure, and also that when the surplus in any year exceeds 5 per cent. it shall be compulsory upon the undertakers to make a reduction to their customers. I suggest that a better system of finance would result from the following amended regulations:

All municipal electrical undertakings should be granted a

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period of 42 years for the repayment of loans. Each application for a loan should be subjected to an enquiry of the Board of Trade so as to ensure that respectable schemes only were submitted, and it should be compulsory upon the municipal authority to set aside an additional sum (over and above the sinking fund thereby entailed) of 1½ per cent. of the value of the capital expenditure commencing not later than two years after such expenditure had been made, to form a depreciation fund. If the gross profits of the undertaking were unable to meet this liability, then the deficiency to be met from the local rate as at present, or if the deficiency continue for more than a given period, the charges for energy supplied to be raised so as to meet the deficiency. Now, the capital charges on an undertaking taken at 42 years and with 3½ per cent. interest will amount to £4. 17s. 6d. per cent., and upon the same basis for 25 years amounts to £6. 8s. 7d. per cent., showing a saving of £1. 11s. 1d. per centum per annum, against which has to be set the 1½ per centum for the depreciation fund. As an example, take the expenditure on the electrical undertaking of this town. Our capital expenditure to date is £224,000, and our average capital expenditure for the last 12 months was £211,600. The accumulated sinking fund paid out of gross profit is £20,073, which amounts to practically 10 per cent. of the average capital outlay. We have no depreciation fund in addition to this amount, although we have a small reserve fund, and intend, of course, to add to this fund when we can. If the conditions which I suggest had existed from the first we should have had about £10,500 in the sinking fund and £9,600 in the depreciation fund, representing 4½ per cent. on the average capital outlay. I assert that this would have been a sounder financial position than the present. A sinking fund is an absolutely inflexible sum which cannot be appropriated for any other purpose, of course, than the cancellation of the original debt, but electrical undertakings require something over and above this—a fund from which sums can be taken from time to time to make good any shorter-lived and worn-out plant.

It has always been argued that the 21 years' life which was given to company undertakings by the Act of 1882 (after which period municipalities could buy an undertaking at its then value), was an insufficient period for the use of the shareholders' money, and that the proper thing was done when Parliament (Section 2, Electric Lighting Act, 1888) increased this period to 42 years. What, then, do we find these companies doing, controlled as they are by most able financial and engineering exports? They are content to form a depreciation and reserve fund which amounts to something like, and, so far as I am aware, often much less than, 10 per cent. of the capital outlay. Presumably, therefore, this must be considered a sound position, otherwise companies could never have the stability which they enjoy. As this is true of company undertakings, what logic or reason is there in refusing to give municipalities precisely the same privileges, or why should municipalities pay more than companies? Both will have enjoyed 42 years' use of the original capital, and will be, as a result of their trading, able to re-enter on their obligations to their consumers. It has been argued and reiterated that the action of our Legislature in the eighties was the primary cause of our backwardness in electrical developments when compared with America and foreign countries. Parliament having granted municipalities the power of creating and working their own electricity supply works, cannot now cancel those powers, the matter having gone too far. Is the Legislature, therefore, going again to be the means of restricting electrical developments in England by putting unduly onerous charges upon those undertakings under municipal control? It is in the developing days of all commercial enterprises that the severest struggle is felt. There is a big and growing demand in England to-day for electrical power. England is suffering in its competition with other countries, *inter alia*, for want of this more efficient agent. In the majority of cases the municipality is the authority which has been granted the statutory powers to provide this want, and I emphatically state that the onerous regulations imposed upon us for the too rapid repayment of our capital is preventing us from developing as rapidly as we ought to do, by its necessary reactance on the charges to consumers, and is injuriously affecting our manufactures.

I hope I have clearly shown that there is need, and urgent need, for concerted action to obtain a revision and simplification of these regulations. I want to see municipalities placed on a par with admittedly well-regulated companies, and I believe that the extended period of repayment, the compulsory formation of a depreciation fund in addition to this extended sinking fund, and an enquiry upon each loan by a properly constituted section of the Board of Trade composed of a few electrical experts, would prove a panacea for the present evils. It would have the effect further of bringing all the present anomalies into alignment, and it would enable municipally-controlled undertakings to be governed on thoroughly sound financial lines. The present Government has just authorised the formation of a Royal Commission to enquire into the whole question of municipal trading. I do earnestly hope, for the good of municipal electricity, and for the whole electrical industry at large, that vigorous action will be taken by the Association of Municipal Corporations, and by ourselves, backed up, I hope, by the loyal co-operation of the Institution of Electrical Engineers and by the electrical Press, to attain this end. This may be Utopian, but I have faith in the common-sense and justice of these bodies, and I believe that this item—which I consider to be the most important on our costs sheet to-day—can be thus more fairly apportioned among the present and succeeding generations.

Another point on which I wish to speak is the tendency of many municipalities to allow tried and capable officials to leave their service at a critical time in the development of their systems. On this point I feel perfectly free to speak without the risk of being misunderstood, because of my known relations to the Sunderland Council. I think it wise that a municipality should engage an independent expert engineer to launch the undertaking, and to assist in the selection of a capable chief officer. This officer being appointed will then seriously consider local conditions, and if he is worth anything at all will devote his energy to the proper and careful development of the work entrusted to him. But being young and ambitious he will be naturally allured to another town offering a wider field and a bigger salary, and I have known men who have been allowed to leave because their councils have been niggardly, and have declined to increase salaries which were entirely disproportionate to their serious responsibilities. One does not hear of the like changes on the staffs of the larger companies. A change of management in such a case must affect, temporarily, the progress and development of the system, for it takes time for a new man, however capable, to acquire a thorough knowledge of local conditions, and even a slight change of policy may cost the municipality a great deal of money. Councils, I think, want to form an idea of the depreciation of the engineers, the wear and tear on whom is a really serious factor, for the responsibility of electrical supply undertakings is a very heavy strain. I think more encouragement is required to be given to officials of proved efficiency.

One other word which, at the risk of being considered priggish, I would address to my brother engineers. There is a tendency to attempt to make engineers, who are responsible for the selection of contracts, stray from their strict sense of duty by offering, directly or indirectly, some inducement to them to become biassed in favour of some particular plant. We have maintained an excellent record for purity of conduct, and the result is that, young men as we all are, we have earned the respect and confidence of our councils, which it must be our endeavour to retain. I do not wish to preach a sermon, but there are so many young engineers starting in public life—and there is no question that the temptation does exist—that I hope the same character for commercial purity and for strict professional etiquette will always be a significant factor in our careers.

There are many questions which must give rise to anxious thought. The progress of gas-engines and the production of high calorific gas, the improvement of the steam-turbine, the probable economies in methods of electrical illumination, the increasingly greater scope of electrical applications, all present material for judgment in forecasting their influence upon future extensions. However, a modern electrical station is so highly efficient that there does not seem to be much probability of such improvements in either generation or distribution as will make it worth while to scrap modern installations. If machinery which was installed 14 or 15 years ago is able to-day to keep up with present-day requirements, how much truer this must be of plant which is being put down at the present time. I think, therefore, after making due allowance for the possibilities of improved prime movers and other things, we must not let this unduly interfere with our judgment and enterprise. One wishes that more progress could be made with electrical storage, as an efficient battery would very materially alter the problem of electrical supply. We shall have during the convention some excellent papers dealing with both the commercial and the technical aspects of our service, and it is gratifying to know that the distinguished chairmen of committees who have written them are among those who are so widely known for their experience in municipal government. The technical papers also contain materials for most profitable discussions.

I sincerely hope that the Sunderland and District Convention will be a means of widening our knowledge, and, together with the hospitality and assistance which I know is to be given to the association by the corporations whose towns we shall visit, will be productive of much real good.

Alderman NORMAN, of Cheltenham, proposed that a vote of thanks be given to Mr. Snell for his most able and instructive address. He agreed with it, and especially with that part which dealt with the remuneration of electrical engineers. He held that the chairman of an electricity

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committee should see that his engineer was rewarded for work done, and that if the council would not make reasonable provision for the same, he suggested that the chairman should resign when the electrical engineer was induced to leave for a more remunerative position elsewhere.

Bailie MACLAY, of Glasgow, seconded the vote of thanks, which was carried with acclamation.

Mr. SNELL then called upon Alderman J. P. Smith, J.P., to read the following paper:

Some Statistics of Electricity Supply.

BY ALDERMAN J. P. SMITH, J.P., MEMBER OF COUNCIL, EX-MAYOR AND CHAIRMAN OF THE ELECTRICITY COMMITTEE, BARROW-IN-FURNESS.

In laying before the members of this association the following paper, the writer has done so for the purpose of enabling them to take a general survey of the present position of electricity supply as viewed from a commercial standpoint, and the progress which has been made in the industry during the last seven or eight years. It is to be hoped that some committee members will take part in the discussion on this paper, the subject of which should interest especially all chairmen of committees, for it must not be forgotten that when the balance-sheet at the year end is not satisfactory, it is those gentlemen who have to explain it to their colleagues and defend their engineer and station as best they can. The difficulty and danger of dealing with figures has not been overlooked, nor the fact that with a little careful selection and manipulation they can be made to prove almost anything, but in this case the figures have not been *selected* to try and prove any theories previously held, but rather the whole of the available returns are presented for examination to see whether any instructive lesson can be deduced therefrom.

TABLE I.

SUMMARY OF ELECTRICITY UNDERTAKINGS.

		Local Authorities.	Companies.	Total.
1	Works in Operation ..	204	103	307
2	Works under Construction ..	104	36	140
3.	Orders Obtained ..	114	19	133
		422	158	580

TABLE II.

OUTPUT.

Year.	Companies. No. of Co.	Companies. Capital. £	Municipalities. No. of Stations.	Municipalities. Capital. £	Companies. No. of Co.	Companies. Units.	Municipalities. No. of Stations.	Municipalities. Units.
1896	38	5,831,073	33	1,967,050	27	20,560,128	33	9,637,638
1897	58	6,647,792	57	3,509,317	34	25,465,302	48	17,837,874
1898-9	70	8,407,028	93	5,734,938	39	32,964,125	56	27,101,351
1899-0	87	9,165,793	124	8,531,167	41	42,672,341	64	42,476,726
1900-1	108	12,434,827	169	13,776,372	82	50,883,927	111	68,232,688
1901-2	142	18,553,390	191	19,165,405	107	71,200,691	151	165,232,043
1902 3	157	21,560,199	213	23,417,410	92	84,404,279	178	162,505,417

It will be seen from the *Electrical Times* quarterly returns, that the number of municipal stations in operation is practically double of the companies, while of the works under construction the proportion is nearly 3 to 1, and of the orders still to be put into operation, almost the whole are in the hands of the municipalities, many of whom, however, it is to be feared are only using them for a purpose for which they were never intended—viz., to keep out a private company. This is a practice very much to be condemned, and it seems a pity that the Local Government Board have not seen their way to try and stop it. In the earlier days of the industry, most of the pioneer work was done by companies, to whom great credit is due, but the majority of municipalities soon saw the advantages to be derived from having the control of such an important and profitable undertaking in their own hands, and it is an interesting and notable fact that 15 towns and cities who allowed private enterprise to step in and take up this work at the commencement have since seen the folly of that course, and have bought them out (often at a very big price). In no case has a municipal supply when once started been transferred to a company. According to this table, taken from *Garcke's Manual*, both classes of stations are going ahead very nicely, but the local authorities, which for the first four years given were far behind the companies, have now made up all arrears and are well ahead, especially in the matter of output, which has grown enormously of late—probably due in no little degree to supply for motive power and traction.

TABLE OF CAPITAL OUTLAY PER KILOWATT.

The great importance of the question of capital expenditure, and the heavy burden in the shape of interest and sinking fund which unfortunately accompanies it, and which tells so very severely in our profit and loss accounts, justifies us in examining very carefully into this matter with a view to seeing whether there is any likelihood of an improvement in the future.

Table IIIa (*Corporations v. Companies*) deals with the question as between municipal stations and those owned by companies, and it is very gratifying to notice that, whatever the system in vogue, the municipalities show much the better results. Thus, in the case of alternating plant it is only £92 per kilowatt, as against £106, whilst a comparison of continuous-current stations shows an outlay of £89 against £129; or by grouping the whole of the stations together, the cost to municipalities is £90, and of companies £117. These figures cover a period of eight years, totalling altogether 829 returns, and in the case of the last year extend over no less than 182 separate stations, and may, therefore, be taken as a pretty reliable estimate of the cost per kilowatt installed. It is to be hoped that they will satisfy the most rabid anti-municipalist that in electricity supply stations at least local authorities obtain good value for the money spent. There is one feature about these returns which is not very encouraging—viz., that the very heavy expenditure for every kilowatt installed does not show any signs of reduction as time goes on. The figures fluctuate a little from year to year, but do not show any definite signs of either improvement or the reverse.

TABLE III.

CAPITAL OUTLAY PER KILOWATT.

IIIa. CORPORATIONS v. COMPANIES.

Year.	Corporations. Continuous. No.	Corporations. Continuous. Cost.	Corporations. Alternating. No.	Corporations. Alternating. Cost.	Corporations. Total. No.	Corporations. Total. Cost.	Companies. Continuous. No	Companies. Continuous. Cost.	Companies. Alternating. No.	Companies. Alternating. Cost.	Companies. Total. No.	Companies. Total. Cost.
		£		£		£		£		£		£
1894	10	89	8	85	18	87	11	129	14	120	25	124
1895	17	89	19	86	36	87	17	130	13	92	30	114
1896	24	89	26	103	50	96	17	133	14	100	31	116
1897	28	96	32	103	60	99	20	132	16	109	36	121
1898	28	95	38	97	66	96	22	123	16	114	38	118
1899	34	88	39	87	73	87	25	117	14	114	39	115
1900	48	81	49	92	97	86	31	130	17	107	48	121
1901	78	85	51	81	129	83	34	127	19	99	53	113
Average for 8 years—		£89		£92		£90		£120		£106		£117

IIIb. CONTINUOUS v. ALTERNATING.

Year.	Continuous. Corporations. No.	Continuous. Corporations. Cost.	Continuous. Companies. No.	Continuous. Companies. Cost.	Continuous. Total. No.	Continuous. Total. Cost.	Alternating. Corporations. No.	Alternating. Corporations. Cost.	Alternating. Companies. No	Alternating. Companies. Cost.	Alternating. Total. No.	Alternating. Total. Cost.
		£		£		£		£		£		£
1894	10	89	11	129	21	109	8	85	14	120	22	103
1895	17	89	17	136	34	112	19	86	13	92	32	89
1896	24	89	17	133	41	111	26	103	14	100	40	101
1897	28	96	20	132	48	114	32	103	16	109	48	106
1898	28	95	22	123	50	109	38	97	16	114	54	105
1899	34	88	25	117	59	102	39	87	14	114	53	100
1900	48	81	31	136	79	108	49	92	17	107	66	99
1901	78	85	34	127	112	106	51	81	19	99	70	90
Average for 8 years—		£89		£129		£109		£92		£106		£99

Table IIIb (*Continuous v. Alternating*) deals with the same question, but is arranged rather differently to show a comparison as between alternating and continuous current systems. It will be seen that in the case of corporations the balance is slightly in favour of continuous, whilst in the case of companies it is very strongly the other way, and taking the whole of the returns together, the alternating system comes out slightly the cheaper.

TABLES OF COST OF PRODUCTION.

These tables are arranged in the same way as the preceding ones, but show the cost of production, and on the whole are more encouraging. For the first three or four years the reduction of costs was fairly rapid, but during the last two or three years has remained almost at a standstill. It must be remembered, however, that the lower the costs of production are reduced, the greater become the difficulties of still further improvements; and another factor in the case is the abnormal rise in the cost of coal in 1900 and 1901. The figures for 1901 show a decided gain on 1900 in all classes of stations, and when the returns of 1902 are available, it is confidently expected that a still further improvement will be recorded.

Table IVa.—Corporations v. Companies.—With the exception of the first year, municipal stations show much lower costs all round than those of companies, the average of all the returns available being 2·75, as against 3·3, a notable saving of over ½d. per unit.

Table IVb.—Alternating v. Continuous.—Alternating plants run by local authorities show an increased cost of production over continuous in the proportion of 3·1d. to 2·4d., a difference of ·7d. per unit in favour of continuous. In the case of company stations, both systems show the same results. By grouping all the returns together, a balance of ·35d. per unit in favour of continuous is observed. In comparing the two systems, however, we must not forget that the districts which were most favourable to electricity supply were those where continuous-current stations were first erected, and it was not until the alternating system was introduced that the more sparsely populated towns were taken in hand. It must be mentioned, however, that in both these tables all figures for

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repairs in any first year have been ignored for obvious reasons. With a view to seeing how far it is possible that the costs of production might be reduced in the near future, without assuming any radical change in the present methods of generation, two imaginary costs sheets have been prepared. The first one (IVc.) is obtained by taking the absolute lowest figures for each item, as shown in the *Lightning* Analysis, and combining same. The result is a total cost of ·78d. per unit. The item of ·02 sinking fund for Stepney is, however, quite out of the ordinary, and is bound to be misleading, but if we substitute the next lowest, Shoreditch, which is ·19d., then the total would be ·95d. The second table (IVd.) is one which is more likely to obtain in practice, and is made up by taking the average of the 10 lowest costs in each item, and this gives a total of 1·41d. In connection with the cost of production, it will be generally conceded that there are very many factors which have an important bearing on this, but the three which are usually considered to have the greatest influence on costs are output, load factor, and cost of fuel. In order to see how this works out in actual practice, four tables have been compiled. The first one consists of the 40 stations having the largest output (all but two having an output of 1,000,000 and over). The second table gives the 40 stations with the highest load factor (the highest being 29·4 per cent., and the lowest 14 per cent.). The third table shows the 40 stations with the lowest costs per unit for fuel (the figures varying from ·16d. to ·60d.); and the fourth gives the 40 stations with the lowest total costs (the extremes being ·96d. and 1·75d.). Referring first of all to the influence of *output* on costs, we find that out of the 40 stations with the highest output, only 24 appear in the list of the 40 lowest costs. Turning next to the influence of *load factor*, it is seen that there are only 23 appearing in the table giving the best results; and, finally, the importance of low fuel costs is shown by the fact that out of the 40 best returns, 29 appear in the list of lowest total costs. All these figures tend to show that no *single* favourable factor is in itself sufficient to command success, and that no station engineer need be discouraged because the works under his control are only of moderate size. The figures given in this table are only for what is termed private supply, and do not include current supplied either for public lighting or traction purposes.

TABLE IV.

COST OF PRODUCING ONE (Board of Trade) UNIT.

IVa. CORPORATIONS *v.* COMPANIES.

Year.	CORPORATIONS.						COMPANIES.					
	Continuous.		Alternating.		Total.		Continuous.		Alternating.		Total.	
	No.	Cost.	No.	Cost.	No.	Cost.	No.	Cost.	No.	Cost.	No.	Cost.
		d.		d.		d.		d.		d.		d.
1894	10	3·3	8	4·5	18	3·95	12	3·5	14	3·9	26	3·70
1895	17	2·9	19	4·1	36	3·50	17	3·6	15	4·1	32	3·85
1896	24	2·5	26	3·7	50	3·10	18	3·5	16	3·7	34	3·60
1897	28	2·2	32	3·0	60	2·60	22	3·8	17	3·4	39	3·60
1898	28	2·0	38	2·5	66	2·25	22	3·3	10	3·2	38	3·25
1899	35	2·1	40	2·3	75	2·20	26	2·8	14	2·9	40	2·85
1900	48	2·2	49	2·7	97	2·45	31	3·3	17	3·0	48	3·15
1901	78	2·1	51	2·3	129	2·20	34	2·9	18	2·6	52	2·75
Average for 8 years —		2·4d.		3·1d		2·75d.		3·3d.		3·3d		3·30d.

IVb. CONTINUOUS *v* ALTERNATING.

Year.	CONTINUOUS						ALTERNATING.					
	Corporations.		Companies.		Total.		Corporations.		Companies.		Total.	
	No.	Cost.	No.	Cost.	No.	Cost.	No.	Cost.	No.	Cost.	No.	Cost.
		d.		d.		d.		d.		d.		d.
1894	10	3·3	12	3·5	22	3·40	8	4·5	14	3·9	22	4·20
1895	17	2·9	17	3·6	34	3·25	19	4·1	15	4·1	34	4·10
1896	24	2·5	18	3·5	42	3·00	26	3·7	16	3·7	42	3·70
1897	28	2·2	22	3·8	50	3·00	32	3·0	17	3·4	49	3·20
1898	28	2·0	22	3·3	50	2·65	38	2·5	16	3·2	54	2·85
1899	35	2·1	26	2·8	61	2·45	40	2·3	14	2·9	54	2·60
1900	48	2·2	31	3·3	79	2·75	49	2·7	17	3·0	66	2·85
1901	78	2·1	34	2·9	112	2·50	51	2·3	18	2·6	69	2·45
Average for 8 years —		2·4d.		3·3d		2·85d.		3·1d.		3·3d.		3·20d.

IVc.

Minimum Costs per Unit.

			d.	d.
St. Helens,	Coal	..	·26	
Oldham	Stores	..	·03	
Bradford	Wages	..	·09	
Ealing	*Repairs	..	·07	
				44
Nottingham,	Rent, &c.	..	·02	
Stockport	Salaries, &c.		·08	
				·10
				·54
Bootle	Interest	..	·22	
Stepney	Sinking Fund		·02	
				·24
				·78d.

Substituting Shoreditch ·19 for Stepney ·02, Total = ·95d.

IVd.

Average Minimum Costs (at 10 Stations) per Unit.

	d.	d.
Coal	·34	
Stores	·03	
Wages	·15	
*Repairs	·09	
		·61
Rent, &c. ..	·03	
Salaries, &c.	·13	
		·16
		·77
Interest	·42	
Sinking Fund ..	·22	
		·64
		1·41d.

*First year stations ignored.

TABLE IVc.

No.	Output. Town.	Output Units.	Load Factor. Town	Load Factor	Fuel Costs. Town.	Cost of Fuel	Total Costs. Town.	Total Costs.
				%		d.		d.
1	Liverpool ..	20,018,143	Bootle ..	19·42	Accrington ..	·16	Bolton ..	·96
2	Manchester ..	10,502,290	Liverpool ..	24·33	Monmouth ..	·19	Bradford ..	1·00
3	Glasgow ..	9,292,044	Stepney ..	22·74	St. Helen's ..	·26	Liverpool ..	1·00
4	Edinburgh ..	7,760,807	Shoreditch ..	21·99	Leeds ..	·27	Nottingham ..	1·01
5	Bradford ..	4,801,172	Leith ..	19·79	Wakefield ..	·28	Leeds ..	1·04
6	Brighton ..	4,680,480	Rathmines ..	19·18	Edinburgh ..	·34	St. Helen's ..	1·04
7	St. Pancras ..	4,749,560	Ayr ..	18·31	Leigh ..	·35	Edinburgh ..	1·07
8	Nottingham ..	4,094,897	Wimbledon ..	18·05	Glasgow ..	·36	Bootle ..	1·09
9	Birmingham ..	3,341,099	St. Helens ..	17·84	Burton ..	·84	Stepney ..	1·22
10	Bolton ..	3,130,709	Bolton ..	17·81	Bradford ..	·39	Southport ..	1·23
11	Leeds ..	3,066,165	Ashton-u.-Lyne	17·11	Burnley ..	·40	Leith ..	1·24
12	Bristol ..	2,756,624	Monmouth ..	16·88	Manchester ..	·41	Glasgow ..	1·27
13	Shoreditch ..	2,734,613	Pembroke ..	16·77	Govan ..	·42	South Shields ..	1·29
14	Halifax ..	2,557,648	St. Pancras ..	16·58	Bolton ..	·44	Sheffield ..	1·31
15	Sheffield ..	2,487,654	Sunderland ..	16·54	South Shields ..	·44	Darwen ..	1·34
16	Sunderland ..	2,375,557	Halifax ..	16·40	Wigan ..	·46	Crewe ..	1·37
17	Islington ..	2,186,044	Blackburn ..	16·26	Motherwell ..	·48	Dundee ..	1·37
18	Hampstead ..	2,127,173	Barking Town ..	16·00	Nottingham ..	·48	Motherwell ..	1·45
19	Blackpool ..	2,018,182	Stafford ..	15·94	Sheffield ..	·48	Halifax ..	1·47
20	Blackburn ..	2,002,141	King's Lynn ..	15·58	Dundee ..	·48	Blackburn ..	1·48
21	Dundee ..	1,856,943	Bradford ..	15·51	Halifax ..	·48	Ashton-u.-Lyne ..	1·49
22	Portsmouth ..	1,847,790	Brighton ..	15·36	swansea ..	·48	Sunderland ..	1·49
23	Croydon ..	1,810,387	Leyton ..	15·01	Bury ..	·49	Aberdeen ..	1·51
24	West Ham ..	1,583,421	Aberdeen ..	14·92	Southport ..	·49	Ayr ..	1·55
25	Aberdeen ..	1,546,589	Edinburgh ..	14·75	Stepney ..	·50	Huddersfield ..	1·58
26	Hull ..	1,490,099	South Shields ..	14·67	Liverpool ..	·50	Chester ..	1·59
27	Southport ..	1,464,407	Wigan ..	14·61	Newport ..	·50	Govan ..	1·62
28	Hammersmith ..	1,461,427	Govan ..	14·60	Huddersfield ..	·51	Leicester ..	1·63
29	Southampton ..	1,430,272	Ealing ..	14·52	Nelson ..	·53	Stockport ..	1·64
30	Bootle ..	1,427,683	Crewe ..	14·47	Leicester ..	·55	Wakefield ..	1·66
31	St. Helens ..	1,237,965	Bedford ..	14·36	Leith ..	·55	Leigh ..	1·66
32	Belfast ..	1,216,699	Southampton ..	14·28	Chester ..	·56	Wigan ..	1·68
33	Huddersfield ..	1,179,849	Southwark ..	14·23	Darlington ..	·57	Cheltenham ..	1·69
34	Derby ..	1,081,487	Southport ..	14·22	St Anne's ..	·57	Manchester ..	1·69
35	Leicester ..	1,042,302	Hammersmith ..	14·20	Gloucester ..	·58	Burnley ..	1·70
36	Oldham ..	1,042,066	Blackpool ..	14·18	Lincoln ..	·58	Swansea ..	1·71
37	Stepney ..	1,008,087	Chester ..	14·14	Bootle ..	·59	Brighton ..	1·72
38	Cardiff ..	1,006,763	Harrogate ..	14·08	Crewe ..	·59	Tynemouth ..	1·74
39	South Shields ..	986,646	Worcester ..	14·06	King's Lynn ..	·59	Worcester ..	1·74
40	Ashton-u.-Lyne ..	977,044	Croydon ..	13·94	Dewsbury ..	·60	King's Lynn ..	1·75

TABLE V.

AVERAGE PRICE OBTAINED (per Unit) FOR PRIVATE SUPPLY.

Year.	Companies.							Local Authorities.						
	7d. and	6d. and 7d.	5d. and 6d.	4d. and 5d.	3d. and 4d.	Over 1d. & under 3d.	Total.	Average Price obtained.	7d. and	6d. and 7d.	5d. and 6d.	4d. and 5d.	3d. and 4d.	2d. and under 3d.	Total.	Average Price Obtained.
								d.								d.
1896	6	11	12	5	..	..	34	6·01	..	13	23	12	2		50	5·38
1897	6	14	10	9	..	..	39	5·93	..	6	24	23	7		60	4·99
1898	3	15	11	8	1	..	38	5·74	..	1	21	32	11	1	66	4·68
1899	2	6	19	10	3	..	40	5·28	1	1	13	43	15	2	75	4·46
1900	..	7	20	15	5	1	48	5·02	1	4	15	48	26	3	97	4·36
1901	1	3	20	17	6	1	48	4·96	..	1	23	49	43	4	123	4·27

TABLE VI.

SINKING FUND.

VIa. PERCENTAGE TO CAPITAL EXPENDITURE (Average).

Year of Working.	1st.	2nd.	3rd.	4th.	5th.	6th.	7th	8th.
No. of Undertakings	110	96	81	73	66	53	42	20
Average Percentage	2·44	2·52	2·57	2·02	2·69	2·69	2·91	2·64

Year.	1894.	1895.	1896.	1897.	1898.	1899.	1900.	1901.
No. of Undertakings	16	37	51	60	67	79	100	126
Average Percentage	3·22	2·87	2·89	2·70	2·58	2·44	2·58	2·57

VIb. COST IN PENCE PER UNIT SOLD.

Year of Working.	1st.	2nd	3rd.	4th.	5th.	6th.	7th.	8th.
No. of Undertakings	108	95	81	73	66	53	42	20
Average Cost	1·24	1·03	·97	·92	·82	·75	·79	·76

Year.	1894.	1895.	1896.	1897.	1898.	1899.	1900.	1901.
No. of Undertakings	16	38	51	59	67	78	99	126
Average Cost ..	1·59	1·29	1·32	1·01	·92	·80	·80	·85

TABLE VII.

LOAD FACTOR.

VIIa. Year	1896	1897	1898	1899	1900	1901
No. of Undertakings	48	59	66	74	96	121
Percentage ..	9·49	10·42	10·79	11·48	12 48	12·76

VIIb. Year of Working	1st.	2nd.	3rd.	4th.	5th.	6th.	7th.	8th.
No. of Undertakings	69	75	71	66	61	49	42	19
Percentage	11·04	11·34	11·07	11·34	12·15	12·23	11·91	11·89

Table V.—The question of the price at which current is sold is one which has special interest for committeemen and others who stand to some extent between the producer and the con-

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TABLE VIII.

LOCAL AUTHORITIES.

FINANCIAL RESULTS OF ELECTRICITY UNDERTAKINGS for Years 1896-1901 inclusive.

No. of Undertakings.	Year.	Capital.	Revenue.	Total Costs.	Gross Profits	Interest.		& Sinking Fund.		Interest, Depreciation, and Sinking Fund.		Cost per Unit.	Trade Costs, including Interest, per unit.	Units Sold.
							per unit.		per unit.		per unit.			
		£	£	£	£	£	d.	£	d.	£	d.	d.	d.	
50	1896	3,471,496	405,613	193,182	207,431	86,316	1·05	94,006	1·14	180,322	2·19	2·42	4·61	19,691,042
60	1897	4,529,545	562,831	278,721	284,110	109,920	·86	111,457	·87	221,377	1·73	2·17	3·90	30,721,564
66	1898	6 673.340	793.754	388,169	405,585	149,228	·76	157,670	·80	306,898	1·56	1·97	3·53	47,204,576
75	1899	9,180,448	1,047,480	555,603	491,877	233,732	·81	188,739	·65	422,471	1 46	1·91	3·37	69,562,652
97	1900	13.129,532	1,518,434	903,980	614.154	260,855	·57	270,523	·60	531,378	1·17	2·0	3·17	108,681,443
123	1901	16,905,034	1,995,821	1,067 963	927,858	478,181	·74	367.769	·57	845,950	1·31	1·65	2 96	154,615,339
471			6,323,933	3,392,618	2,931 315	1,318,232	·73	1,190,164	·66	2,508,396	1.39	1·89	3·28	430,476,615

sumer, and it is gratifying to find from Table V. that there is a steady reduction year by year in the price charged. During the six years dealt with the companies have reduced their average charge from 6·01d. to 4·96d., a difference of 1·05d. per unit, whilst the corporations, although starting from the lower level of 5·38d., have been able to reduce their charges by a still greater amount of 1·11d., bringing down the price to 4·27d. It will be observed that, taking the last year's returns available—viz., 1901—that no less than 50 per cent. of the companies are obtaining 5d. per unit and over for their current, whilst in the case of corporations only 19½ per cent. obtain such a large rate of revenue. This is an important point to notice, as municipalities are often twitted with showing a very poor return on the capital expended. They can at least point to the fact that they are supplying their consumers at a much lower rate than is the case with private companies. Had the municipal stations charged the same rate as the companies they would have enjoyed an increased revenue during 1901 of no less than £444,519, equal to 2·62 per cent. on the capital invested.

Interest and Sinking Fund.

Many are the troubles and worries which beset the electrical engineer in his efforts to give a continuous and steady supply, and numerous are the difficulties which bar the way to such a substantial reduction of price as will enable him to realise the forecast of Sir William Preece and make electricity the poor man's light. Discussions innumerable have taken place as to what is the real cure to be sought for, and free lamps, free wiring, prepayment meters, utilisation of water power, maximum demand meters, hiring out of motors, etc., all have their advocates. But in the opinion of the writer the biggest bugbear in the whole business is the abnormally heavy payments for interest and sinking fund; and if the heart of a chairman of committee is not too hard to receive any impression at all, surely these three fatal words would be revealed by a post-mortem examination. How often do we scan the records in the weekly analysis and read something of this sort?

	Revenue.	Expenses.	Gross profit.	Int. and S.F.	Net profit
No. 1 ...	£60,000	... £35,000	... £25,000	... £24,500	... £500
No. 2 ...	86,000	... 35,000	... 52,000	... 42,000	... 10,000
No. 3 ...	168,000	... 83,000	... 85,000	... 66,000	... 20,000
No. 4 ...	24,000	... 14,000	... 10,000	... 12,500	... -2,500

It is not the amount of these sums which appals one, but the relation which they bear to the total costs. Take the case numbered 2, the figures are not absolute, but quite near enough for our purpose. Here we find a well-managed station where the costs bear a very favourable comparison with the receipts, and yet out of the very handsome apparent surplus there has to be taken a further sum for interest and sinking fund, actually more than the whole of the rest of the costs put together. This may seem an extreme case, but an examination of a series of very lengthy tables which the writer has prepared show that in this particular town the cost of sinking fund per unit sold is rather under than over the average. The rate of interest at which our municipal authorities borrow money is so nearly alike in different towns that the writer did not think it worth while to go into this question in detail. Table VIII., however, gives the average for each year.

The question of sinking fund is, however, much more intricate, and the practice varies very much. As is well known, the London boroughs obtain money through the London County Council on a 42 years' repayment system, whilst most other boroughs are only allowed 25 years by the Local Government Board. In some towns powers have been taken under various old local Acts—in many cases for very long periods. In Glasgow, for example, under the old borrowing powers (which are now, the author believes, exhausted) the repayment spreads out up to 62 years. Tables have therefore been prepared showing both the cost per unit sold, and also the percentage to average capital invested; and to still further probe this question, these have been arranged in two ways—first, giving the results for each year from 1894 to 1901 inclusive, and, second, giving the figures according to the year of working from first to eighth.

Table VIa.—As far as percentage to capital is concerned, it is bound, more or less, to follow the question of capital expenditure, and yet it is satisfactory to notice that the percentage fell from 3·22 in 1894 to 2·44 in 1899. Since then, however, it shows a slight rise. In connection with this, it may be interesting to note that while in the case of municipalities the charges for sinking fund in 1901 amounted to 2·57 per cent., and in the case of companies for the same year it works out to only 1·09 per cent., 10 out of 51 companies making *no* allowance whatever under this head.

Table VIb.—The cost per unit sold, however, does show some improvement, and this may be expected to still further improve as the load factor continues to rise. It should perhaps be stated that these tables are compiled almost entirely from the well-known *Lightning* analysis, and in some few cases the amount set down as sinking fund also includes sums set aside as depreciation, renewals, etc., in addition to the sinking fund, as required under statutory obligations. The full tables are unfortunately much too bulky for the *Proceedings*, but a summary of each is given. The individual figures vary very much, and excluding first years, which are often quite fictitious, the highest cost per unit is a medium-sized manufacturing town, where for the second year the figure is no less than 4·09d. per unit, and even in the third year is practically 3·0d. (2·99d.). In another case, and this one of our large cities, the charge under this head is 1·6d. on the seventh year's working. Another town of medium size is paying 1·45 at the end of eight years' running, and in another case 1·79 on the fourth year of operation. There is no doubt that the reduction in the cost per unit is due to the improvement of the load factor, and it is gratifying to find from Table VIIa. how steadily this is increasing, having risen from 9·49 per cent. in 1896 to 12·76 per cent. in 1901.

Table VIIb., however, reveals the somewhat curious fact that the age of a station does not seem to have such a marked effect on the load factor as one would expect. A glance at Table VIII. will show perhaps better than anything else what an incubus these capital charges really are. Taking a summary of six years we find the following:

Total revenue		£6,323,933
,, costs		3,392,618
Gross profits		£2,931,315
Capital charges—Interest	£1,318,232	
Sinking fund	1,190,164	
		2,508,396
Net profit		£422,919

As to the effect on the cost of production, this may be summarised as follows:

Ordinary total cost of producing one unit		1·89d.
Capital charges—Interest	·73d.	
Sinking fund	·66d.	
		1·39d.
Total cost		3·28d.

There are really two separate points in connection with these capital charges which ought not to be confused. The first is the heavy capital expenditure for a given revenue-earning capacity, and the second is the short term for repayment which is allowed by the Local Government Board. As to the first, it is only natural, perhaps, to compare with the rival lighting concerns, and see how far the gas industry is affected. Taking the author's own town of Barrow as an example of an excellently managed and very successful municipal gas undertaking and comparing it with our own electricity works, we find that in the case of the former the revenue amounts to no less than 36·3 per cent. of the capital invested, whilst in the latter it is only 10·1 per cent. To put it in another way, the Gas Com-

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mittee in order to produce £1 of revenue have only got to invest about £2. 15s., whilst the Electricity Committee have to spend no less than £10.

The fact of having to lay out more than three times the capital in order to produce the same revenue is surely in itself a sufficient handicap to the electricity undertaking; but when we consider the second phase of the subject—viz., the short period allowed for repayment—it makes matters much worse. Reverting again to the comparison at Barrow, we find that the gas undertaking, with a capital of £116,500, is only compelled to repay £1,056 for the year, whereas the electricity undertaking with a capital of less than half—viz., £54,846—is under obligation to repay actually more—viz., £1,079—the percentage working out in the one case at 0·9 per cent. and in the other 2·34 per cent. Apart from these capital charges the electricity undertaking would compare very favourably, the gross profit being 37·8 per cent. of the revenue, whilst in the case of gas t is only 25·4 per cent.

It may be a perfectly good subject for discussion, whether the 25 years allowed by the Local Government Board or the 42 years of the London County Council is the fairer; probably 30 (with perhaps 35 in some cases) would be about right, but the writer would prefer to err if anything on the side of safe and sound finance, if only the "powers that be" would see the necessity and advisability of suspending the sinking fund for the first three years. No one who has the interests of municipal trading really at heart would object to a repayment of capital on sound and safe lines. To build up a strong reserve fund (call it what you like) before contributing to the relief of rates ought to be the leading object of any electricity committee, but what we *do* object to, and that very strenuously, is being *compelled* to build up this reserve *out of the rates* in the first years of an undertaking when no profits are being made. It is this fear of a call on the rates, in the earlier stages, that causes 19 out of 20 stations to be built on such narrow lines, that extensions are wanted before even the original scheme is completed, and waste of capital results, which brings about the very evil which it is sought to avoid. So much was said on this subject during the past year that the author was loath to touch on it, but felt that a paper dealing with electricity supply from a financial point could not be complete without at least a reference to it.

Mr. W. A. CHAMEN, of Glasgow, opened the discussion, and said that the paper was a difficult one to criticise, and one which would be of great service to the members of the association. In the last part of the paper Alderman Smith had compared the working of gas and electric light undertakings. He had recently looked through the accounts of the Glasgow gas department and found that the cost of coal was 40 per cent. of the total revenue. In their electricity department the coal bill was only 12 per cent., which seemed to him to suggest that they had still a considerable margin to draw upon. He agreed with the author that a standard for the duration of electric lighting loans should be adopted throughout the country. It was a mistake to think they could now get loans for 62 years in Glasgow. Under their new Bill they had to repay at the rate of $2\frac{1}{2}$ per cent. per annum.

Mr. VESEY BROWN, an old member of the association, commented on the first few paragraphs of the paper. He argued that local authorities with small areas were now finding it more advantageous to transfer their provisional orders to private companies. He did not agree with the figures given in Table III., as he thought they made no allowance for the fact that a good number of the corporations supplied their own tramway systems, whereas only one company had a tramway load. He gave individual instances to show that the cost per kilowatt was frequently lower for companies than for local authorities in towns of the same size. The costs in the case of companies was also higher, because they had not street-lighting or tramways. As regards the depreciation in the case of companies, he thought that where large dividends were paid the shareholders should divide individually for depreciation out of these dividends.

Major-General WEBBER complained that companies were not placed on the same footing as local authorities with respect to rating and to the charges made for road repairs. High rates seriously handicapped the London company, and he thought in this respect the local authorities had a very great advantage. At the time Paris was divided up into secteurs for electric lighting purposes, this was provided against by a clause which fixed the maximum tax for rates at 10 or 11 per cent. on the income, which would otherwise be received by shareholders. In London the companies had to pay from 11 to 17 per cent. of their profits to the local authorities in rates. This income was not usually taken into account when considering the relative advantages of company and municipal management.

Bailie WILLOCK, of Glasgow, did not agree with Mr. Vesey Brown on the question of company finance. He thought that the directors in early years declared dividends without providing for depreciation, whereas local authorities had to pay their sinking fund charges even before the plant was used. At Glasgow they had gone most carefully into this matter. A few years ago they were supplying from a small station, which was completely filled with machinery, and which was worked to its utmost limits as regards output. In consequence, they had a large surplus at the end of the year. After Mr. Chamen joined them they had to lay down large new works, which they had to depreciate before they could be used, and in consequence the surplus had decreased. At the present time the small station was practically shut down, and they were going to sell the plant, which would have been quite able to supply the original load for which it was intended for another 50 years. This showed the need for depreciation funds, and he only hoped they would make as good prices for their old plant as Mr. Snell had succeeded in doing. He pointed out that the Government had very distinct views as to what was the profit of the undertaking, and insisted that in Glasgow they should pay income tax on their whole surplus of £24,000 before anything was written off for depreciation or reserve. He, personally, was in favour of writing off depreciation rather than establishing large reserve funds, which might be called upon at some time for the relief of the rates. They had quite decided on his Council that none of their undertakings should contribute to the relief of the rates, but that any reduction which could be made should be given to the consumers.

Bailie MACKENZIE, of Edinburgh, thought it was only an idle waste of time to compare the working of company with corporation undertakings. He thought that the fault in corporation management was that the fear of the November elections influenced sometimes the actions of the councillors. They had last year in Edinburgh earned the substantial profit of £14,000. When the report came before the Council last week, certain members demanded that £5,000 of this should be handed over for the relief of rates. It was this kind of proposal, brought forward by councillors who had not really considered the matter, which he so strongly deprecated in municipal control. He, personally, preferred a large reserve fund to writing off much depreciation, as with a reserve fund you had the money at hand. He believed in the municipalisation of such things as electricity, water, and gas, but strongly deprecated councils going into the supply of accessories and other small trading work.

Councillor SCOTT, of York, referring to Mr. Vesey Brown's remarks, said he did not share that gentleman's ideas of company management. He thought the directors did not pay high dividends in order that the individual shareholders might make their own reserve funds, but in order to increase the price of shares which afterwards would be unloaded on the public. He thought that all the figures in the paper were in favour of the municipal undertakings.

Councillor J. E. PANTON, of Bolton, said that he had worked out similar figures to those given in the paper some years ago, and that the advantages of municipal ownership was clearly shown before electric tramways were started. The reason, he thought, for the higher capital expenditure of the companies was that they often paid in shares instead of in cash for their machinery. He would point out to Major-General Webber in the country the local authorities had not anything to do with the rating. Having analysed accounts, he found that the municipal undertaking on an average provided twice as much for depreciation as did the companies.

Mr. W. L. MADGEN strongly resented the remarks of Councillor Scott as to the integrity of company directors. With respect to Table III., which showed an average cost of £90 per kilowatt for the municipalities as against £117 for the companies, the figures did not include a certain amount of preliminary expenses. The comparison also

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neglected the question of the length of mains. When considering the figures of cost, it should be remembered that the success at Liverpool and Leeds had been gained under company management. In his opinion, there was more credit due to the engineer who could make a small undertaking successful. He concluded by suggesting that the paper might better be termed "early thoughts on electric supply."

Alderman SMITH, in reply, said that the difference introduced by tramway plant was exceedingly small. As a rule, with the tramway undertaking the corporation had to supply feeders, and he had found that the ratio both in cost and management in favour of corporation management had not altered of recent years. The discussion had taken up the controversy between the two systems of management. He had not intended that this should be so, but it must be remembered that the war had been commenced by the company exponents, who complained that the corporations had not provided for depreciation. Enquiry had shown that the companies themselves were more to blame in this matter. He was sorry to hear for the first time from Mr. Madgen that the figures published regularly in *Lightning* were not correct, as they had been largely used throughout the country.

A hearty vote of thanks to Alderman Smith was then given, and the following paper by Mr. W. A. Chamen was taken as read.

The Possibilities of Future Economies in Electrical Illumination.

BY W. A. CHAMEN, CITY ELECTRICAL ENGINEER, GLASGOW.

The question of possible future economies in electric illumination is one of very considerable importance. There is hardly need to point out that if the economy is brought about by consuming a smaller amount of energy to produce a given amount of light, the ultimate result is not a reduction of revenue to the undertaking, but an increase, owing to the larger number of consumers who adopt electric light in preference to the older means of illumination, as well as to the more generous use of it by existing consumers. There is also another advantage to the undertaking in the reduction of the proportion which the peak lighting load bears to power or other day load, though it may be some time before this becomes noticeable. The subject of possible economies in illumination, however, covers a wider field than the saving in consumption of energy, for any reduction which can be made in the cost of maintenance of the lamps, and particularly in the trimming and attendance on arc lamps, may come within the scope of this paper. No doubt the question of cost of production of energy also might fairly be treated as part of the subject, but it is not proposed now to deal with that matter at all.

Our attention is naturally drawn first to the ordinary incandescent lamp as we know it to-day and have known it for some years past. Is there any probability that the carbon filament is capable of being worked, with satisfaction as to its lasting properties, at any materially higher efficiency than the 3½ to 4½ watts per candle-power to which we are accustomed? The outlook in this direction does not seem very encouraging, though some 8-c.p. 250-volt lamps recently tested in Glasgow have started with an efficiency of 3½ watts per candle, while after 600 hours of burning the efficiency has not gone below 4½ watts per candle, thus showing that this degree of efficiency is not confined to lamps of 16 c.p. or over. Some 12 months or more ago an incandescent lamp bearing the name of "Crawford-Voelker," was brought out, having a filament alleged to be made of some carbide and promising considerable improvement in efficiency as well as long life. As, however, nothing has been heard of this lamp for some time, it must be assumed that some difficulties have arisen in its manufacture which have so far prevented its coming into the market.

The next lamp to claim our attention is a departure from the ordinary filament in vacuum. It is the now fairly well-known Nernst lamp. In Glasgow alone it is stated that there are about 10,000 of these lamps in use in ordinary consumers' premises. A large number of them have been in use in Buckingham Palace for some 13 months past and have given great satisfaction, having reduced the consumption of current by about 50 per cent. The large clock at the Houses of Parliament has also now been lighted by Nernst lamps, and very satisfactory starts have been made in its adoption for street-lighting at Maidstone, Barking, Barnes, Colchester, Gravesend, Erith, and Brighton, and experiments in this direction have been in progress in Glasgow for over six months past. Indeed, it is a question whether the Nernst lamp should be classed as a possibility of the future or not rather a realisation of the present time. The results of recent experience from several different sources show that an average life of 600 hours is by no means too much to expect, and doubtless this figure will be improved upon as time goes on. As regards economy, the claim put forward is that, light for light, the Nernst lamp consumes about half the energy consumed by the ordinary carbon-filament incandescent lamp. Assuming the useful life of the latter to be about 800 hours, and that, roughly, eight lamps of 16 c.p. will give as much light as one one-ampere 250-volt Nernst lamp, it will be seen that at an efficiency of four watts per candle some 409 units will be consumed by eight ordinary 16-c.p. lamps in 800 hours, the cost of which, at, say, 4d. per unit, equals about £6. 16s., to which must be added the cost of renewals—viz., eight lamps at, say, 1s. each = 8s., or a total of £7. 4s. With the Nernst lamp the cost of energy will be about £3. 8s., to which must be added the cost of renewals, or, say, one and one-third times 3s. 6d. (if we include the resistance as well), say 4s. 8d., a total of £3. 12s. 8d., being a saving of £3. 11s. 4d., or nearly 50 per cent. This is a good margin to allow for even more frequent renewals of Nernst filaments, etc., and the average Glasgow consumer has not been slow to grasp the point, particularly in business premises, where the charge for energy is 6d. per unit for the first 365 hours' use of maximum demand, and 1d. per unit for all further quantity. The fact that the filament requires heating before it will conduct the current, an operation requiring about half a minute, is against the Nernst lamp to some extent, but in many cases it is of no real consequence. It is, so far, not made in very small sizes, the smallest absorbing one quarter of an ampere (which equals, at 250 volts pressure, about as much energy as is consumed by one ordinary 16-c.p. lamp), but giving a light of fully 32 c.p. This is too large a unit of light for ordinary domestic use, and, combined with the last-named disadvantage of not lighting immediately when switched on, is, perhaps, the reason why it has not found its way to a larger extent into private houses. For perfection of lighting, however, in a large room, a one-ampere Nernst lamp fixed near the ceiling, with a nearly opaque shade beneath it, so that nearly all the light is reflected off the ceiling, is hard to beat.

It is not within the scope of this paper to discuss the details of manufacture of any lamp, but one cannot help remarking that as substances are evidently known which will give off a brilliant light when heated to a moderate extent, as in the incandescent gas mantle and the Nernst lamp, there is no apparent reason why some combination of carbon filament with one or other of these materials should not be evolved, which will combine the advantage of instantaneous lighting with that of high efficiency. This, however, is no new idea, as many inventors are said to have been at work taking out patents for various combinations. Perhaps a little more work in the laboratory and a little less at the patents might have produced the result we are now awaiting. The "Meridian" lamp, which is apparently being made by the General Electric Company of America, may be a step in this direction, though no information as to the composition of its filament is at present available. It seems only to be made in one size of 55 c.p., and the efficiency claimed for it is a consumption of about two watts per candle. No lamps can, however, be obtained to experiment with up to the time of writing this paper.

In passing away from filament lamps our attention is first attracted by the Hewitt mercury vapour lamp, which is now well known by repute to most electrical engineers, but which has been seen, perhaps, by comparatively few. It consists of a glass tube about 1in. in diameter and some 3ft. or 4ft. long, having a bulb at the bottom containing mercury and an iron electrode at the top. The tube is hermetically sealed, and the air is exhausted to a considerable degree. The electric current is passed through the tube from the electrode at the top, which is connected to the positive pole of the circuit to the mercury in the bottom. The working pressure for a tube some 3ft. or 4ft. in length is about 100 volts, but a much higher pressure is required to start it. This is produced by the insertion of a simple self-induction coil connected in the lamp circuit and coupled up with a switch in such a way that the tube can be momentarily short-circuited, thus putting the coil direct on to the 100 volts pressure. On breaking this switch the kick or extra E.M.F. produced by the coil forces a passage through the tube, starting the mercury into vapour, and immediately a steady current commences to flow. The light at first is tinged with purple, but as the tube warms up it becomes whiter. The peculiarity of the light itself is that there are no red rays in it, and its effect upon the beauty of a rosy complexion is disastrous. This cannot, of course, be set right by making the tube of red glass. A plate of red glass, which will let through floods of red light from a ray of sunshine, acts almost like a total eclipse when applied to the Hewitt lamp.

Here again, however, it would seem possible by means of combination—that is to say, by mixing something with the mercury—to produce light of a different character, having red rays in it, which would remove this one objection. Even as

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it is, it could be used for street-lighting and similar purposes with great advantage, for its economy is of a high order, the consumption of energy being only about half a watt per candle-power, or about the same as that of the ordinary open-type arc lamp. It is claimed that the lamp can be made in any size, from a tube ⅛in. diameter and 3in. in length to 3in. diameter and 12ft. in length, while the range of illumination may vary from 16 c.p. to several thousands, according to the size of the tube. Voltage seems to present no difficulty, as lamps can be made to work at any pressure from 50 to 500 volts. A peculiarity of the lamp, apart from its light, is that the current will only pass through it in one direction—viz., from the iron to the mercury (if we are right in saying that the current flows out along the positive wire and back the negative). Alternating current will not pass through the lamp, and a modification of it is made, called the "Hewitt static converter," which will let through only those waves of alternating current which are above or below the zero line, as the case may be. This recalls to one's mind the amusing remark made by Mr. Mordey some years ago that "one of the great advantages of alternating current was the impossibility of using accumulators with it." The Hewitt lamp seems to have a great future before it. One cannot but feel that the absence of red rays is an objection that will be overcome. Its economy leaves little to be desired if it can be maintained in small sizes, and its length of life seems to know no limit, except that after every 1,200 or 1,400 hours of use the tube requires opening and washing out. It is then, when re-exhausted, as good as new.

Turning our attention now to arc lamps, we find by mixing various substances with the carbon during the process of manufacture that it becomes possible to completely alter the nature of the electric arc flowing between carbon points as we have known it hitherto. The arc, for instance, in the Bremer and other arc lamps of the "flame" type is much prolonged and the light can be coloured with various tints, the most common and, probably, the most satisfactory being yellow, somewhat approaching orange. Instead of the light being almost entirely emitted from the crater of the positive carbon, it now proceeds from the carbon particles or vapour froming the arc itself, which in many respects resembles a gas flame, as the name given to this type of arc lamp implies. The efficiency of the light is also very largely increased, for instead of the consumption of half a watt per candle, which is usually obtained with the ordinary 10-ampere arc lamp of the open type, it is now reduced to about a quarter of a watt per candle. There are, however, still some objections and difficulties to be overcome before this type of lamp can come into general use for street-lighting. Firstly, the consumption of carbon is very much greater than with the ordinary type of arc lamp, thus necessitating trimming at more frequent intervals. Secondly, the light is not so steady as that of the ordinary arc, having a continual quiver rather like a badly burning gas flame. Thirdly, it does not seem to have been possible so far to produce a satisfactory burning lamp which will give the same candle-power as the present 10-ampere lamp with a consumption of only half the energy. All that has been brought about seems to be the doubling of the light without altering the present consumption of energy, and this is hardly what is required in ordinary street-lighting. The light given by an ordinary open arc of 10 amperes (which one may take as being in round figures 1,000 c.p.) is a sufficiently large unit for almost any class of street-lighting, and in many cases a 7½-ampere lamp is ample for the purpose. One cannot but feel, however, that all these difficulties will in one way or another disappear as time goes on and as various further improvements are developed.

Another departure in arc lighting is worth our attention—viz., the "very small current" arc lamp, consuming about one ampere and burning either with an enclosed or an open arc. That an arc can be maintained with so small a current with a fair degree of satisfaction seems to be beyond doubt, and the only question is whether in actual cost of maintenance it will prove cheaper than the Nernst lamp or the mercury vapour lamp. No actual experience appears to have yet been gained regarding the cost of maintaining these small lamps for long hours of burning, but it does not appear probable that they can do better than the Nernst lamp when one takes into account the cost of retrimming, etc. The enclosed arc lamp can scarcely be dealt with as a possible source of future economy, it having been for some years past a recognised and readily obtained marketable article. Beyond the fact that it increases the hours of burning without retrimming, there is not much to be said for it, as it certainly does not appear to reduce the consumption of energy per candle-power as compared with the ordinary arc. It has done considerable good, however, by spurring on the makers of the ordinary open-type arc lamp to produce lamps which will burn longer hours without retrimming, this being brought about by simply increasing the length of carbon which a lamp can take at one filling. The 38 or 40 hour arc lamp with two pairs of carbons is in use in most electric-lighted towns in the United Kingdom, the method of working usually being to trim alternate lamps each day, thus doubling the number of arc lamps which can be put under the charge of one trimmer and his mate, as compared with the old method, when the lamps would burn through one night only. At the present time 60-hour lamps are to be obtained in the market, and the Thames Embankment in London is probably one of the best instances of the adoption of this long-hour type of lamp. It obviously allows of every third lamp being trimmed each day, and thus of putting three times the number of lamps under the control of one trimmer and his mate, as compared with the old single-night lamps. There are rumours that even 80-hour lamps may be forthcoming, but it is well not to jump too hurriedly to conclusions.

In some towns raising and lowering gear is used upon the arc lamp-posts, the object being to enable one man—*i.e.*, the trimmer only—to go his round without the assistance of a mate to help him with the ladder. Whether there is any real economy brought about by the introduction of this hoisting gear is not quite clear. It obviously depends upon the original cost of the hoisting gear and the annual cost of its maintenance. Those engineers who have to deal with large numbers of arc lamps in big cities will doubtless feel more comfortable in their minds if they adhere to the fixed suspension arrangement which is mostly in use, as the risk of accidents in large cities is beyond question far greater than in provincial towns. It may be reckoned that the saving of labour by the adoption of 60-hour instead of 40-hour lamps would be about 11s. per lamp per annum, and in places where the number of arc lamps approaches a thousand or may be considerably more, this is a saving which amounts to a considerable total in the year. The possibilities of economy in the use of the ordinary arc lamp for street-lighting do not therefore appear to be yet exhausted.

To summarise, therefore, briefly the results of our enquiries, it may surely be stated without much stretch of imagination that the possibilities of future economies in electric illumination for all purposes are considerable, and even that we may hope to see the consumption of energy for a given amount of light cut down by something approaching one half of the present figure, besides reaping the benefits of other economies of maintenance, at any rate as regards street-lighting. This paper is necessarily very incomplete, but if it should serve to bring out further information in the course of this discussion, it will not have been written altogether in vain.

Mr. J. W. SWAN opened the discussion by commenting on the possible increases in efficiency of carbon-filament lamps. He thought that this improvement would be considerable, but it would involve the lamps being worked very near their breaking point, and hence on an extremely heavy voltage. The comparison made by the author between the carbon lamp and the Nernst lamp was not a fair one, because he had compared eight 16-c.p. lamps with a single Nernst lamp of 128 c.p. If a carbon-filament lamp of the same candle-power had been taken for comparison, the difference would have been much less marked, as the efficiency of such a lamp would be from 2 to 2½ watts per candle-power. The life of such a lamp would be long enough to make it economical, although he rather preferred smaller units, as they gave a more distributive illumination.

Mr. STONEY advocated the over-running of lamps even when they had to be renewed after 100 hours owing to blackening. He gave some good figures for the life of Nernst lamps, and said that a most excellent light was obtained by having a Nernst and a carbon lamp on the same bracket.

Mr. A. E. HOADLEY, of Maidstone, gave some figures he had obtained for Nernst lamps for street-lighting. He found that if the rod lasted for over a few hours, it would stand, as a rule, over 700 hours. He thought that the shape of the burner needed to be altered to be more suitable for reflectors to spread the light economically. In this respect the form of the incandescent light burner was a great advantage to its users.

Mr. W. L. CHAMEN, in reply, thanked Mr. Swan for his remarks, and also Mr. Hoadley. He said that, in spite of the theoretical advantage of small candle-power lamp for giving a distributed light, the larger units were more used in practice.

The company then adjourned to the town hall, where they were entertained to lunch by the Mayor and Corporation.

(To be continued.)

Book Received.—Mr. Edward Stanford, London, has published "Annals and Aims of the Pacific Cable," edited by Mr. George Johnson. The price is 6s.

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TRADE NOTICES AND NOVELTIES.

Crompton 250-kw. Three-Phase Alternator for Bloemfontein (South Africa) Corporation.

This alternator, of which we give an illustration herewith, is of Messrs. Crompton's standard three-phase pattern, designed for an output of 250 kilo-volt-amperes at 2,200 volts per phase, the periodicity of the circuit being 50 complete cycles per second. The machine has a stationary armature, the coils being fitted in open slots, and held in position by hardwood dovetails. The armature can be moved along the bedplate to give access to the machine, a barring rack being provided on the bedplate for this purpose. The end windings are fully protected by suitable end covers, one of which is arranged to form a terminal box for the main current. The field magnets are of the rotating type, with radial poles, the pole-pieces being laminated and bolted to a cast-steel hub. The hub is extended to form a half coupling, and connected direct to the flywheel of the engine, strains on the shaft thus being avoided. A direct-coupled exciter of the multipolar type is mounted on an extension of the alternator spindle. The engine is of Messrs. Belliss and Morcom's three-crank triple-expansion type, designed to work on 160lb. steam pressure at the stop valve, and capable of driving the generator either condensing or non-condensing. The speed of the combined set is 375 revolutions per minute. Two of these sets were built by Messrs. Crompton and Co. for the Bloemfontein Corporation under the specification issued by Mr. Robert Hammond, and at the official tests at Messrs. Belliss's works the machines exceeded in every way their guarantees, as shown in the table given below :

	Specified.	Actual.
Temperature rise after 10 hours' run at full load—armature	65° F.	39° F.
Ditto field	65° F.	18° F.
Steam consumption in pounds per kilo-watt-hour	26	24·4
Voltage drop from no load to full non-inductive load	7 %	4·5 %
Exciting watts	3,500	2,100

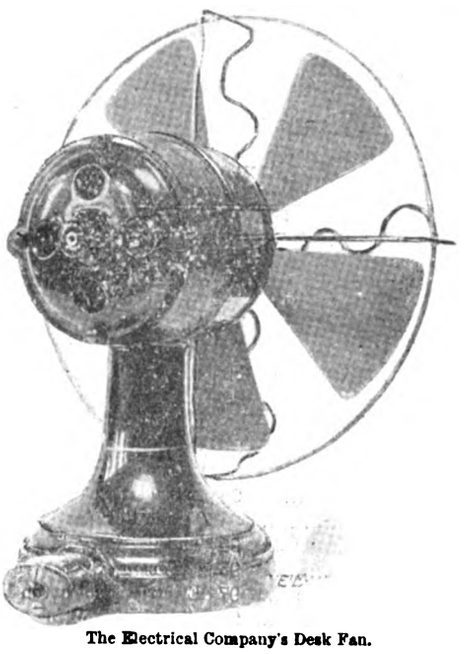
In addition, the sets were tested under severe conditions for parallel running, and gave most unqualified satisfaction to the consulting engineer. The governor trials also fully realised the expectations of the English builders. We understand that Messrs. Crompton and Co. are now manufacturing a complete line of single and polyphase generators and motors, and have some important orders for this class of machinery in hand at the present time.

Callender's Telegraph Construction Company.

Under the above title the Callender Company have just issued a well-printed album, containing a large collection of photographs of the work executed by them in all parts of the inhabitated globe, containing views of many places which were not dreamed of in our "jography" in the days when we went to school. The pictures include scenes of Messrs. Callender's men at work laying cables at Christiania, Odessa, Aalberg, Copenhagen, Gibraltar, Barcelona, Madrid, Durban, the Sheba Gold Mines (South Africa), Colombo, Calcutta, Alipore, Sydney, Auckland, Mexico, etc.

Desk Fan.

The accompanying illustration shows one of the desk fans made by the Electrical Company, Charing Cross-road, a specimen of which we have recently had under observation. These little fans are very neat and compact and take up a minimum of space on the table. They are made of various voltages, and are very well made indeed. The apparatus should

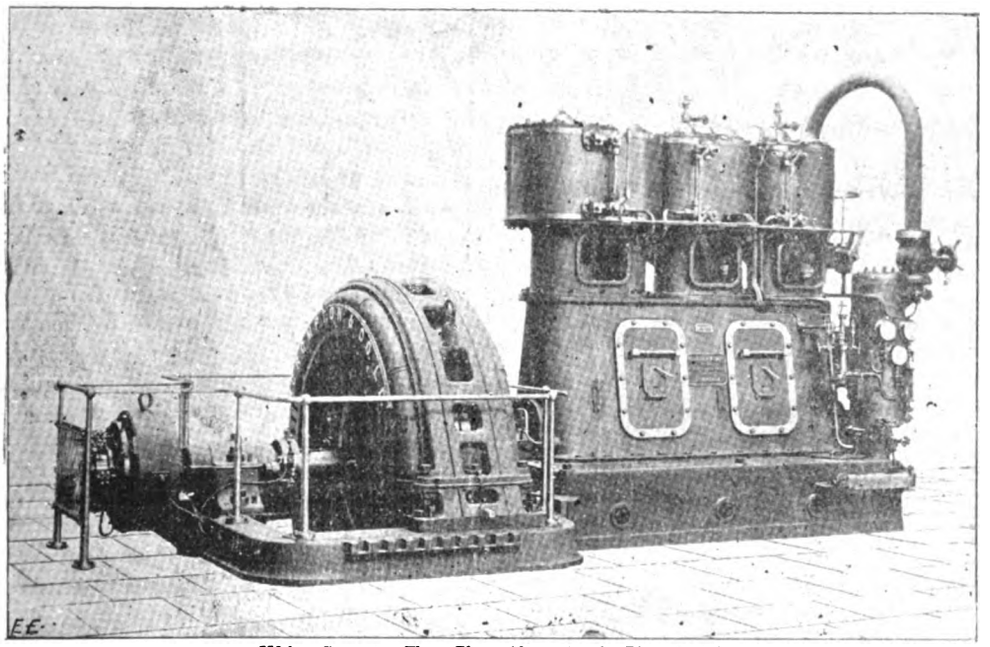


The Electrical Company's Desk Fan.

be well appreciated in basement offices especially, and in London offices generally in the summer—when there is any summer.

Catalogues and Pamphlets Received.

LAURENCE, SCOTT, AND CO., LIMITED, Gothic Works, Norwich: Pocket list (illustrated) containing revised prices of semi-enclosed motors for continuous current of various voltages. These 1903 motors retain all the leading characteristics of the 1900 type of machines, and the armatures, bearings, etc., are interchangeable with them. The alteration from the cast-iron yoke frames with steel magnet cores cast into cast-steel yoke frames and magnet cores has been made because these latter, in excellent metal for the purpose, can now be obtained with much more facility than formerly, and the firm have taken the opportunity afforded by this alteration to make many minor improvements that experience has shown are desirable. Much more space is allowed round the commutator and brush gear, and the ventilation has been improved without materially diminishing the protection afforded by the end brackets, and these being of larger diameter, the magnet coils are also made more accessible. In fact, so much has the design been improved in these respects that the firm are now supplying large numbers as dynamos, both for belt driving and for direct coupling.



250-kw. Crompton Three-Phase Alternator for Bloemfontein.

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All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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MUNICIPAL ELECTRICAL ENGINEERS.

The eighth annual convention of this association is being held this year in the Sunderland district, under the presidency of Mr. J. F. C. Snell, the electrical engineer of Sunderland. A gentleman once remarked to us that if he had the choice of a profession he would be either a schoolmaster, clergyman, or naval officer, because each of them can say his say and give his orders without discussion or contradiction. Right or wrong, the say is said; and right or wrong, the order is given and obeyed. Ordinarily, the president of an association is in a similar position so far as his presidential address is concerned. It is not fashionable, nor would it be tolerable if it were discussed by his audience, but members of the Fourth Estate are privileged, and can make a presidential text the moral of a sermon. We all are, or ought to be, trying to arrive at the truth. The principal text of Mr. Snell's address dealt with the vexed question of depreciation—a subject upon which there seems to be any amount of divergent opinion. Why it is so, we cannot understand, except that every man is fighting for his own hand, and so long as he gets what he wants, does not care if his gain be a disadvantage to another. Before passing to the main text of the address, we may be permitted to refer to the remark that "during the last year there has been an outburst from a section of the community against municipalisation, and there can be no question that Parliament apparently intends to restrict us to narrower bounds." Of course, the agitation against a certain phase of municipalisation has had a longer life, and we contend the agitation is perfectly justified, in order to obtain a legislative and legal boundary to municipal vagaries. The Lord Provost of Glasgow last week in welcoming to Glasgow the Municipal Tramways Association referred to the Glasgow authorities as being pioneers in tramway work of a municipal character. This is true in a measure, but really all the pioneering work to prove electric traction practical and commercially successful was done by private enterprise. Municipalities cannot pioneer is the usual acceptation of that term, so that the opposition has something on its side when it says, "Private enterprise pioneers, and municipalities take the reward." That term "in its infancy" has been used both for blessing and cursing but usually it is put forward by men as indicating there exists a doubt about pecuniary success. There are many other reasons for enquiry into and regulation of municipal trading. Now, one point as to depreciation. Mr. Snell says: "There is a class of critic which affirms that municipalities are not working on a financially sound basis because the majority of them do not form any depreciation fund, or at least have not yet commenced to form one. These critics state that in order to be sound we ought to pay off our capital by sinking fund as at present, and, in addition, to form a sufficient and separate depreciation fund." "A class of critic which affirms." What class? It is sometimes necessary to enquire into motives as well as to count heads. The class referred to consists principally of those connected with companies competing or wanting to compete with municipalities, or to stop municipalities from doing anything at all. An opposition is bound to oppose, but we are not necessarily bound to take its affirmations at their face value, or, indeed, at any value at all; and in this particular case the less credit is to be given to the affirmation, in that the critics do not follow their own suggestion. Analyse carefully the balance-sheets of various companies, and if you are anything of a prude in matters financial your hair will stand on end. In hardly

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a single case—we know not even one—do they practice what they preach, hence their preaching is and will remain ineffective. Both municipalities and companies want a certain twenty shillings in the pound, and if they have it, they are all right. Mr. Snell goes on to point out the differences in the—shall we call it—legal time of repayment of loans—forty-two years in some cases, twenty-five years and thirty years in others—and justly argues that something is wrong under these circumstances. Mr. Snell says: "We must look squarely at this fact. Some of the plant in both electricity and tramway concerns has a shorter life than the twenty-five or thirty years allowed by the Local Government Board—some a much longer." Mr. Snell himself, from the Sunderland undertaking, comes to an average of 42·8 years, and his conclusions are summed up in the following words: "I want to see municipalities placed on a par with admittedly well-regulated companies, and I believe that the extended period of repayment, the compulsory formation of a depreciation fund in addition to this extended (forty-two years) sinking fund, and an enquiry upon each loan by a properly constituted section of the Board of Trade . . . would prove a panacea for the present evils." Candidly, we do not agree with Mr. Snell, nor do we think the terms he uses to be the correct ones. Taking this latter point first, and assume a capital expenditure of £42,000, he would repay it on the forty-two years' plan at the rate of £1,000 a year, and would depreciate—how much? Upon the existing system (twenty-five years) he would repay at the rate of £1,680 a year. Probably the only difference in carrying out Mr. Snell's views would be to pay off £1,000 and depreciate £680, a distinction without much difference. With regard to the other point, there seems to be some inability to understand that an "average" does provide for the short-lived portion of the plant as well as the long-lived portion—the average depreciation at too great a rate on the one hand and at too slow a rate on the other, thus equalising matters. To discuss this admirable and thoughtful address as it deserves is altogether out of the question in a short article. Would it be impossible to get a meeting of those interested under the auspices of the association, and go thoroughly into the whole matter? It is evident that most engineers having responsibility want three things: (1) to pay off capital; (2) to have a renewal fund to draw upon without fresh borrowing; and (3) to keep the plant in a state of perfect efficiency. Users have to pay, and the question resolves itself into, Is this huge demand a fair bargain with buyers? Going on as at present, twenty-five years hence A will have a station standing in the books as costing nothing, it will have a plant efficient and standing in the books at zero, and if depreciation is also compulsory, it will have a renewal fund upon which to draw for new plant. Can any company be named where these conditions exist?

QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any questions should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

601. It is desired to add condensing plant to an electric light station. It is proposed to draw the circulating water from the sea, which is at hand and is 25ft. below level of condenser at low water, by means of a pair of suction pumps. What precautions must be taken in putting down the pumps and piping? Is it the case that a U-bend in the pipe interferes appreciably with the suction?—D. R.

602. Describe a suitable form of sand-drying stove capable of delivering one ton of dry sand per day for use in car hoppers. The car-shed does not adjoin the power-house, so that flue gases are not available. Discuss the relative advantages of hand and mechanical feeding in such an apparatus.—C. M.

ANSWERS.

Question No. 593.—Suppose a bipolar continuous-current dynamo to be excited with an alternating current so that any one conductor on the armature is always moving in a field of the same polarity, would the machine generate any E.M.F.?

Best Answer to No. 593 (*awarded* 10*s.*).—Since in the above case the machine is excited with an alternating current, the result of such excitation will be an alternating magnetic flux surging to and fro through the armature. Also, since the question indicates that any *one* conductor is always moving in a field of the same polarity, the frequency of the exciting current must correspond and be equal to the speed. Thus, if the speed is 3,000 revolutions per minute, or 50 revolutions per second, then it is essential to fulfil the above condition that the frequency of the current be 50 ~ per second. Also the indication that any one conductor is always fulfilling the above condition does not imply that every conductor is acting in that way. For it can be proved that such is not the case that there are only two conductors or sets of conductors which do act as indicated, and these conductors are diametrically opposite each

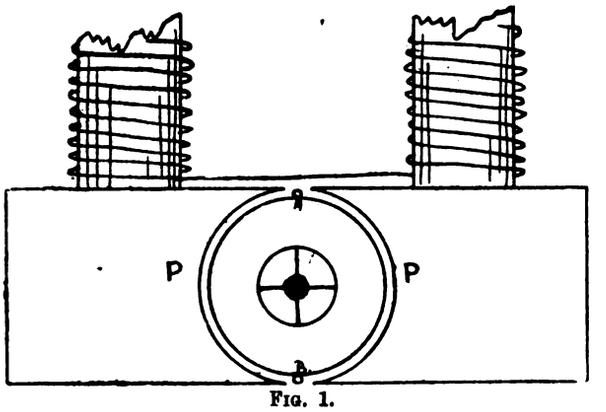

FIG. 1.

other. Fig. 1 shows a diagrammatic sketch of the field magnets and armature of a two-pole dynamo, with A and B, two conductors diametrically opposite, represented in the position of worst action in a uniform unidirectional magnetic field. It is at this point in such a field that the conductors begin to move in a field of the opposite polarity to which they have moved in during half revolution before they reach this point. But if the conductor is at this point when the field reverses, then the conductor will always move in a field of the same polarity. With any other conductors in other positions of the periphery of the armature, however, such is not the case, since the field in which they move will reverse its polarity when the exciting current reaches its zero value, and also when the conductor reaches the positions occupied in Fig. 1 by A and B, making four reversals of the field in which the conductor moves per revolution of that conductor. Hence A and B in Fig. 1 are the only conductors always moving in a field of the same polarity.

Now, as to whether the machine would generate any E.M.F. Since each conductor is not placed in the same position on the armature relatively to the alternating character of the magnetic flux, it is advisable to consider what takes place in each conductor per revolution, considering the conductors separately. Every conductor need not be taken, as it is not a question of calculation, but of action.

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Certain conductors placed equidistant from each other on the periphery of the armature need only be taken. As in Fig. 2, A and B, C and D, E and F, G and H will be considered, and the question as to whether any E.M.F. will be generated can be solved from these. In considering the actions taking place in each conductor there are two causes which combine to produce an effect. The first is that of the alternating magnetic flux, and the other is that of the relative motion of the conductor, because in a uniform field the number of lines cut by the conductor is not the same in all positions of the

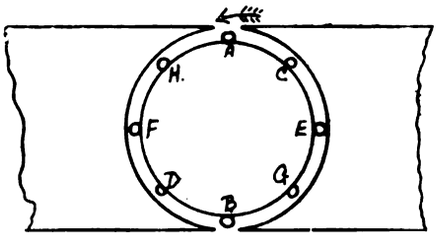

FIG. 2.

field—there are positions of best action and also of worst action. Taking, therefore, the conductor, A, in Fig. 2 in the position shown when the magnetic field has a zero value, the E.M.F. then generated in this conductor has a zero value also. Supposing the armature to revolve in the direction of the arrow head, as the conductor, A, moves the field is strengthened, increasing the number of lines pervading the armature until a position 90deg. to the former is attained, and then decreases to its zero value, and then changes its direction. If the conductor had been

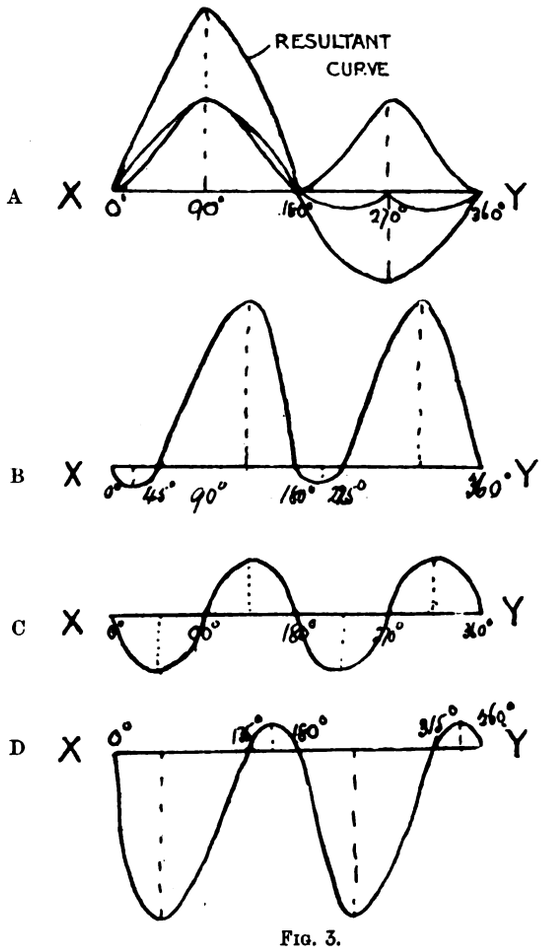

FIG. 3.

stationary, the E.M.F. generated in it would have had the same character as the magnetic flux, excepting that whereas the flux changes its direction, the E.M.F. does not, because that conductor is always moving in a field of the same polarity. This can be shown in a curve (Fig. 3A) which represents the character of the E.M.F. with the line $x\ y$ representing one revolution. On this line $x\ y$ can also be placed the curve which would be obtained if the field was a uniform unidirectional field with the armature rotating. Combining these two curves we obtain the character of the E.M.F. generated in that conductor during one revolution. This also applies to the conductor B, with the exception that the sign of the E.M.F. is changed, because it is moving in a field of the opposite polarity to A. Taking now conductor C, in Fig. 2, in the position shown, 45deg. behind A, when the flux has a zero value, hence no E.M.F. is generated in this conductor at that position. When it has reached the position 45deg. ahead, there is no E.M.F. generated in it. Moving till it reaches the position diametrically opposite its initial position, the flux again has a zero value, therefore no E.M.F. Moving 45deg. further, the conductor is again in another position where no E.M.F. is generated in this conductor. These alternations of E.M.F. can be placed as in Fig. 3B, where $x\ y$ again represent one revolution. This curve shows somewhat the character of the E.M.F. generated in the conductor C. This curve applies to the conductor D, save that the sign of the E.M.F. is changed.

Taking, now, conductor E, in Fig. 2, 90deg. behind A when the flux has zero value, hence no E.M.F. is generated in the conductor at that position. After moving through 90deg., it attains a position again when no E.M.F. is generated in it, and still another 90deg. when the flux has again its zero value, and therefore E.M.F. in the conductor. Moving through another 90deg., it reaches the last position in the revolution, where no E.M.F. is generated in the conductor. Plotting these points of no E.M.F. on the line $x\ y$ in Fig. 3C, we can construct a curve characteristic of the E.M.F. generated in the conductor.

Taking, now, the last to be considered, G, in Fig. 2, in the position shown 135deg. behind A, when the flux has a zero value, also it will have a zero value when the conductor has moved 180deg., therefore these are positions of no E.M.F. Also, when the conductor has moved through 135deg. and 315deg. to the positions of worst actions, again is no E.M.F. generated in it. These four points of no E.M.F. can be plotted on the line $x\ y$ in Fig. 3D, and the characteristic curve of the E.M.F. generated in the conductor can be constructed.

Combining all the four curves thus obtained together, we shall get a resultant curve which will approximately show the character of the E.M.F. generated in the armature. This curve is shown in Fig. 4, and shows that an

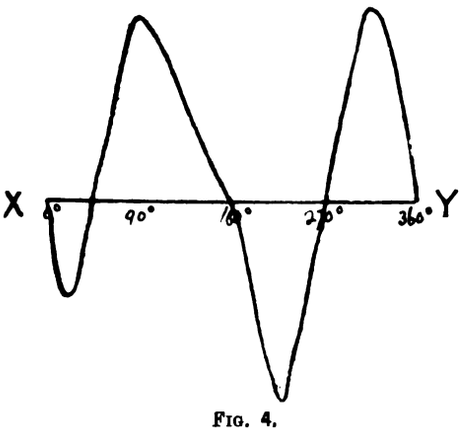

FIG. 4.

E.M.F. is generated in the armature; but the peculiar part about it is that though there is a commutator which rectifies the E.M.F. generated in a uniform field, the E.M.F. generated under the conditions enumerated in the question is an alternating one of an irregular character, which can be seen from the curve, the E.M.F. having a periodicity double that of the exciting current.—G. W. B.

Answer to No. 593 (*awarded 7s. 6d.*).—In order to determine what happens in the example given by the question, let us take the case of an ordinary two-pole continuous-current dynamo and see what happens. We have here a flux which is constant in magnitude and direction, in which is revolved two parallel circuits of conductors in series. The number of conductors in series is unaltered as the armature revolves, since as each individual bar leaves one circuit for the other by passing under a brush, another takes its place by passing under the other brush. We thus see that if the

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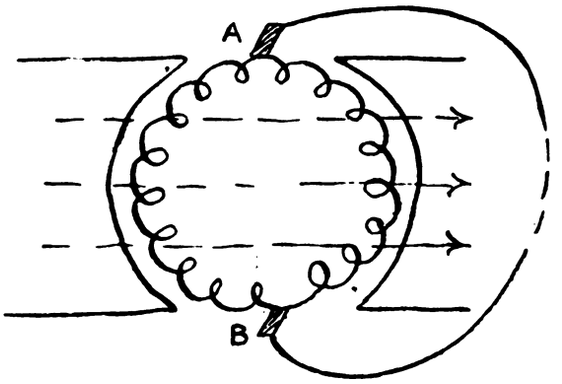
speed is kept constant the volts must also be constant, since the "lines cut per second × conductors" is constant.

If, now, instead of a flux which is constant in direction and magnitude, we substitute an alternating flux as given in the question, everything else remaining the same, the number of lines cut at any instant will evidently vary, and hence, as the voltage depends on the product, "lines cut × conductors," the voltage generated between the two brushes, A and B, will also vary. During one alternation of the flux cycle the brush A is positive with regard to B; when the flux is zero the voltage between A and B must be zero, and during the other alternation of the period the brush A is negative with regard to B. We thus see that the voltage generated between the two brushes, A and B, is an alternating voltage, and is of and follows exactly the periodicity of the alternating flux—*i.e.*, the alternating exciting current.



This periodicity is evidently unaltered if we vary the speed, the only effect of this being clearly to increase the rate of cutting lines, and hence the voltage. Hence we have an alternator which will give constant periodicity—*i.e.*, that of the exciting current—however we vary the speed, and the voltage of which varies directly as we vary the speed.

We can now see that if we introduce the second condition mentioned in the question—namely, that any one conductor on the armature is always moving in a field of the same polarity—*i.e.*, the armature is revolving in synchronism with the flux—all we should get would be a particular value for the voltage, since the number of revolutions per second of the armature would then be equal to the periodicity of the exciting current, the alternating voltage being, as mentioned above, directly proportional to the speed. What I think "F. C. P." had in his mind was a polyphase induction motor. In this case, when any one conductor of the rotor is always moving so as to be in a field of the same polarity, the rotor is running in synchronism, and there is no "slip." Here, however, we have a *rotating*, not an *alternating*, field. The flux never sinks down to zero, but remains about constant in value, and the magnetic poles actually travel round the circumference of the stator instead of pumping to and fro in one constant direction. If, then, the rotor conductors move always in the same field—*i.e.*, at the same rate as the revolving flux—it is evident that they can cut no lines, and hence no voltage is produced. An induction motor can never quite reach synchronous speed, since there must always be some losses to make up—*e.g.*, bearing friction and iron loss—and these will tend to hold the rotor back to such an extent that the "slipping" back from synchronous speed is just sufficient to set up an E.M.F. in the rotor windings which will send a current through them of sufficient strength to satisfy the equation,

$$\text{Constant} \times \text{rotor conductors} \times \text{flux} \times \text{speed} = \text{torque due to losses, etc.}$$

In the case of a generator the rotor, of course, could be driven at synchronous speed, but, as explained above, it would generate no volts. If the rotor be, however, driven above synchronous speed, it will then cut lines and generate an E.M.F. This system of polyphase generators has lately been introduced by Alexander Heyland, and has several important advantages.

The arrangement given in the question is a reversed dynamo. If we were to take an ordinary two-pole dynamo without any commutator, connect the armature conductors in series, and bring the ends out to two slip-rings, and then revolve the armature in a constant field, we should, of course, get an alternating current, the ⌒⌣ and voltage of which would vary directly as the speed. A commutator if fitted would turn this in a direct-current machine. If, now, we next change the field to an alternating one, we shall again come back to an alternating current, only now the volts alone will vary with the speed. We should in this case have to laminate our field frame and poles as well as the armature, or the losses due to eddy currents caused by the alternating flux would enormously increase the exciting current required, and bring down the efficiency to a very low figure.

Another difficulty in working a machine of this sort is that of commutation. In addition to the volts of self-induction of the short-circuited coil due to the change of current during commutation, which is the cause of sparking in ordinary continuous-current dynamos, we should have two new effects coming in, both of which are probably worse than it is: first, the self-induction volts due to the fact that the current through the armature is an alternating one; and, secondly, the self-induction volts due to the fact that the short-circuited armature coil acts as a short-circuited secondary of a transformer due to the alternating flux set up by the field coils (which act as primaries) pumping through it. All these three voltages add up and produce a large potential difference at the terminals of the coil, which sets up a large circulating current around it and through the brushes, so causing a good display of pyrotechnics. It is easy to calculate the value of the alternating voltage which will be set up by a machine arranged in this way. Knowing the number of turns on the field, and the value of the alternating exciting current at any moment, we know the ampere-turns acting. If we plot these against time for one-half period we should get a sine wave. If we have the characteristic curve for the magnetic system giving flux against ampere turns, we can at once plot the corresponding flux wave for the half period. If the iron in the system is unsaturated, this flux curve will also be practically a sine curve, but if it is saturated it will be flat-topped. The shape of this wave will evidently be exactly the shape of the voltage wave set up by the armature, no matter what the shape of the wave of the exciting current is. Hence, if we want to generate a sine wave E.M.F., we must *not* have our iron saturated. Having plotted this flux wave we find its root mean square ordinate, and the ratio of this to the value of the constant flux of the continuous-current machine will give us the ratio of the alternating to the continuous E.M.F.—T. SQUARE.

Answer to No. 593 (*awarded* 5*s.*).—"F. C. P." requires to know what takes place when a bipolar continuous-current dynamo is excited with an alternating current, and the armature rotated at such a speed that the time for one complete revolution equals the periodic time of the exciting current. Referring to Fig. 1, while

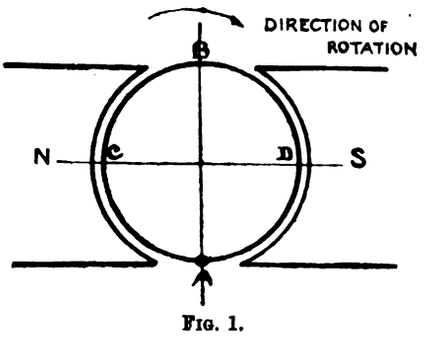


FIG. 1.

any one conductor is moving from A to B, the left-hand pole, say, will be a *north* pole and the right-hand one a *south* pole; and assuming the flux follows a sine law variation, the field will be zero when the conductor is at A and B, and at its maximum when at C. Fig. 2 represents the state of affairs during the second half of the revolution—that is, while the conductor is moving from B to A. It can be seen that in the first case the effect of the armature

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revolving in the magnetic field is similar to what occurs when the machine is excited with a continuous current, the only difference being that, instead of the field being constant and a constant E.M.F. being produced, the field varies in strength and a corresponding varying voltage will be produced—in fact, the voltage will follow the same variation as the field. In the second case exactly the same thing occurs, only the polarity of the field magnets now being reversed, the E.M.F. produced due to the motion of the armature will also have reversed. So it is seen that, corresponding to one revolution of the armature, a complete alternation of the E.M.F. occurs, so that, due to the motion of the armature alone, an alternating E.M.F. is produced, being in phase with the alternating magnetic field and following the same law of variation.

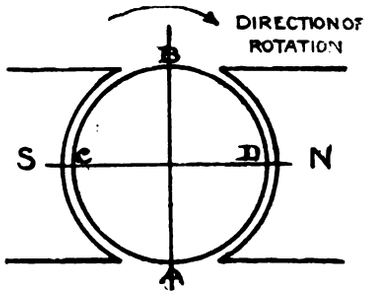

Fig. 2.

In addition to this E.M.F., however, we have that the armature is acting as the secondary of a transformer, the primary winding being the field winding. The E.M.F. induced in the armature due to this cause alone will at any instant be proportional to the rate of change of the magnetic field—that is, it will be an alternating E.M.F. passing through its zero value when the field is a maximum, and reaching a maximum value when the field passes through zero. Fig. 3 explains this Curve 1 represents the magnetic field, Curve 2 the E.M F. induced in the armature due to its motion in this field; Curve 3 the E.M.F. induced in the armature due to the alternating magnetic field. Adding Curves 2 and 3 together we obtain Curve 4, which shows the E.M.F. that would be obtained from the machine. As can be seen from this diagram, it is an alternating E.M.F.; the effect of the

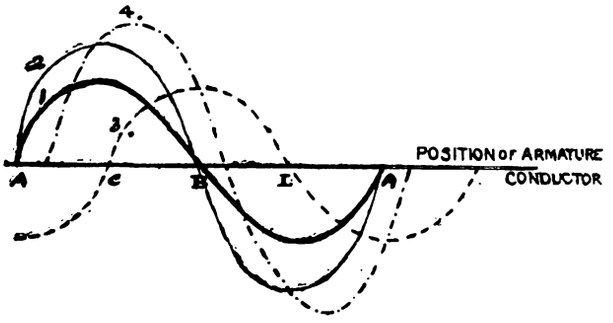

Fig. 3.

auxiliary E.M.F. represented by Curve 3 being to increase the maximum value of the resultant E.M.F., and cause a phase displacement between it and the exciting current.—A. G. YOUNG.

Answer to No. 593 (*awarded* 5*s.*).—Under such circumstances an ordinary alternating E.M.F. would be generated. It would have a periodicity equal to that of the exciting current, and its amount would depend on the flux set up, the number of conductors, and the speed. The fact that the armature rotates at synchronous speed, so that a given conductor is always moving in a field of the same polarity, does not affect the matter qualitatively, as the same result, even as regards the periodicity of the resulting E.M.F. (which would always equal that of the exciting current), would be obtained at any speed, the actual value of the E.M.F. being simply proportional to the speed and flux.

The action can be followed most simply in the case of a Gramme armature (Fig. 1), though the net result is precisely the same with a drum winding. When the armature is at rest, with the brushes set on the neutral line, no E.M.F. will be measurable between the brushes, as it is evident that the E.M.F.'s induced by the alternating flux in the parts of the winding, A to C and A to D, are opposed and cancelled by the E.M.F.'s set up in B C and B D respectively. At the same time a considerable current may be set up in the sections short-circuited under the brushes, as these sections are traversed by the full flux, and act just like the short-circuited secondary of a transformer of which the field winding is the primary. If, instead of the brushes being set on the neutral line, they are given some lead, the E.M.F.'s between A and B will no longer just cancel out, as the distribution

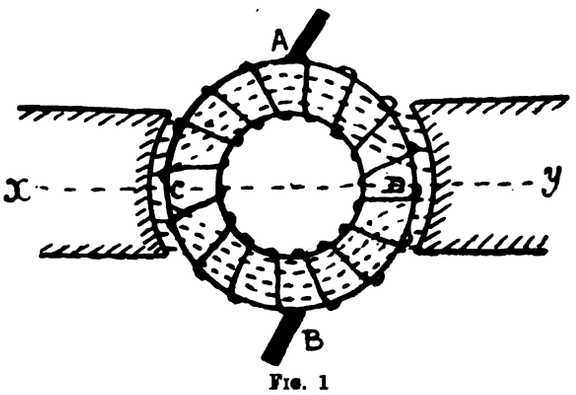

Fig. 1

of the windings between A and B is no longer exactly symmetrical about the pole axis $x\,y$ These, however, are only secondary starting effects, the former being more or less easily overcome by employing high-resistance connections to the commutator plates, and the latter by keeping the armature reaction low, and so avoiding the necessity of brush lead. As soon as the armature is rotated, a voltage will be generated whose instantaneous value is, in accordance with the fundamental dynamo equation, $E = C \times R \times N \times 2 \div 10^8$, where C = the number of conductors in series from brush to brush—*i.e.*, half the total conductors on the face of the armature in this case; R = the number of revolutions per second; N = the instantaneous value of the flux entering the armature at one pole in C.G.S. lines. When the field is excited with an alternating current, the instantaneous flux, N, has not a constant value, but varies from moment to moment, and the armature voltage, E, rises and falls in unison and changes sign every time a pole changes from a north to a south pole, or *vice versâ*, under the action of the alternating excitation.

It may be pointed out that series alternating motors having large starting torque have occasionally been constructed on this principle, the same alternating current traversing armature and field windings, and thus producing a unidirectional though intermittent torque. Such machines have not come into general use, more from practical difficulties as to sparking and low power factors than from any theoretical defect.—Q.

Question No. 594.—It is frequently stated that induction motors having short-circuited rotors can be started up with normal full-load torque, and about one and a quarter times full-load current, by means of an auto-transformer. As an auto-transformer is merely a means of supplying the motor with an impressed voltage lower than that of the line, how is it possible to do so? From the writer's experiments, it appears that whether the impressed voltage is reduced by an auto-transformer or a non-inductive resistance, the starting torque with full-load current is only one-eighth full-load torque, and in order to get full-load torque it has been necessary to get about four times the full-load current through the motor. N.B.—The question relates only to motors having so-called "squirrel-cage rotors."

Best Answer to No. 594 (*awarded* 10*s.*).—It is almost impossible to design a polyphase induction motor with reasonably efficient squirrel-cage rotor to give full-load torque at starting with as low a current as $1\frac{1}{4}$ times the normal full-load current. The usual figure for this result is four times, or at least three times, the normal full-load current. This is without the use of an auto-transformer. Auto-transformers, when used to reduce the pressure (Fig. 1), are usually employed in the case of motors starting on light pulleys or, at any rate, with very low torque, as the only effect of reducing the motor terminal pressure

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is to reduce the starting torque for a given current, and at the same time reduce the value of the maximum current passing through the motor at the instant of starting when the motor behaves as a short-circuited transformer. In this way an auto-transformer increases the time taken for

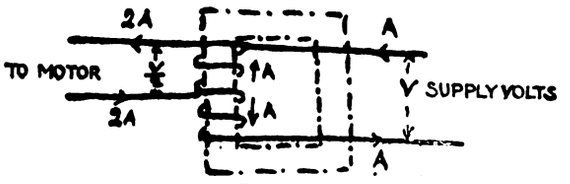

Fig. 1.

the motor to reach full speed, but also reduces the maximum current drawn from the mains.

Occasionally in the case of crane motors or railway motors, an increased starting torque is obtained by employing an auto-transformer to *raise* the pressure at starting (Fig. 2). In this way, especially if the whole iron path of

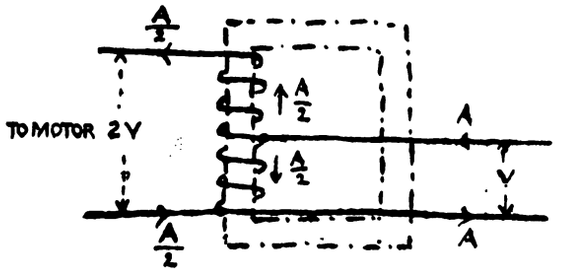

Fig. 2.

the motor is quite unsaturated at the normal voltage, it would be possible to get full-load torque with a current consumption of perhaps double the normal, and possibly this is the case referred to by the writer of the question. It will be seen from Figs. 1 and 2, which show the instantaneous current distribution on auto-transformers employed respectively to halve and to double the terminal pressure, that such transformers cannot fairly be considered as simply pressure-reducing devices, like choking coils or resistances. On the contrary, auto-transformers act as true transformers, altering the volts at the expense of the amperes, so that if, for instance, a motor input of 100 volts, 50 amperes is required from a 200-volt supply circuit the actual current drawn from the mains if an auto-transformer is used will be 25 amperes, neglecting losses, whilst if a choking coil or non-inductive resistance were used it would be 50 amperes.—Q.

Answer to No. 594 (*awarded* 5*s.*).—The claims as to the starting current of alternating-current motors are judiciously stated rather ambiguously. The statement that they will start with 1¼ times normal current means 1¼ times normal will be taken *from the mains*. "J. A." has evidently taken it to mean the current in the motor, as he speaks of reducing the voltage "by an auto-transformer or a non-inductive resistance." As far as the current in the motor is con-

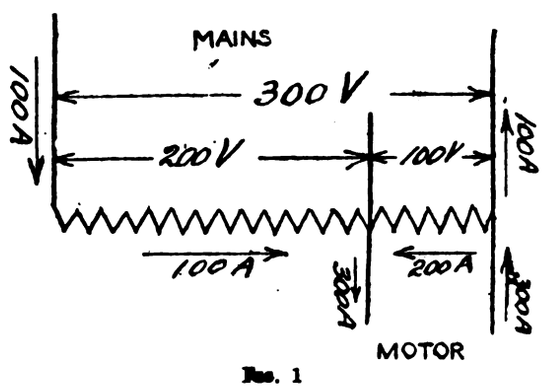

Fig. 1

cerned, there is no difference between these two methods, but as regards that in the mains there is all the difference. The transformer may be made to give one-third of the line voltage to the motor; then the motor current will be three times the line current (Fig. 1). Then with 1¼ times normal line current the motor will get 3¾ times its normal current, which is about the same as "J. A.'s" experimental value. Four times normal certainly seems a large current to put into a motor, but the armature cannot heat appreciably in the short time taken to run up to speed, and there can be no sparking troubles, which would prevent

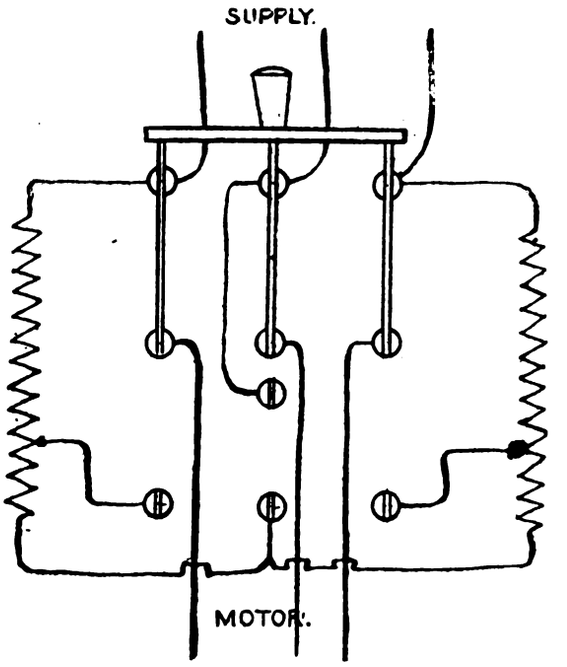

Fig. 2.

any such use of a direct-current motor. Fig. 2 shows the arrangement of two auto-transformers and a three-pole throw-over switch for starting a three-phase motor.—W.

Answer to No. 594 (*awarded* 5*s.*).—The seeming contradiction which "J. A." has experienced is due to erroneous, or, perhaps, rather incomplete ideas of the

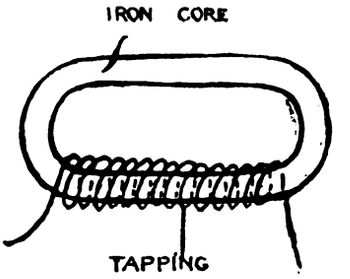

Fig. 1.

functions of an auto-transformer. An auto-transformer consists of an iron core similar to an ordinary transformer, but having only one coil wound on it (as shown diagram-

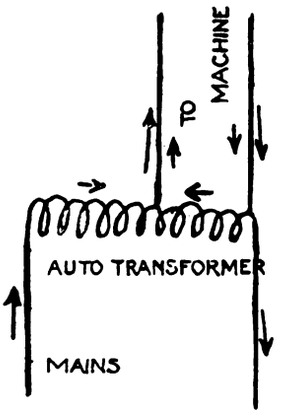

Fig. 2.

matically in Fig. 1). From some part in the winding, the position of which depends on the voltage required and the supply, voltage and tapping is brought out. The two terminals of the auto-transformer are connected to the mains, and the terminal and the tapping wire connected to machine or apparatus requiring the reduced pressure,

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as in Fig. 2. The working is quite clear. The current flows through the front part of auto-transformer winding through the machine, but in passing through the auto-transformer winding it not only reduces the pressure, but sets up a magnetic field which induces a current in the second half of the winding, which flows in an opposite direction to that of the primary, as indicated by the arrows in Fig. 2, and thus the current flowing through the machine is the sum of the current from line plus the induced current. Obviously, if the tapping is in the centre of the winding, the line current and induced current will be approximately equal (neglecting the magnetising current), and the machine will receive twice the current drawn from the mains. By suitably placing the tapping point the machine can be fed with three to four times the current taken from the mains, which would be arranged to be about full-load current, and thus start up with full-load torque. Another condition might be added. An auto-transformer is designed to start a certain motor with a certain load. If it is put on to an entirely different load, good results cannot be expected.—ERG.

CABLEMAKERS' ASSOCIATION.

We have received the following circular, signed by the British Insulated and Helsby Cables, Limited, Connolly Bros., Limited, W. T. Glover and Co., Limited, W. T. Henley's Telegraph Works Company, Limited, the India Rubber, Gutta Percha, and Telegraph Works Company, Limited, the London Electric Wire Company, Limited, Siemens Bros. and Co., Limited, Callender Cable and Construction Company, Limited: The importance of using thoroughly reliable flexible cords in electric light installations is fully recognised by insurance offices and public bodies generally. Their stringent regulations on this subject show that they appreciate the danger attached to the use of inferior material. The ordinary user, however, does not appreciate the risk of fire which arises from the use of cheap flexible cords, often in situations exposed to mechanical injury and in contact with inflammable material, such as curtains, bed hangings, carpets, tablecloths, etc. The cost of the flexible cords bears such a small proportion to the total cost of an installation that on the score of economy no importance need be attached to the extra cost for a good quality. The Cablemakers' Association, as representing the principal makers of insulated wire in this country, has been asked if a cord could not be produced bearing some distinctive label which would comply with the requirements of the insurance offices and public bodies, and would ensure to consulting engineers, contractors, and others that a thoroughly reliable and safe article was being employed. The association has, therefore, arranged for the manufacture of a flexible cord to a special specification, which, though naturally rather higher in price than some of the cords now in use, will increase the total cost of an installation only to an appreciable extent. This cord is insulated with pure and vulcanised indiarubber, and gives a minimum insulation resistance of 600 megohms per mile at 60deg. F. after 24 hours' immersion in water and one minutes' electrification, and is tested with 1,000 volts alternating current for 15 minutes. This cord can be obtained from supply houses generally, or from the members of the Cablemakers' Association, whose names are subscribed, and each coil will bear a label with a registered trade mark, which consists of a shield bearing three heads of lions *plain*, who have each suspended from its mouth a ring, surcharged C, M, and A respectively.

PERSONAL.

Mr. W. T. Wardale has been appointed shift engineer at the Corporation tramways power station, Sheffield, at a salary of £120.

Mr. Llewelyn B. Atkinson, A.M.I.C.E., has recently joined the board of W. T. Glover and Co., Limited. His lengthy and varied experience with mining work will be especially valuable, now that this branch of engineering is coming more under the influence of electricity.

We understand that Mr. W. J Sowter, who is superintending the erection of the electricity works at Dorchester, will take charge of the same when completed as borough electrical engineer.

FORTHCOMING EVENTS.

Municipal Electrical Association.—July 17 and 18, concluding days of annual convention, Sunderland. July 17, Middlesbrough Corporation luncheon. (Programme appeared in our issue of the 12th ult.)

Iron and Steel Institute.—Summer meeting, Barrow-in-Furness, September 1-4.

Municipal and County Engineers.—Meetings: Widnes, July 18; Aberdeen, August 20, 21, and 22; Hastings, September 11 and 12. Detailed programmes will be issued when definite arrangements are made.

CROYDON ELECTRICITY ACCOUNTS.

From the statement of accounts for the year ended March 25 last, it is seen that the total expenditure on capital account on that date amounted to £231,343. We append abstracts of the revenue account and balance-sheet, together with statement of electricity generated, sold, etc.

REVENUE ACCOUNT.

Dr.	£	s.	d.
Generation of Electricity.			
Coals or other fuel	10,758	5	10
Oil and engine-room stores	1,231	18	1
Wages at generating station	2,259	16	7
Repairs and maintenance	1,211	18	11
Distribution of Electricity.			
Wages to linesmen, etc.	634	10	5
Repairs and maintenance of mains	489	11	0
Attending public lamps and repairs	1,237	10	0
Rents, Rates, and Taxes.			
Rents and interest	83	3	10
Rates and taxes	1,008	13	11
Management Expenses.			
Salaries	1,520	1	5
Stationery, printing, etc.	210	18	11
General establishment charges	570	14	5
General district rate	500	0	0
Special Charges.			
Insurances	160	11	4
Interest on deposits	11	11	3
Total expenditure	21,989	5	11
Amount carried to net revenue account	18,100	0	0
Balance to be carried to next account	67	12	8
	£40,156	18	7

Cr.	£	s.	d.
Electricity Sales.			
Balance from last account	51	8	0
Sale of current	32,585	13	7
Less discounts and allowances	173	11	6
	32,412	2	1
Bad debts written off	84	3	7
	32,327	18	6
Additional amounts	58	2	1
Public lighting	7,126	5	3
Rental of meters, etc.	411	1	6
Sundry receipts	148	16	3
Northern Assurance Company, Limited, for damage done by fire at Thornton Heath sub-station on July 21, 1902	23	18	3
Rents	9	8	9
	£40,156	18	7

GENERAL BALANCE-SHEET.

Cr.	£	s.	d.
Liabilities.			
3 per cent. redeemable stock	227,998	0	0
Revenue account	67	12	8
Net revenue account	4,773	5	4
Reserve fund	3,000	0	0
Suspense account	2,379	18	6
Outstanding balance of expenses in connection with fire	2,027	9	4
Sundry creditors	8,960	7	4
Consumers' deposit account	685	17	0
Due to bankers	8,755	9	7
Surplus account—loans repaid	3,583	0	0
Contributions to loans fund for sinking fund to March 25, 1902	5,081	0	9
Interest thereon	152	7	8
Contributions to loans fund for sinking fund year ending March 25, 1903	6,705	3	4
	£274,169	11	6

Cr.	£	s.	d.
Assets.			
Capital account	231,343	0	6
Costs of issue, etc., capitalised	13,297	0	0
Stores, etc.	1,267	1	3
Debtors for current	12,944	7	11
Sundry debtors	869	1	1
Reserve fund investment account	2,500	0	0
Petty cash	10	9	0
Consolidated loans fund for sinking fund contributions	11,938	11	9
	£274,169	11	6

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T. units			3,889,794
Quantity sold	Public lamps	630,921	
	Traction	1,310,977	3,131,841
	Private consumers by meter	1,189,943	
Quantity used on works			420,827
Total quantity accounted for			3,552,668
Quantity not accounted for			337,126
Total maximum supply demanded (kilowatts)			2,127

Number of public lamps: arcs, 392; incandescents, 26.

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LONDON TRAFFIC COMMISSION.

Mr. J. W. Benn, the chairman of the Highways Committee of the London County Council, gave further evidence before the Commission which is enquiring into the question of locomotion in London at its further sitting last Friday. He began by giving some interesting figures with regard to tramway and omnibus traffic in the Metropolis, particular reference being made to the County Council's undertaking. He stated that there were 15,000 tramcars and 4,000 omnibuses running daily in London. An electric car carrying 65 passengers was only 35ft. 6in. in length, as against 35ft. 6in. of a horse and tram and 20ft. of an omnibus; 2,615 of those vehicles, against 5,500 horse vehicles, covering 16½ miles, as against 27½ miles, would be sufficient to carry the same number of passengers—viz., 170,000. There would be a saving of nearly 3,000 vehicles and a space of 10½ acres in London by the adoption of the new electric system, without any prejudice to the public service. In the south the County Council had adopted the conduit system, while in the north a tramway company leased the tramways, and they were opposed to the adoption of that system. At the present time there was a proposal before the Council showing the conduit system for the central portion of London up to the Angel, Islington, and the King's Cross terminus, and beyond that zone they had submitted proposals for the overhead system. The difficulty was that the borough councils were invested with a veto, and almost uniformly declared against the supposed disadvantages of the trolley system. The difficulties of the Council had been remarkably few, and had been overcome. They did not find any serious difficulties in regard to wet with the conduit system. The storms a fortnight ago were a severe trial, and they got through without any discomfort. The Council proposed running tramways in shallow subways under the road. They would use the conduit system in the line running from Islington, *via* Theobald's-road, dipping down under the street, and emerging, when Parliament permitted, on the Embankment. For the moment their cars would have to stop somewhere near the Strand. The figures of the working of the trams in the South of London for the last four years showed a total net profit to the ratepayers of £72,910. Last year there was a loss, after setting aside interest and sinking fund. Since electric traction had been started they were rapidly recovering their arrears, and next year promised to be a good one. In addition, the reserve fund now stood at £31,391.

In answer to further questions, the witness said that the Council desired that their powers as the local tramways authority should not come within the jurisdiction of the tribunal, the Council being recognised as the sole authority in London, and retaining its present power to promote Bills dealing with tramways without being obliged to obtain the consent of the road authorities. A resolution to that effect had been passed by the Council. They had endeavoured to co-ordinate the undertakings acquired into one comprehensive system. To allow other promoters to come into London would be simply to revert to the old system of haphazard enterprise. The Council practically only asked that it might be left in its present position. The witness, continuing, submitted that the borough councils should have the fullest right to be heard before any authority before whom it might be determined that the Council should promote tramway schemes, but a scheme should be heard on its merits, and not be subject to the uncontrolled veto of the metropolitan borough councils. From the Council's experience of the working of the conduit and overhead systems he estimated that the cost of the former was 33 per cent. greater than the latter, but the durability was much greater. With regard to the leasing of the northern lines to the North Metropolitan Tramways Company, the profits to the Council had been reduced by over £10,000 a year owing to the company's having sold their lines which were outside the London county area, a proportion of the receipts of which the Council had taken before the sale.

Mr Samuel George Burgess, housing manager of the London County Council, then gave evidence with regard to the question of overcrowding. The electrification of the South London tramways would no doubt induce people to move out from Southwark and Lambeth to Tooting. The solution of the difficulty with regard to the working classes would be found in opening up new districts with cheap and quick means of communication.

The Commission adjourned.

LEGAL INTELLIGENCE.

CHARING CROSS AND HAMPSTEAD TUBE.

In the King's Bench Division of the High Court on Tuesday, Mr. Henry Herbert Montague Smith sued the Charing Cross, Euston, and Hampstead Railway Company for £4,000 salary as secretary since 1897.

It appeared that the plaintiff had been engaged for a very considerable time in assisting in the formation of tube railways. In 1893 he was employed, at £800 per annum, as manager and secretary of the Charing Cross, Euston, and Hampstead Railway. The original intention was to raise the capital by issuing a prospectus, but this was found to be unsatisfactory, and plaintiff went to America to enter into negotiations with Mr. Yerkes to provide the capital. Mr. Smith was employed under an agreement setting forth that he was to receive no salary until the first public allotment of shares was made, when he was to be paid all arrears. If there was no public allotment he was to receive no remuneration. This agreement was to hold good for a period of three years after the railway was opened for traffic. He was paid his salary up to Oct. 30, 1897, on which date he was dismissed, and it was for subsequent salary that the plantiff was now suing

Mr. R. W. Perks, M.P., solicitor to the company, said that the agreement by which Mr. Smith was to receive £800 a year was terminated long since. He regarded the services rendered by the plaintiff as being worth only £150 or £200 a year.

His Lordship said that in his mind there had been no public allotment, so that no salary was due to the plaintiff. There had, however, been wrongful dismissal, for which he considered the plaintiff was entitled to recover 40s. as compensation, each side paying its own costs.

ACTION FOR LIBEL.

A libel action arising out of the series of articles that appeared in the *Daily News* at the end of last year on the subject of municipal trading was heard before Mr. Justice Lawrance and a special jury in the King's Bench Division of the High Court of Justice this week. The plaintiff was Mr S. P. W. D'Alte Sellor, engineer to the British Electric Traction Company, and he sued the proprietors of the *Daily News* to recover damages for alleged libel. The defendant company pleaded that there was no libel, denied the innuendoes placed on the words by the plaintiff, and justified the words used.

Mr. Gill, K.C., for the plaintiff, said that his client was retained by the British Electric Traction Company as their engineer for the purpose of advising them at a salary of £1,500 a year, being left free to carry on his private business as well. In November last the *Daily News* published an article discussing the question of municipal trading. It was called "The Development of the Electrical Trust," and, said counsel, was really an attack on the British Electric Traction Company, which did a very large business in various parts of the country. Plaintiff complained that the headings and sub-headings of the article ostensibly connected him with Jabez Spencer Balfour and Henry Granville Wright, and that the writer then proceeded to comment on the fact that plaintiff served on Mr. Bryce's Light Railway Commission, that he was a member of numerous societies, and consulting engineer to several corporations and tramway companies, besides being a paid servant of the Electric Traction Company in a manner which, having regard to what had gone before, reflected discreditably on him and imputed professional misconduct.

The **Plaintiff** was called, and in cross-examination said that the *Daily News* article was one of a series in answer to the articles in the *Times* on "Municipal Socialism." He could not point out any statement of fact in the article which was untrue. He had dictated or edited the autobiography from which the "two facts" with regard to himself had been taken. It was the comments of which he complained.

Mr. Gill asked the jury to give damages which would mark their disapproval of this kind of journalism.

Mr. Rufus Isaacs, for the defence, declared that there was not the remotest intention on the part of the defendants to reflect on the plaintiff's character or professional conduct. The article was an attack on the British Electric Traction Company, and Mr. Sellon, who played only a very unimportant part in the controversy, had not suffered the slightest damage. The *Daily News* or anybody else was, he submitted, entitled to comment fearlessly, independently, and boldly.

Mr. Justice Lawrance said the question the jury had to consider was whether the *Daily News* had exercised the right of the Press to use strong language, so long as it was honestly used, on a matter of public interest, or had gone out of its way to attack the private character of the plaintiff.

The jury found for the plaintiff, and awarded him one farthing damages.

Mr. Justice Lawrance having left the court before the jury returned, judgment was not entered.

ALLEGED UNSATISFACTORY TELEPHONE.

At the Marylebone County Court on Monday, before Deputy-Judge Fitzroy Cowper and a jury, the National Telephone Company brought an action against Mr. Henry Samuel, 11, Cleveland-square, Hyde Park, W., and Basildon House, Moorgate-street, E.C., claiming £10. 11s. 8d. in respect of the rent of a telephone.

Plaintiff's counsel stated that in January, 1900, the defendant entered into an agreement with the plaintiff company for the latter to supply a telephone with telephonic communication with other subscribers. The agreement was for five years, the defendant undertaking to pay £10. 5s. annually in advance. According to the terms of the agreement, the company were to maintain the telephone in good working order. When defendant's subscription became due in January last he declined to pay, and on March 6 the defendant was disconnected. The defence was that the telephonic communication was so ineffective that the defendant ought to be released from his agreement.

The jury returned a verdict to the effect that the telephone in question had not worked reasonably well, the Foreman remarking that they considered it was radically wrong.

His Honour accordingly gave judgment for the defendant with costs, and made an order for the recision of the five years' agreement.

Counsel for the plaintiff company intimated that there would probably be an appeal.

WHAT IS ENGINEERING WORK?

A novel issue under the Workmen's Compensation Act came before Judge Williams on Wednesday at Pontypridd County Court. The applicant for compensation sustained injury whilst doing duty on a steam-roller used to level roads, which had been disturbed by the respondents, Callender's Cable and Construction Company, who were contractors for the Electric Power Distribution Company. The contention of respondents was that this case did not come within the purview of the Act; that it was not engineering or kindred work in any sense. The Judge, however, decided for the claimant, and made an award for 13s. 5d. a week to be paid to the workman during incapacity.

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COMPANIES' MEETINGS AND REPORTS.

TELEGRAPH CONSTRUCTION AND MAINTENANCE.

The half-yearly meeting of the shareholders in this Company was held on the 14th inst. at the offices, Old Broad-street, Sir R. G. W. Herbert presiding.

The **Chairman** reminded the shareholders that they were on that occasion holding only their half-yearly meeting, at which no accounts were presented. Since their last meeting the second of the Company's great cable constructions across the Pacific had been completed—that which had been carried out by them for the Commercial Company from Honolulu to Manila. This considerable work was completed by them, to the great satisfaction of the Government and people of the United States, on their Independence Day, the 4th inst., and the directors were glad to know that, as far as they had heard, the cable was quite equal in its character and performances to those which the Company had laid to other places. It was about 5,800 knots, so it was a very considerable work, and on completing it they had brought up their record since the formation of the Company to no less than 175,000 miles of deep-sea cable and to as much as 200,000 knots of insulated guttapercha-covered wires for submarine telegraph purposes. This was really a very remarkable record. The works were in very good order, and there was an amount of work in hand which would carry them on through a considerable part of the current year. He thought it might be said that the prospects of cable construction generally were not bad, although perhaps there was nothing of any very great importance to be dealt with immediately. There seemed, however, to be a tendency to have more and more direct cable communication between different ports and points, and the directors felt that the prospects of the industry were not at all interfered with by the aerial telegraph system, inasmuch as the conviction seemed to be growing stronger that that system could not compete with cables on a commercial basis, or at long distances more particularly. It might have been observed that the shares of cable companies had risen very materially from the low quotations to which they fell, and on the whole he thought that the prospects of submarine telegraphy were quite good. He expressed his readiness to give any further information which the shareholders might require, but reminded them that the directors had no resolution to submit on that occasion. No question, however, was asked by any shareholder, and the proceedings terminated with the chairman's statement.

ELECTRICAL POWER STORAGE.

Presiding over the ordinary general meeting at the offices, Great Winchester-street, on the 9th inst., **Mr. J. Irving Courtenay**, in moving the adoption of the report (which appeared in our issue of the 3rd inst.), said the steady improvement in the business justified them in recommending an increase of 1 per cent. in the dividend, making it 6 per cent., while again transferring £5,000 to the reserve fund and £1,000 to the contingent fund. In addition to their usual business in smaller batteries for lighting and traction, they had completed during the year under review more than 20 large installations in connection with lighting and power stations in various parts of the kingdom, and they had in course of erection or on their books at the beginning of the year orders for 13 similar installations. They therefore commenced the year with their order-book well filled, and it was gratifying to know that in every department the works were fully employed. The new Carzonode plate had created considerable interest, and was achieving most satisfactory results wherever it had been used. The Company had had a very large sale for batteries for propelling electric carriages, and in this connection they had been steadily continuing experiments with the Company's own vehicles, and thus collecting a mass of valuable statistics. The competition had been quite as severe as in previous years, and they had also had an American invasion, as the largest storage battery company on the other side of the water had acquired the controlling interest in one of the competing companies in this country. They were quite alive to the possibilities of further competition, but they were well prepared to meet it if necessary. There was no fresh fact connected with Mr. Edison's battery which would tend to modify the opinion the directors formed of it when it was first brought out, and the opinion in America was similar to that held by themselves—that it was no nearer to being a commercial battery than it was three years ago. The directors had full confidence in the stability and prospects of the Company's business.

Mr. Frederick Green seconded the motion, which was carried *nem. con.*

ELECTRIC CONSTRUCTION.

The annual general meeting of the shareholders in this Company was held on the 9th inst. at Winchester House, E.C., Mr. J. W. Barclay presiding.

The **Chairman**, in moving the adoption of the report (*vide* issue of 3rd inst.), said that, considering the conditions of the business during the past year, the results submitted in the accounts before them were satisfactory. The net profit of £20,737 compared favourably with that of last year, and enabled them to recommend the same dividends and appropriations, while a larger amount was carried forward. Referring to the suggested new fiscal policy and its probable effect on their business, he considered they had passed through as severe a struggle with foreign competitors as they might reasonably expect to have to encounter in the future. The Germans had pushed hard, and secured orders from some corporations who preferred the cheapness of goods made in Germany to the higher quality of British manufactures; but the Germans had made no profit on their business in this country. It was not prosperity that had sent them to this country, but the depression that had now for some years prevailed in Germany. They considered their loss would be less in selling at unremunerative prices in this country than to allow their works to stand idle. When they had better trade at home, and when their factories, unhealthily stimulated by their protective policy, had been eliminated, we should have little to fear from German competition. Again, the American manufacturers did not seem to find much advantage from protection; for although, as they were frequently told, they had unbounded natural resources at home, two of the largest companies had come across and established works in this country. No protective tariff would help them against that competition. In his opinion, our industries had suffered more from legislative interference and restrictions, and from the mistaken notions of those who thought they were furthering the interests of the working-men, than from foreign competition. A recent case in point would illustrate this statement. The London County Council the other day resolved to accept the cheapest tenders for their work, whether from home or foreign manufacturers. The London County Council stipulated that every contractor should observe the trade union rates of wages and hours, and that the rates of wages should be published publicly in the workshops. Those conditions were enforced against manufacturers in this country, but they were not and could not be enforced against the foreign contractor. The conditions were presumably intended to prevent sweating by employers, but the result to our artisans was that work they should naturally have goes out of the country, because the interference between employers and their workmen tended to raise friction and dispeace in the factory, which employers strove to avoid, and indirectly added considerably to the cost and risk of manufacturing. He did not like foreign competition, but he did not believe that the doom of our manufacturing interests was to come by foreign competition.

Mr. P. E. Beachcroft seconded the motion, and it was unanimously adopted.

NATIONAL TELEPHONE.

The report of the directors for the half-year ended June 30 last states that the income accrued in respect of the business of the half-year amounts to £894,047, as compared with £823,243 for the corresponding period of 1902, being an increase of £70,803. Working expenses for the half-year amount to £516,052, as compared with £478,032 for the corresponding period of 1902, being an increase of £38,020. The net result for the half-year (after deducting the Post Office royalties amounting to £81,930) is a profit of £296,064, as compared with £269,445 for the corresponding period of 1902, being an increase of £26,619. The rentals carried forward for unexpired terms of running contracts amount to £874,383, as compared with £821,397 at the corresponding period of 1902, being an increase of £52,985. Out of the available balance of £239,748 the Board recommends the payment for the half-year of a dividend at the rate of 6 per cent. per annum on the first and second preference shares, 5 per cent. per annum on the third preference shares, 6 per cent. per annum on the preferred stock, and 5 per cent. per annum on the deferred stock; to transfer £85,000 to reserve fund, carrying forward £5,831. The sum of £334,116 has been expended on capital account during the half-year in the erection of 14,606 additional exchange and private stations and in the construction of underground works.

NEW COMPANIES REGISTERED.

Bridge Accumulator Syndicate, Limited.—Capital, £1,000, in £1 shares. Object: to carry on the business of manufacturers of accumulators for dynamos, engines, and motors under the new "Bridge" process.

Portpatrick Electric Supply Company, Limited.—Registered in Edinburgh. Capital, £2,000. Object: to carry on the business of suppliers of electricity in all its branches. Registered office: Dunskey Estates Office, Portpatrick.

London General Automobile Company, Limited. — Capital, £10,750. Object: to carry on the business of builders and proprietors of automobiles, motorcars, engines, and carriages, whether propelled by electricity or other power.

Ozone Generators, Limited.—Capital, £6,000. Objects: to adopt a contract between E. Coustau and H. Diamant and to carry on the business of manufacturers and sellers of a gas generally known as "ozone," either by means of an electrical apparatus or otherwise. Registered office: 29-30, King-street, E.C.

Uddingston District Electric Lighting Company, Limited. — Capital, £1,000. Object: to carry on in Bothwell, county Lanark, the business of electricians, mechanical engineers, and suppliers of electric light in all its branches. Registered without articles of association. Registered office: 83, Cannon-street, E.C.

Hyde Electrical Manfacturing Company, Limited.—Capital, £5,000. Objects: to acquire the business of electrical and mechanical engineers carried on at Hyde, Cheshire, as the Pollard Electrical Engineering Company, Limited, and to carry on the business of electrical engineers, electricians, and suppliers of electric light, heat, and power. Registered office: Mary-street, Hyde.

Glamorgan Engineering Company, Limited.—Capital, £16,000. Objects: to acquire and carry on the business of electrical and mechanical engineers (but not of metal merchants, machinery brokers, and licensed valuers) carried on by C. E. and H. M. Peel, Limited, at Swansea and elsewhere, and to adopt an agreement with the said company, C. T. Peel, H. M. Peel, and A. L. Furneaux. Registered office: Glamorgan Engineering Works, Upper Strand, Swansea.

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APPOINTMENTS VACANT.

Clerk of Works, London County Council Tramways, 3 to 3½ guineas per week, July 22.

Assistant Electrical Engineer, Corporation of Torquay, £150 per annum, July 20.

Assistant to Electrical Engineer, Bray Urban District Council, £80 per annum, Aug. 4.

Engineer - in - Charge, Electricity Department, Borough of Bermondsey, £104 per annum. See advertisement.

Electric Lighting Superintendent, Electricity Works, 27, Osborn-street, Whitechapel, E., July 20. See advertisement in last issue.

Assistant Superintendent, Indian Telegraph Department, Rs.4,200 a year. Apply, Secretary, Judicial and Public Department, India Office, Whitehall, London, S.W., Aug. 1. See advertisement.

Two Skilled Cable Jointers, Durban Municipality, 15s. a day. Applications, by letter, to be sent to Z.X.Y.Z., care of Deacon's Advertising Offices, Leadenhall-street, London, E.C., by July 27. See advertisement in last issue.

CONTRACTS FOR ELECTRICAL SUPPLIES.

Lisbon.—The Public Works Department require tenders for the public electric lighting of Macao. Tenders by Oct. 21.

Hammersmith.—The Borough Council require tenders for circulating pumps, motor pipework, and accessories by July 21.

Birkenhead.—The Corporation require tenders for one 350-kw. direct-current high-speed steam dynamo. Tenders by July 28.

Beszterczebanya, Neusohl (Austria).—The Municipality require tenders for the construction of an electricity station and plant of about 600 h.p. Tenders by Aug. 1.

London, S.W.—The London County Council invite tenders for switchboards. Particulars may be obtained at the County Hall, Spring-gardens, S.W. Tenders by Aug. 11.

Stepney.—The Electrical Committee of the Borough Council invite tenders for the supply of feed, suction, and other pipework, water-softening plant, and storage tanks. Tenders by July 21.

Sheffield.—The Electric Light Committee invite tenders for various electricity meters. Particulars may be obtained from Mr. S. E. Fedden, general manager and engineer. Tenders by July 21. See advertisement in last issue.

Pietermaritzburg.—The Corporation invite tenders for the supply of electric tramcars. Particulars may be obtained from Messrs. Mordey and Dawbarn, 82, Victoria-street, London, S.W. Tenders by July 29.

Colchester.—The Tramways Committee invite tenders for the erection of a tramcar shed, consisting chiefly of iron and steel. Particulars may be obtained upon application at the Surveyor's Office. Tenders by July 28.

Pointe-a-Pitre (Guadeloupe).—The Municipality invite offers for a concession for public and private electric lighting for 15 years. Tenders by Aug. 29. Particulars may be obtained from the Colonial Office, Paris.

Hapton.—Tenders are invited for lighting the township with electricity. Particulars may be obtained from Mr. Edward O'Shaughnessy, clerk to the Hapton Parish Council, 16, Hamilton-terrace, Padiham. Tenders by July 31.

Lisbon.—The Public Works Department require tenders for the construction of 1m. gauge light railways as follows: (1) Limatal, Vianna-Ponte de Barca; (2) Oberer Minho, Braga-Monçao; (3) Braga-Guimaraes. Tenders by Aug. 1.

Atherton.—The Urban District Council invite tenders for the supply and delivery of electricity meters. Particulars may be obtained from Mr. D. Schofield, clerk to the Council, Town Hall. Tenders by July 28. See advertisement.

Rochdale.—The Corporation invite tenders for the supply and delivery of copper tramway rail bonds. Particulars may be obtained from Messrs. Lacey and Sillar, 2, Queen Anne's-gate, Westminster. Tenders by 28th inst. See advertisement.

Blackburn.—The Town Council invite tenders for one complete main switchboard and accessories. Particulars may be obtained from Messrs. Lacey and Sillar, 2, Queen Anne's-gate, Westminster. Tenders by July 27. See advertisement in last issue.

Chelsea.—The Borough Council invite tenders for the installation of the electric light in the lower hall of the town hall buildings. Particulars may be obtained at the office of the Borough Surveyor, Town Hall. Tenders by July 22. See advertisement.

Shanghai.—The French Colony propose to instal motor-propelled tramways. Tenders may be sent by Oct. 31, 1903, to Secrétariat de la Municipalité Française de Shanghai. Particulars may be obtained from l'Office National du Commerce Extérieur, Rue Feydeau, 3, Paris.

Manchester.—The Paving, Sewering, and Highways Committee invite tenders for laying underground telephone pipes, with other appurtenant works. Particulars may be obtained on application at the City Surveyor's Office, Town Hall, Manchester. Tenders by July 20.

Swindon.—The Corporation invite tenders for seven electric tramcars, with all trucks, motors, and accessories. Particulars may be obtained from Messrs. Lacey and Sillar, 78, King-street, Manchester, and 2, Queen Anne's-gate, Westminster. Tenders by July 23. See advertisement in last issue.

Gloucester.—Tenders have been accepted by the Corporation for electrical work from the General Electric Company, Statter and Co., Crompton and Co., G. Law, British Electrical Equipment Company, J. G. White and Co., Brush Company, and Dick, Kerr, and Co. Fuller particulars in our next issue.

Heston and Isleworth.—The Urban District Council invite tenders for the supply of steam-engines, dynamos, boosters, etc., storage batteries, cables, and arc lamps and glow lamps. Particulars may be obtained from the Council's engineers, Messrs. J. and J. S. Enright, 47, Victoria-street, S.W. Tenders by 23rd inst.

Preston.—The Corporation invite tenders for the supply and erection of economisers, feed-water heaters, electrically and steam driven pumps, and overhead travelling crane. Particulars may be obtained from Mr. Walter H. Tittensor, consulting and resident electrical engineer, 25, Burrow-road, Preston. Tenders by July 22.

Launceston (Tasmania).—The Mayor and Aldermen invite tenders for the supply of 500 or more electric meters. Particulars may be obtained on application to Mr. William Corin, city electrical engineer, Launceston, Tasmania, or to Messrs. John Terry and Co., 7, Great Winchester-street, London, E.C. Tenders by Sept. 28.

Aldershot.—The Urban District Council invite tenders for the supply and erection at the sewage works of two 4in. motor-driven centrifugal pumps; also generator, battery, and automatic starting switches. Particulars may be obtained at the office of the Engineer and Surveyor to the Council. Tenders by Aug. 4. See advertisement.

Wednesbury.—The Corporation invite offers from firms willing to undertake free and hire-purchase electric wiring and motors within the borough. Full particulars may be obtained from Mr. F. J. Warden-Stevens, the consulting engineer to the Corporation, 34, Victoria-street, Westminster. Tenders by July 30. See advertisement.

Bath.—The Corporation invite tenders for the supply and erection of a main switchboard at the new generating station. Particulars may be obtained from Messrs. Kincaid, Waller, Manville, and Dawson, 29, Great George-street, Westminster, or at the City Electrical Engineer's Office, 7, Dorchester-street, Bath. Tenders by 27th inst. See advertisement.

Cheadle (Cheshire).—The Urban District Council invite tenders for the supply and delivery of about 350 tons of grooved steel girder tramway rails, eight tons of tie-bars, 13½ tons of fishplates, and three tons of bolts and nuts; also for 17 sets of points and crossings. Particulars may be obtained from Mr. Charles R. Brady, A.M.I.C.E., 13, Warren-street, Stockport. Tenders by July 27.

Madrid.—The Posts and Telegraphs Department require tenders for the supply of 25 telegraph apparatus of the Hughes system and 25 motors with weight elevators for the same, for the service of the telegraph stations of the State, at the upset price of 2,530 pesetas, or about £73, for each apparatus with its accessories as detailed, and 408 pesetas, or about £12, for each motor with its corresponding elevator.

RESULTS OF TENDERS.

Houghton. — The contract for laying down the rails for the tramways has been let to Messrs. Krauss and Co., Limited, of Bristol and Germany.

Gloucester.—The Corporation have accepted the tender of J. G. White and Co., Limited, for the supply of poles and mountings for the tramways, at £4,381. 5s.

London County Council.—The Council have placed a contract for lamps (British made), high and low voltage, with Mackey's Electric Lamp Company, Limited.

Dewsbury.—The Electricity Committee recommend that the tender of Messrs. J. and J. Horsfield, Dewsbury, be accepted for the supply, delivery, and erection of one Lancashire boiler.

Kettering.—The Urban District Council have accepted the tender of the Electrical Power Storage Company, Limited, 4, Great Winchester-street, London, E.C., for a storage battery.

Colchester.—The Corporation have accepted the tender of J. G. White and Co., Limited, for complete construction of the tramways—permanent way, overhead equipment, and cables—at £35,039. 8s.

Manchester.—The Corporation have accepted the tender of Messrs. Rowland Carr and Co. for the supply of box compound for the whole of their requirements for the electrical department for the next 12 months.

Derby.—The Corporation have accepted the tender of J. G. White and Co., Limited, for complete construction of the tramways—permanent way, overhead equipment, cables, cars, and equipments—at £87,627. 10s.

Gibraltar.—The sub-contract for the storage battery has been placed by the Electric Construction Company, Limited, of London and Wolverhampton, with the Electrical Power Storage Company, Limited, 4, Great Winchester-street, London, E.C.

Devenport.—The sub-contract for the storage battery has been placed by the British Westinghouse Electric and Manufacturing Company, Limited, of London and Manchester, with the Electrical Power Storage Company, Limited, of 4, Great Winchester-street, E.C.

Littleborough.—The Urban District Council have accepted the tender of the Rochdale Electric Company, Limited, for the complete electrical equipment of their new supply station, together with the wiring of the Carnegie library, municipal offices, new Board schools, etc.

Stepney.—The Borough Council has accepted the following tenders: Johnson and Phillips, Victoria Works, Old Charlton, carbons, £263 13s. 6d.; Reason Manufacturing Company, Limited, Lewes-road, Brighton, meters up to 10 amperes and demand indicators; Ferranti Limited, Hollinwood, Lancashire, meters above 10 amperes.

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Aston.—The Town Council have accepted the following tenders: British Thomson-Houston Company, Manchester, tramway feeder cables; Naylor Bros., Golborne, side bracket arms with mild-steel pressed clamps; Tramways Electrical Equipment Company, section insulators; Lancashire Electrical Engineering Company, wiring, etc., the car-shed.

Brighton.—The tender of the British Westinghouse Electric and Manufacturing Company has been accepted for the supply and erection of generating plant at the Southwick power station and motor-generator converting plant, together with switchboards, instruments, etc., at the North-road power station, including maintenance for 12 months, at £79,846, with an addition of £580 for electrically-driven condensers, subject to a set of drawings being submitted.

BUSINESS NOTES.

TRACTION.

Swindon.—The tramway tracks are to be lighted by arc lamps.

Dublin.—A scheme is on foot for a tramway from Dublin to Slane.

Dartmouth.—The Corporation have agreed to support the South Hams Light Railway scheme.

Coatbridge.—The Town Council have approved plans of the overhead equipment for the tramways.

Burnley.—Major Druitt has inspected the Accrington-road branch line, and it is now in full operation.

North Ormesby.—The Imperial Tramways Company are desirous of promoting a tramway scheme in this district.

Chester.—Residents at Great Boughton are agitating for an extension of the city tramway system to their district.

Kirkcaldy.—The Town Council have agreed to borrow a further sum of £20,000 for the purpose of tramway extensions.

Leicester.—The work of constructing the new tramways in the West End and Highfields districts has been commenced.

Reading.—Several successful trial trips have been made on the new electric tramways preparatory to the opening on the 22nd inst.

Dundee.—Heads of agreement have been drawn up with reference to the proposal to construct an electric tramway to Broughty Ferry.

Yarmouth.—The Corporation propose to apply forthwith for power to carry out several important tramway extensions at an estimated cost of £44,400.

Barrowford.—The first section of the light railway—that between Newbridge and Higherford—has been inspected by Major Druitt and opened for traffic.

Wandsworth.—The London County Council's proposal to adopt the overhead trolley system for the tramway in Garratt-lane has been negatived by the Borough Council.

Islington.—The Borough Council have decided to inform the County Council of their opinion that the conduit system of traction alone should be adopted throughout the borough.

Cheadle and Gatley.—The Board of Trade have sanctioned the borrowing of £19,740 for the purpose of tramway construction in the Council's district from Cheadle Heath to Gatley.

Ashton.—The tramways manager has been instructed to have a consultation with the engineer to the Stalybridge Joint Board relative to a temporary service of cars between the two places.

Bradford.—At Tuesday's meeting of the Bradford City Council the Tramways Committee recommended the acceptance of the offer of the Shelf Tramway Company, Limited, to sell their undertaking for £1,875, and £75 costs.

Huddersfield.—At the last meeting of the Tramways Committee the borough treasurer presented a statement showing that for the year ended June 30 the receipts were £16,749. 16s. 5d., and the expenditure £18,485. 13s. 3d., leaving a deficiency of £1,735. 16s. 10d.

Wednesbury.—It has been agreed to lease the tramways within the borough to the South Staffs Tramways Company for 30 years. The first line to be equipped for electrical working will probably be that between Wednesbury and the West Bromwich boundary.

South Bank.—The District Council have agreed that no further negotiations be entered into with the electric tramways company, seeing that the Council had an alternative scheme on foot with the Middlesbrough Corporation and North Ormesby District Council.

North Metropolitan Tramways—The directors recommend for the half-year ended June 30 last a dividend at the rate of 2½ per cent. per annum, carrying forward about £400. During the half-year the number of miles run were 7,318,017 and passengers carried 70,701,915.

Lowestoft.—The opening of the new tramway system, which was to have taken place on Saturday, has had to be postponed, as the Board of Trade officials cannot make the inspection till the 21st inst. The full service will run on the 22nd, and the formal opening will be on the 25th inst.

Heywood.—The negotiations for taking over the tramways are proceeding slowly. The differences in the valuation of the lines, etc., between the company's valuer and the valuer appointed by the various local authorities are so large that it is thought it will be necessary to resort to arbitration.

Flint.—Both the Flint Corporation and the Holywell Urban District Council have agreed to support the application of a company for parliamentary powers to construct an electric tramway running from Sandycroft along the shore to Bagilt, and thence up to Holywell, and on to Mold, Buckley, and Hawarden.

Cheltenham.—Messrs. Dodd and Dodd, civil engineers, Birmingham, have received instructions from the Cheltenham and District Light Railway Company to prepare all necessary plans to enable the light railway company to construct the authorised extensions to Charlton Kings and Leckhampton.

Rochdale.—The Town Council have sealed an agreement between the Bury, Rochdale, and Oldham Tramways Company, Limited, and the Corporations of Bury, Rochdale, and Heywood, and others for the transfer of the undertaking of the company and for carrying on the tramways until completion of the purchase.

Mid-Yorkshire.—The Mid-Yorkshire Tramways Bill, which has already been passed by the House of Lords, came last week before the examiners of the House of Commons, who certified that the further Standing Orders had been duly complied with. The Bill will, in the usual course, be reported for second reading.

Worcester.—The liquidator of the Worcester Tramways, Limited, has given notice that an application will be made to the Board of Trade to extend the time for the completion of the tramways from Aug. 9, 1903, to Feb. 9, 1904. The matter has been referred to the Streets Committee of the City Council to take action.

Dudley and Stourbridge Tramways.—The Bill to empower the Dudley, Stourbridge, and District Traction Company to work their tramways by electricity has passed through Committee of the House of Commons without opposition. The Bill, which has already passed the House of Lords, has been reported for third reading.

Pemberton.—The electrical engineer has reported that everything is now in order for the commencing of work of overhead equipment in Ormskirk-road, the British Insulated Wire Company, Limited, having been notified of the acceptance of their tender, and the overhead equipment will be started in the course of a month.

Electric Traction for Lucknow.—*Indian Engineering* states that an application has been made by Messrs. Crompton and Co., London, to the Provincial Government to supply Lucknow with electric traction. If sanction is given, the Municipality will probably introduce a system of electric lighting, and thus supply a much-needed want.

Camberwell.—Yesterday a conference between the Highways Committee and the Improvements Committee of the London County Council and representatives from the Camberwell Council was held in reference to this Council's proposed extension of the tramways from Lordship-lane to Forest-hill and from Goose-green to Stuart-road, The Newlands.

Leeds.—An accident occurred on the electric tramways last Friday, involving personal injuries to three passengers and considerable damage to the car. When going down a hill the trolley left the line, and swinging to the side of the road, caught one of the brackets. The sudden wrench tore the standard on the car from its fastenings, and in falling injured three outside passengers.

London and North-Western Railway.—A correspondent states that the London and North-Western Railway Company have decided upon a scheme for the electrification of the Newport Pagnell branch line, which leaves the main through route to the north of Wolverton, where the company's extensive wagon works are located. The branch is four miles in length, with two intermediate stations.

Blackpool, St. Annes, and Lytham.—The effect of electrically equipping the Blackpool, St. Annes, and Lytham tramway has been to more than double the receipts of last year, when the gas cars were running. For the week ending July 9 the receipts were £513. 2s., as against £202. 14s. 5d. the same week last year, and the totals from May 30 to July 9 are respectively £2,957. 0s. 1d. and £1,223. 5s. 9d.

Portsmouth.—An unfortunate breakdown on the electric tramway system, involving the suspension of traffic on several routes, took place on Tuesday last week. The mishap occurred when the cars were carrying large numbers to the beach to witness the illumination of the Channel Fleet, and the loss was consequently heavy. The mishap is attributed to the failure of a line tap. Traffic was suspended for about two hours.

Ince.—After a lively debate the following resolution was adopted at the last meeting of the District Council: "That the purchase of that portion of the Wigan and Hindley tramways situate in Higher Ince be made without any arrangement as to the future leasing of the same to the Wigan Corporation, unless the proposal or scheme to include Ince within the borough be withdrawn by the Wigan Corporation.

Sutton Coldfield.—The Bill promoted by the Corporation of Sutton Coldfield with the object of authorising them to construct tramways and to carry out a variety of improvements for the benefit of their town has been before the Police and Sanitary Regulations Committee of the House of Commons, presided over by Mr. Heywood Johnstone. So far as it related to the proposed tramways, the Committee found the preamble not proved.

Brighton.—The Lords Committee, having authorised all the proposed extensions to the tramways except that of the Montpelier-road route, have now dealt with the gas company's opposition, and granted a clause protecting the company's mains on new routes only. The gas company also opposed the application for powers to supply electricity outside the borough at a loss. Other portions of the Bill were unopposed, and with provisions specified the preamble was passed.

City and South London Railway.—The accounts of this railway for the half-year ended June 30 last show a balance, after providing for the debenture stock interest, dividend on the preference stocks, and transfer to the renewal fund of £1,500, sufficient to allow a dividend on the consolidated ordinary stock for the half-year at the rate of 2¾ per cent. per annum, carrying forward £1,500. The dividend for the corresponding period last year was at the rate of 3 per cent. per annum, carrying forward £1,750.

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Sunderland.—The Tramways Committee have referred back to the Traffic Sub-Committee a resolution prohibiting passengers from carrying with them more luggage than can be held upon the knee, unless such parcels be placed on the motorman's platform and charged for. The Electricity Committee have decided to offer the Tramways Committee a reduction from 2d. to 1½d. per unit, to take effect from April 1 last and to continue till March 31, 1904, when the question of a further reduction will be considered.

Blackwall Tunnel.—The General Purposes Committee of the Poplar Borough Council on Wednesday reported that they had considered the proposals of the London County Council to construct a tramway from Greenwich to Poplar through the Blackwall Tunnel, and recommended that consent should be withheld. It will be remembered the proposal was brought forward in the parliamentary Bill of 1903, but owing to the opposition of the Greenwich and Poplar Borough Councils, had to be withdrawn.

Leigh.—At the last meeting of the Town Council it was reported that under the South Lancashire Tramways Act, 1900, the South Lancashire Tramways Company were compelled to furnish the Corporation with a free supply of electricity for the lighting of those streets within the borough within which their tramways were laid. The committee recommended that the chief thoroughfare should be lighted with electric arc lamps, and also that all the borough gas lamps be fitted with incandescent burners. The recommendations were approved.

Liverpool and Yorkshire Railway.—A newspaper report says that rapid progress is being made by Messrs. Dick, Kerr, and Co. with the electrification of the Lancashire and Yorkshire Railway between Liverpool and Southport. A start was made early in the present year, and the work, it is fully expected, will be completed within the next few months, so as to allow the opening of the line on Jan. 1, 1904. The Liverpool and Yorkshire officials are, says the report, loud in their praise of the progress so far made with the contract by Messrs. Dick, Kerr, and Co.

New South Wales.—English manufacturers of heavy electrical machinery will be interested to learn that the Railway Commissioners of New South Wales are inviting offers for additional machinery for the traction power-house at Ultimo. Tenders are to be received by Sept. 12. It is deemed necessary to give this extended notice, as competition is open to manufacturers in different parts of the world. Twelve months or more will elapse after the tender is accepted before the work is completed. The principal work is the building and erection of another engine at the power-house.

Additional Traffic Returns.—Anglo-Argentine, £1,372 increase; Barcelona Ensanche y Gracia, £210 increase; Barcelona, £278 decrease; Brisbane, £15 decrease (month of June, £9,575, decrease £612); British Columbia Electric (month of March), gross earnings £10,352, net income £2,658; Buenos Ayres and Belgrano Electric, £154 increase (month of April, £12,995, increase £1,123); Calcutta, £630 increase; Cape Town (month of April), receipts £16,003, expenditure £8,313; Isle of Thanet Electric, £78 increase; Mexico Electric (month of June), receipts £46,270; Perth Electric, £30 increase; Port Elizabeth (month of April), receipts £4,292, expenditure £2,281.

Bury, Rochdale, and Oldham Tramways.—It was stated at the last meeting of the Whitefield District Council that at a conference of representatives of the joint authorities interested in the acquisition of the Bury, Rochdale, and Oldham Tramway Company, held at Rochdale, the sub-committee appointed by the representatives of the various authorities to confer with the tramway company with reference to this matter reported that they could not agree upon a price for the purchase of the undertaking, and that they would have to resort to arbitration. They had, however, agreed upon a working agreement pending the decision of the arbitrator.

Bath.—Complaints are being made that the operations in connection with the laying of the tramways are not being carried out as expeditiously as they might be. The following resolution has been adopted by the Surveying Committee: "That the electric tramways company be informed that the Surveying Committee are much dissatisfied at the slow progress of the work of laying the tramlines through the centre of the city, and that unless immediate arrangements are made to carry on the work night and day, the committee must, in the interest of the convenience of the public, insist upon the limitations as to the length of street being open at the same time being strictly enforced."

Manchester-Liverpool Monorail.—The Manchester and Liverpool Electric Express Railway Company will be issued to-morrow (Saturday). The capital is £2,100,000 in £10 shares, all of which are to be offered to the public. The company is to construct and work an electrical railway between Manchester and Liverpool on Behr's so-called monorail system. The length of the railway will be about 34½ miles. It is proposed to run trains every 10 minutes at a speed of 110 miles an hour, doing the journey in 20 minutes, instead of the 40 minutes of the ordinary express trains. Two classes of passengers will be carried, at fares not exceeding those at present charged by the ther railways.

Dangerous Tramrails.—Dr. J. J. Gorham, M.D., writes to the *Times* calling attention to the danger to cyclists involved in the practice of oiling or wetting tramrails. Special reference is made to the London County Council's lines at Clapham, where the correspondent testifies that "it is almost impossible to avoid side-slipping on the tramrails so long as the authorities continue to deluge the metals, which they do almost daily, after the present fashion. The process of watering the roadway, as done by the ordinary water-cart, he says, is attended with little or no danger to anybody, but the method which the tram people adopt of pouring a copious stream of water on the wheel tracks leaves them in a greasy state for the rest of the day."

Bournemouth.—Application is to be made to the Board of Trade to borrow £14,000 for the purchase of 16 additional cars. A proposal for Sunday trams has been rejected in Council by a large majority. The Corporation of Poole and the Poole and District Electric Traction Company having withdrawn their opposition to the Tramways Bill of the Corporation of Bournemouth, which has already been passed by the House of Lords the Bill has been referred as an uncontested measure to the Committee of the House of Commons presided over by the Deputy-Chairman of Ways and Means. The Corporation of Bournemouth, in return, have withdrawn their opposition to the Bill of the Poole and District Electric Traction Company, which has been referred to the same committee.

Dewsbury.—A conference was held last week between representatives from Dewsbury Corporation, Ossett Corporation, and Soothill Nether District Council to take into consideration the question of promoting a scheme for the construction of a tramway between Ossett and Dewsbury. The feeling was generally expressed that a tramway line between Dewsbury and Ossett was highly desirable, and that it was necessary in the interests of the districts. A resolution was adopted recommending the three Councils to make a joint application under the Tramways Act to the Board of Trade for an order authorising the construction of such a line. It is hoped that the Councils will adopt this resolution, and that the ratepayers will give them active support in thus trying to promote the interests of the district.

Cardiff.—A discussion took place on the tramway finances at the last meeting of the Tramways Committee. Alderman Trounce, in speaking against the construction of an electric tramway along the old horse-line route from the monument *via* Penarth-road to Grangetown, complained that the accounts showing a profit of £9,500 on the tramways on the past year were inaccurate, inasmuch as a sum of £8,824 borrowed from the rates in the past year had not yet been repaid. The electrical engineer explained that £8,824 was voted from the rates in 1902 before the tramways got into working order. This past year £9,299 was estimated at the beginning of the year as being required in aid, but the sum was not wanted, and the clear profits for the year on the undertaking worked out at £9,500. It was decided to carry out the reconstruction work indicated above.

Romford.—The Select Committee of the House of Lords presided over by Lord Ribblesdale, have considered the Romford and District Tramways Bill. The Bill, which has passed through the House of Commons, provides for the construction of over three miles of electric tramways through the centre of Romford, joining up with the existing tramways of Ilford, at a cost of about £60.000. The Commons Committee imposed upon the promoters certain street widenings, estimated to involve a further expenditure of £21,000. Mr. Vesey Knox now asked, on behalf of the Romford Urban Council, that where the roads were widened the promoters should give a pavement 8ft. wide. The committee, after hearing evidence on both sides, passed the preamble of the Bill, but declined to accede to the request of the Urban Council. Clauses having been adjusted, the Bill was ordered to be reported for third reading.

Newport (Mon.).—At the last meeting of the Council it was proposed that the Tramways Committee be requested to report upon the question of the adoption of motor 'buses in lieu of tramway on the Stow-hill route, but the motion was lost after a good deal of discussion by nine to seven. An alderman objected to a proposal by the Electricity Committee to purchase 10 additional electric cars. His own impression, founded on the procession of cars he saw frequently in Commercial-street, two or three or more following each other closely, was that there were 10 too many now. The chairman of the committee said the through service from the three routes necessitated frequent cars running along Commercial-street. There were 30 cars at present, and when the four routes were open it would be necessary to provide for the traffic in a proper way. Several members afterwards complained of the fewness and irregularity of the cars on certain sections. The purchase of the cars at £4,780 was afterwards decided upon.

Manchester Southern Tramways.—A committee of the House of Commons presided over by Mr. Gair Ashton has considered the Manchester Southern Tramways Bill, which passed the House of Lords as a practically unopposed measure. There were now several petitioners, including the Eccles Corporation, the Barton-on-Irwell District Council, the Manchester Corporation, the Manchester South Junction and Altrincham Railway Company, the Salford Corporation, and the Sale District Council. Counsel for the promoters of the Bill explained that although there was only one opponent on the preamble, and that was the Manchester South Junction and Altrincham Railway Company, who opposed on various grounds, that morning the promoters had come to terms with them. It was unnecessary, in these circumstances, to go into the merits of the Bill. He stated for the information of the committee that the promoters were persons of financial standing, and that there was no question about their ability to carry out the scheme. The Chairman declared the preamble proved, and the Bill will now be reported to the House for third reading.

Wellingborough.—The Select Committee of the House of Lords o which Lord Harris is chairman has had under consideration the Wellingborough and District Tramroads Bill. Mr. Balfour Browne, in opening, explained that by a Bill obtained in 1900 the British Electric Traction Company were authorised to construct a system of electric tramways connecting Wellingborough with Irchester, Rushden, Higham Ferrers, Irthlingborough, and Finedon, with a branch to Raunds. The object of the present Bill is merely to sanction the abandonment of a very small portion of the authorised line and to substitute a new tramroad for it. The deviation would cross the L. and N.W. Railway by means of a level crossing near Higham Ferrers Station, and running along the public road join the authorised line at the east end of the village of Irthlingborough. The proposed alteration had the consent and approval of all the local authorities. In connection with it the company had undertaken to widen a bridge over the River Nene, which very badly needed widening. The L. and N.W. Company objected to the tramway crossing their

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line. Evidence on behalf of the promoters was given. The Chairman, in giving the decision, said the committee could not agree to the level crossing, but would allow the promoters to construct a bridge over the line, or they could follow the old course. Mr. Moon thought that in the circumstances it was unlikely that the promoters would proceed with the project.

Birmingham.—An important step in the direction of joint operation as to the tramways has been taken by the Birmingham Corporation and the British Electric Traction Company. During the progress of the recent Bill promoted by the British Electric Traction Company and several local authorities to enforce running powers over the Birmingham lines, great stress was laid on the dislocation of traffic resulting from having to change from the company to the Corporation car at the city boundary. Since the parliamentary enquiry on the Bill, Birmingham has entered into a definite undertaking with the company to allow them to run their cars over two of their city lines to the central terminus. The first of a series of conferences between the Tramways Committee and the suburban authorities who have not allied themselves with the British Electric Traction Company was held on Monday. The object of these meetings is to try to arrive at the bases of understandings which will admit of arrangements being made to facilitate intercommunication between the city and the outlying districts. Monday's conference was with the representatives of King's Norton, in whose district are the Moseley-road, King's Heath, and Bristol-road termini. The District Council of King's Norton have come to the decision to exercise their right to purchase the portions of the Moseley and King's Heath lines in its district in 1906, when the leases of the Birmingham portion of these routes expire, and as Birmingham has now resolved to purchase those sections of the lines which were in the district of the old Balsall Heath Local Board, it is not expected that any difficulty will be experienced in arriving at a practical issue, especially as the Birmingham Corporation are willing to rent to the City of Birmingham Tram Company the sections of the line it is about to purchase from it. Although nothing definite was settled, all concerned are hopeful of the result being eminently satisfactory.

Middlesex.—The hearing of objections to the confirmation of the County of Middlesex Light Railways Order made by the Light Railway Commissioners took place on Wednesday last week, at the Board of Trade, before Sir Herbert Jekyll, assistant secretary of the railway department. The order authorises the construction of light railways in the parishes of Acton, Edgware, Edmonton, Enfield, Finchley, Friern Barnet, Hendon, Hornsey, Little Stanmore, Southgate, Tottenham, Wembley, Willesden, and Wood Green. The County Council, the Great Northern Railway Company, the New River Water Company, the local authorities, and various owners were legally represented. Clause 62 dealt with the important question as to whether the County Council should be entitled to carry parcels on their light railways, which might be in competition with the Great Northern Company, the arrangement having been come to between the parties that they should only be entitled to carry passengers' luggage up to a certain weight. Mr. Hill Dawe, solicitor to the company, said the serious question was raised whether the principles which governed the procedure and practice as to private Bills were to have any recognition with regard to light railway orders, whether, in other words, agreements with promoters were to be respected. When opponents of a scheme withdrew their opposition on the preamble on the faith of an agreement they were damnified beyond redress if the agreement were not carried into effect, and the authorities at the House recognised this. In this case a light railway was promoted which would compete with the Great Northern Company, and the company had come to an agreement with the Council as to traffic. But the Light Railway Commissioners had written that Clause 62 went rather beyond what could be properly allowed having regard to the possible interests of the public. He urged that unless agreements were respected it would put an end to all negotiations. Sir Herbert Jeckyll promised that the Board of Trade would consider the point. The order was passed.

Doncaster.—Mr. W. Wyld, borough electrical engineer, has presented a report to the Tramways Committee, in which he gives some interesting figures showing the progress of the electric tramway undertaking in the town. The number of passengers carried since Saturday, June 6, to Saturday last, July 11, was 249,916, representing a revenue of £1,033. 1s. 4d., the numbers for the corresponding weeks last year being 184,429 (£767. 14s. 4d.). The total receipts for the five weeks were as follows: week ending June 13, £166. 5s. 11d.; June 20, £169. 2s. 1d.; June 27, £203. 17s. 4d.; July 4, £296. 9s. 3d.; and July 11, £197. 6s. 4d. The abnormal receipts for the week ending July 4 were due to the agricultural show and Bentley Feast. From the figures given in the report it is noticed that there have been 5,943 ½d. fares since the committee decided to run workmen's cars, this representing 2·3 per cent. of the total number of passengers carried. Although this does not show any great improvement in the revenue, yet it shows that the tramways are fulfilling one of the objects of their institution—*i.e.*, the provision of a cheap form of conveyance to a certain class of the public. The department has just completed the first quarter of the second year. The total expenditure amounted to £2,291. 7s. 10d., while the total receipts were £2,719. 7s. 5d., leaving a credit balance over working expenses of £427. 19s. 7d. The sinking and redemption fund for this period amounts to £677. 2s. 9d., and this brings the net result for the last quarter ending June 30 to a debit balance of £249. 3s. 2d. The expenses during the last quarter include an item of £368. 5s. 4d. for damages and costs in the Nicholson case, and had it not been for this item there would have been a net profit of £120. 2s. 2d. The amount oi £134. 10s. 4d. for the scavenging and repairing of the track outside the borough is included in the expenditure this quarter, but is really for the past year. The average total working cost per car mile works out at 6·18d., leaving a balance between total working costs and receipts per car mile of 1·08d. During the thunderstorm on Saturday afternoon last the overhead line in Thorne-road was struck by lightning, and the insulators on the last bracket arm on that section broken down, which delayed the traffic about an hour.

London County Council (Tramways and Improvements) Bill.—This week the Select Committee of the House of Lords over which Lord Harris presides, were engaged in considering the proposals embodied in this Bill. Mr. Erskine Pollock, K.C., for the London County Council, said that, with the exception of two short lengths, the proposed tramways were all in the borough of Hammersmith. No. 3 was a double line nearly three miles in length, beginning in Scrubbs-lane, on the north side of Wormwood Scrubbs, at the county boundary, and terminating in Queen-street, near its junction with Bridge-road, joining the line authorised last year. In connection with this certain widenings were necessary, and would be carried out before the tramway was made. In connection with this line two short lengths of tramway (single lines) were proposed making junctions with the existing lines of the London United Tramways Company. Tramway No. 4 was a double line of 2 furlongs 4·21 chains beginning in Broadway, Hammersmith, by a junction with No. 3. Passing along Bridge-road, it would stop on the London side of Hammersmith Bridge. Other tramways proposed were in the parishes of Streatham and Wandsworth, No. 6, a double line 1 furlong 6·20 chains in length, beginning at the south-western end of Wimbledon-road, would terminate in Garratt-lane in a junction with the line authorised in 1901, and No. 6A, a short double line beginning in Wimbledon-road, would terminate in Garratt-lane. The lines were proposed to be constructed for the use of electrical power in the working, and certain sections of the Act of 1890 were incorporated by which it was provided that tramway lines within the London area should be electrified under the same rules. The cost of lines Nos. 3, 3A, and 3B would be £68,000 odd, and in connection with these certain widenings and improvements were proposed at a cost of £64,300, of which the Hammersmith Borough Council would contribute a third. The cost of Nos. 4 and 4A would be £15,500, and of the Wimbledon sections £8,300, and the cost of widening would be £5,300. Opposition to the Bill came from the London General Omnibus Company and owners and occupiers of property, and the Hammersmith Council raised various objections. Evidence in support of the Bill was given by Mr. J. W. Benn, chairman of the Tramways Committee of the London County Council; Mr. M. Fitzmaurice, C.E., engineer to the Council; and Mr. A. Young, valuer to the Council. On Tuesday Mr. Pollock said an agreement had been arrived at with the Hammersmith Borough Council, and the latter were now fully protected. Therefore their petition would be withdrawn. On Wednesday the committee found the preamble proved so far as Tramway No. 3 was concerned, it being understood that there was an undertaking on the part of the London County Council that the method of crossing the lines of the London United Tramway Company should be settled by the Board of Trade, and that all costs approved by the Board of Trade in relation to the crossing would be borne by the London County Council, including supervision should that be necessary. The committee found the preamble proved in reference to Tramway No. 6, and in regard to No. 4, except that they did not see the necessity for carrying on the tramway to the proposed terminus. The committee thought it should be terminated at a point a little to the south of Bridge-street.

Halifax.—The tabulated tramway accounts for the year ended March 31, 1903, have now been issued. The revenue from all sources amounted to £61,448, and the expenditure, including sinking fund and interest to £61,661, leaving a deficiency of £213 to charge to the renewal fund. Some of the principal features in the accounts are worthy of particular mention. In 1898·9 the Corporation had 6¼ miles of track and 17 cars. In 1902·3 the track had increased to 30¼ miles, and the number of cars had advanced to 82. In the former period 160,319 miles were run by the cars, and 2,594,478 passengers were carried. Last year the car miles run had advanced to 1,219,939, and the number of passengers reached the enormous aggregate of 14,676,254 persons, or only a small number short of 15,000,000. The receipts during the same time had increased from £10,810 in 1898·9 to £61,151 for the 12 months ending March 31 last. In regard to the receipts per mile run, the return was not so favourable. This stood at 16·20d. in 1898·9 and at 13·27d. in the following year. Since then there had been a gradual diminution, until last year 12·08d. per car mile was recorded, or just a fraction over 1s. In regard to the cost per mile run, the returns show a gradual lessening, which may be possibly regarded as a set-off to the smaller revenue per mile earned. This stood at 10·88d. in 1898·9, and at 9·03d. last year, and which in itself is a reduction of just over ¼d. per mile run, compared with 1901·2. The charges for interest have gone up from 1·54d. in 1898·9 to 1·84d. last year, the highest point yet reached. The amount required for sinking fund has also advanced in the same period from ·57d. to 1·25d. per mile. This brings the total cost to 12·12d. per mile, compared with 12·08d. in receipts, or equivalent to a loss of ·04d. per mile run, an insignificant item on the distance stated, but a substantial figure when the total mileage covered in 22 months is taken into consideration. The previous year, 1901·2, resulted in a loss of 0·7d. per mile, so that relatively speaking the cars last year did slightly better, owing apparently to economies in working. But in 1898·9 there was a profit of 3·21d. per mile, in 1899-1900 a profit of 1·36d. per mile, and in 1900-1 a profit of ·48d. The accounts also show an interesting series of comparisons with the previous year, of which those appended are the most important. In every case the figures first given refer to 1901-2, and the second lot of figures to 1902-3. Expenditure side: current, £14,395, against £16,163; traffic (wages, etc.), £11,941, against £13,811; cleaning cars, £1,322, against £1,275; general repair of cars, £3,029, against £2,598, an appreciable reduction; electrical repair of cars, £1,095, against £1,204; maintenance of permanent way, £1,861, against £2,889; maintenance of works, £512, against, £391; overhead equipment, £1,847, against £1,193; management expenses, £2,238,

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against £2,488; rent, rates, and taxes, £2,727, against £2,094, a reduction on rates which wants some explanation; legal and parliamentary expenses, £300, against £398; and miscellaneous, £340, against £323. The receipts from passengers on the other side amounted to £61,390, as compared with £54,891 in 1901-2, and from parcels £238, against £77. The latter figures show that the parcel traffic was increasing. The deficiency on the net revenue account for the year is debited to the renewal fund, which has now a balance of £5,536. The expenditure on capital account is £313,232.

London County Council.—The annual accounts of the receipts and expenditure in connection with the London County Council's tramway undertaking for the year ended March 31 last were presented at Tuesday's meeting. With regard, first, to the southern system, which is owned and worked by the Council, the net capital expenditure on these tramways amounted at the end of March last to £1,504,460, of which £93,400 has been repaid out of revenue. During the year 1902-3 the expenditure on capital account amounted to £617,210. The total receipts from the undertaking during the year amounted to £444,698, while the working expenses were £397,080, showing a surplus revenue on working of £47,618. Debt charges have had to be met (*a*) for interest £25,627, and (*b*) for sinking fund £24,242—together £49,869—leaving a deficiency of £2,250 to be carried to the appropriation account. The committee attribute this deficiency mainly to the loss of receipts from the dislocation during the reconstruction of parts of the tramways for electrical traction, and they confidently anticipate that when the work is completed and the tramways are being worked by electrical power the receipts, and consequently the surplus revenue, will be largely increased. The Council have established in connection with the undertaking a renewals reserve fund, to which £11,000 has been added during the year out of revenue, and the total amount of the fund on March 31, 1903, was £35 072. 0s. 3d. The moneys of this fund are being used to defray the expenditure incurred during the year in connection with the establishment of temporary power stations at Loughborough Junction and at Deptford for the electrical working of some sections of the tramways pending the construction of the permanent electricity generating station to be established at Greenwich. The total expenditure for these temporary stations is estimated at £27,100, and it has been arranged that this shall be met out of the reserve fund, and repaid out of revenue during the three years ending March 31, 1906, or during the period that the temporary stations shall be required. The number of passengers carried during the year 1902-3 was 109,615,496, a decrease of 10,265,063 on the previous year's figure, due to the fact that the traffic on the sections of the tramways which have been reconstructed for electrical traction was necessarily interfered with to a large extent while the work was in progress. The accounts of the northern system—the lines leased by the Council to the North Metropolitan Company—show a different result. The receipts from these lines during the year by way of rent and percentage of increased receipts amounted to £75,222, and after allowing for certain rent drawbacks, the actual net receipts to the Council were £74,764. Out of this, sum interest and sinking fund charges amounting to £36,970 have been paid, so that the surplus revenue carried to appropriation account was £37,794. Expenses amounting to about £5,000 during the year in connection with the promotion of tramway legislation by the Council have been charged to revenue account. The deficiency on general account amounts to £5,855, making, with that on the southern lines, a total deficiency of £8,106 to be charged against the surplus revenue of the Council's tramways. After deducting that amount from the surplus on the northern system and carrying £20,000 to the relief of rates, a balance of £9,869 is carried forward. Reporting on the application of surplus revenue from the tramways, the committee state that the surplus available on April 1, 1902, was £45,181. 16s. 5d., of which £45,000 has been applied in relief of rate, leaving a balance of £181. 6s. 5d.; the surplus revenue on the northern system in respect of the year 1902-3 is £37,794. 0s. 4d., while the deficiency on the southern system is £2,250. 16s. 10d., and on the general account is £5,855. 13s. 6d., making a total of £8,106. 10s. 4d. The available surplus revenue, including the balance of £181. 6s. 5d. above referred to, amounts, therefore, to £29,869. 6s. 5d., and they propose that £20,000 should be transferred for relief of rates, leaving a balance of £9,869. 6s. 5d. to be carried forward to the year 1903-4 account. A special report, covering some nine pages of the agenda, was also submitted by the Highways Committee containing proposals for new tramways, and advising an application to Parliament for the necessary powers in the next session. The total mileage of the proposed new lines is 29½, and the doubling and reconstruction of existing tramways accounts for another 3¾ miles. The estimated cost for the construction or reconstruction of the tramways, the paving of the tramway tracks, the provision of cars and car-sheds, and other works in connection with the tramways, amounts to about £1,580,325. The necessary street widenings in connection with the scheme are estimated to cost £722,230, so that the total expenditure involved is £2 302,555. This is to be met as follows: estimated recoupment by sale of surplus property, £37 430; contributions from local authorities, £228,261; improvement charge to be borne by the Council, £228,267; and tramway charges for improvements, £228,267; and for construction, etc., £1,580,325. The only charge on the rates will be the outlay by the Improvements Committee of £228.000 on street widenings, and this will be equivalent to about £11,500, or ·06787d. in the £. The proposed new lines, which are mostly revivals of former schemes which have been dropped or rejected by Parliament, are as follows: Hampstead-road tramways terminus to a point in Tottenham Court-road near Oxford-street; Westminster Bridge-road, *via* Victoria-embankment, to north side of Strand; Southwark-street to Lambeth Palace-road; Waterloo-road tramway terminus to a point opposite York-road; Goose-green to Stuart-road, Peckham; Greenwich to East India Dock-road, *via* the Blackwall Tunnel; Shepherd's Bush-road to a point near the Marble Arch; Marble Arch to Cricklewood; Battersea Park-road, *via* Battersea Bridge, to King's-road, Chelsea; Clapham Common to East-hill, Wandsworth; Streatham tramways terminus to county boundary; authorised tramways in Tooting High-street to new county boundary; Lordship-lane to Forest-hill; Lewisham High-road to Forest-hill; New Cross, *via* Lewisham High-road, to Lee-green; Deptford to the Herbert Hospital, Woolwich; doubling of part of and reconstruction of the existing tramways from Beresford-square, Woolwich, to the terminus at High-street, and construction of new tramways thence to county boundary, near Abbey Wood; doubling of existing tramways from Greenwich to Catford. It is proposed to adopt the underground conduit system, with the exception of two routes—one at Woolwich and the other through the Blackwall tunnel, which will be constructed on the overhead trolley system. A further report by the same committee recommended the expenditure of £148,500 for the purchase of plant for the electricity station to be established at Greenwich, including (*a*) three 5,000-h.p. steam generators; (*b*) 10 water-tube boilers with mechanical stokers; (*c*) pumps, tanks, steam, exhaust and feed piping, etc.; (*d*) economisers and switchgear; (*e*) connecting cables, etc. Plans are to be prepared in connection with the proposed Pimlico generating station.

LIGHTING AND GENERAL.

Guildford.—The electricity company intend to extend their main in Mount-street.

Beverley.—The order obtained by the Corporation will lapse at the end of the present month.

Harrogate.—The Town Council have received sanction to borrow £46,000 for electric lighting purposes.

Slough.—The Slough and Datchet Electric Light Company commenced to supply customers on Saturday.

Hollingbourne.—The District Council will oppose the Kent Electricity Company's Bill for the installation of electric light in the district.

Worcester.—The Electricity Committee are considering the question of supplying electricity for power purposes to works in the city.

Newquay.—The Southern District Electricity Corporation intend to apply for a provisional order for the supply of electricity to the urban district.

Warrington.—Owing to increased demand for electric light, the Town Council have decided to lay a new electric feeder and to extend the electric mains.

Colchester.—Mr. H. Ross Hooper has held an enquiry into the application of the Council for sanction to borrow £6,983 for purposes of electric lighting.

Globe Telegraph and Trust Co.—The directors announce a quarterly dividend of 3s. each on the preference shares and 2s. each on the ordinary shares.

Dublin.—Delegates from the International Trades Congress inspected the Corporation electric lighting works at the Pigeon House and in Fleet-street last week.

Watford.—Mr. H. Ross Hooper has held an enquiry into the application of the Urban District Council for sanction to borrow £1,500 for purposes of electric lighting.

Godalming.—The Inland Waterways Company intend to apply in the next session for a provisional order to supply electricity within the Rural District Council's district.

Seaford.—The Hiram Maxim Electrical and Engineering Company, Limited, intend to apply for a provisional order authorising the supply of electrical energy in the district.

Braintree.—The Urban District Council will oppose the application of the Southern District Electricity Corporation, who intend to apply for a provisional order to supply electricity within the urban area.

Ulverston.—The Urban District Council will object to the application of the electric light and power company who intend to apply for a provisional order to supply electricity within the Council's area.

Pontypridd.—The District Council have decided not to enter into an agreement to take energy in bulk from the South Wales Electrical Power Distribution Company, but to erect their own generating station.

Excursion.—On Saturday last the annual excursion of the employés of the Hart Accumulator Company took place. A very enjoyable day was spent at Hastings, the party returning to town in the evening.

Bognor.—The Urban District Council have decided to adopt the principle of an electric lighting scheme submitted by Messrs. J. and S. Enright (for Messrs. Suter and Co.), subject to the security being satisfactory.

London County Council.—The Council on Tuesday agreed to lend the Stepney Borough Council £2,790 for electric lighting and street-lighting purposes, and the Battersea Borough Council £2,336 for street-lighting purposes.

Bishop's Stortford.—The Bishop's Stortford Electricity Supply Company intend to apply for a provisional order for powers to supply electricity for public and private purposes. The Urban District Council will take no action at present.

Brighton.—The Telephones Committee have decided to apply for sanction to the borrowing of £3,000, being the estimated cost of the execution of the necessary works to include the borough of Hove in the Corporation telephone system.

Llandilo.—The Urban District Council are considering the tender of Mr. Bertram Thomas of £1,192 for the new plant and for maintenance for a year, and for supply of light at £290 up to 22,000 units, and at 1½d. per unit for additional current.

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Sunbury.—The Twickenham and Teddington Electric Supply Company intend to apply for a provisional order for supplying electricity in the urban district. The District Council will confer with the company's representative at the next meeting of the Council.

Macclesfield.—The Electricity Sub-Committee of the Corporation are undertaking a second canvass of the town with the object of ascertaining what demand there is likely to be for electricity in the event of an installation being established in the borough.

Northwich.—At a recent meeting the promoters of the North-Western Electricity and Power Bill decided to consent to the amendments suggested, giving the local authorities reasonable protection. In consequence the petition against the Bill has been withdrawn.

Wirral.—The Rural District Council have withdrawn their opposition to the North-Western Electricity Bill, having secured nearly everything they desired. But they have not obtained the same privileges for the district roads as the County Council did for the main road.

Torquay.—The Electric Light Committee in their last report state that an equivalent of 98 8-c.p. lamps were connected during the month, and there are six applications in hand. The committee were of opinion that the present-day demand would not justify the laying down of a main at Chelston.

Kingstown.—The Electric Lighting Committee of the Urban District Council are considering an offer from Mr. William M. Murphy, chairman of the Dublin Tramway Company, to supply Kingstown with electric current on favourable terms without any capital expenditure by the Council.

Glastonbury.—The Southern and Western Electric Corporations intend to apply for provisional orders to supply electricity within the borough. A sub-committee has been appointed to consider the matter and report to the Council. The Town Council's application for the telephone is before the postal authorities.

Hackney.—The Borough Council have decided to reduce the price charged for electrical energy for power purposes from the flat rate of 2d. per unit to the following: for the first 1,000 units per quarter at any one premises, 2d. per unit; all consumption in excess of 1,000 units per at any one premises, 1½d. per unit.

Chippenham. — The Southern District Electricity Corporation intend to apply for a provisional order to supply electricity within the borough. The Town Council have given notice to the Rural District Council of intention to apply for an order to supply with electricity the districts contiguous to the borough.

Caerphilly.—Messrs. Herbert Lewis and Fletcher, of Cardiff, intend to apply for a provisional order for electric lighting within the area of the Council. A similar notice has also been given by the Empire Electric Lighting and Power Company. A special meeting of the Council will be called to consider the whole matter.

Direct United States Cable Co.—The directors recommend a final dividend of 's. per share and a bonus of 1s. per share, making, with the three interim dividends already paid, a total distribution of 3¼ per cent. for the year ended June 30 last. After placing £8,000 to reserve fund account, it is proposed to carry forward a balance of about £2,693.

Electricity in Entertainments.—The electrician at the Oxford frequently makes practical and effective use on the stage of the elaborate electric light installation which is at his command. At present there may be seen as part of a magnificent programme a combination of lamps and acrobatic feats which ought to interest some of the inquisitive amongst our readers.

Dorchester.—At Tuesday's meeting of the Town Council, the Electric Lighting Committee reported that as the proposed cost of the power station with gas plant, machinery, cable, and arc lamps for installation of the electric light over the compulsory area was so excessive, they had adjourned the further consideration of the question for the attendance of the electrical engineer.

Bermondsey.—The Electric Lighting Committee of the Borough Council, at the last Council meeting, asked permission to deal with the tenders, when received, for the erection of a destructor, engine-room, and new boiler-house, etc., in connection with the extensions to the electric lighting installation. The Council, however, decided that a special meeting should be held on the occasion.

Whitefield.—The Council have received the following offer for electric lighting: general supply, 7d. per unit on the maximum demand system for one hour per day, and 3d. per unit for all additional consumption; domestic supply, 5d. per unit; motive power and heating, 4d. per unit on the maximum demand system of one hour per day, and 1d. per unit for all additional consumption.

East Molesey.—The Twickenham and Teddington Electric Supply Company, Limited, intends to apply for a provisional order for electric lighting in this urban district. The Council have decided that before they give any consent to the application the company should undertake to pay all their expenses, together with the £100 or thereabouts which the Council has already spent in regard to the proposed provisional order.

Whitehaven.—The Urban District Council have resolved that on and after Oct. 1 next, the charges for current supplied to private consumers of £12 per annum and 2d. per unit by meter be reduced to £8 per annum and 2d. per unit, and the uniform charge from 6d. to 4½d. per unit. Application will be made for sanction to borrow the sum of £2,500 for the main to the union workhouse and infirmary and extension of mains.

Farnham.—The Sir Hiram Maxim Electrical, etc., Company, Limited, intend to apply for a provisional order for the supply of electricity in Farnham. The Inland Waterways, Limited, have given similar notice. The National Electric Wiring Company, Limited, have made an offer for working the Council's electric light provisional order. The matter will come before the Council in committee at a meeting on Friday.

North Ormesby.—The District Council have referred to a committee a letter from the National Wiring Company, Limited, pointing out the conditions on which they would be prepared to run electric works in the locality, the Council to apply for the provisional order and to provide the capital, and a notice from the Empire Electricity Company of intention to apply for a provisional order for power to lay down works in the district.

Stock Exchange Settlements.—The Stock Exchange Committee have ordered Charing Cross and Strand Electricity Supply Corporation, Limited, further issue of £49,712 4 per cent. debenture stock (redeemable) to be quoted in the official list. Applications have been made to the committee to allow British Electric Traction Company, Limited, further issue of 75,000 6 per cent. cumulative preference shares of £10 each, fully paid, to be quoted in the official list.

Southwark.—The Borough Council have decided that, with the view of encouraging the more general use of electric energy for motor purposes within the Council's area of supply, the electrical engineer should be authorised to enter into an agreement with the British Thomson-Houston Company, Limited, to act as their agent for the sale of motors on the hire-purchase system, the Council having no power to raise money for that purpose or conduct such a business themselves.

Malling.—The Kent Electric Power Syndicate and the Kent Electric Power Company propose to apply at the next Board of Trade session for a provisional order authorising the supply and distribution of electricity for lighting and other purposes within the whole of the Malling area. The Rural District Council are making enquiries especially in regard to the imposition of a time limit and the possibility of being able to purchase the undertaking at cost price at the expiration of a certain period.

Swindon.—The electrical engineer has submitted a statement showing the extensions of the electric mains which may be carried out during the next three or four years, together with an estimate of the cost, with the view of obtaining the sanction of the Local Government Board to the necessary borrowing power. Applications have been received for the supply of current to several premises in Devizes and Westlecott roads and Goddard-avenue. These mains will be available for street-lighting, and will be carried out at a cost of £700.

Finchley.—The North Metropolitan Electric Power Supply Company propose shortly to open up the roads in this Council's district for the purpose of laying mains for the supply of electricity in bulk, and the laying of high-tension cables in connection with the authorised light railways in this district. It has been recommended (1) that as the plan accompanying such notice does not furnish the particulars specified in the company's Act, preliminary objection be taken thereto; (2) that notice be given to the company that the Council object to their supplying energy in bulk within this district, under Section 11 of their Act; (3) that notice be given to the County Council of Middlesex as the authorised users within the said section that this Council will be prepared to consider applications for the supply of such energy.

Useful Arts Catalogue.—Mr. Basil Anderton, B.A., chief librarian at the public library, New Bridge-street, Newcastle-upon-Tyne, has recently issued a new catalogue of books on the useful arts, with the object of bringing home to readers a knowledge of the large resources of the library, so that the fullest use may be made of its books and the greatest possible benefit be obtained from them. We find that nearly six pages are taken up with works on electrical engineering, apart from books specified under the heading of automobiles, tramways, telegraphs and telephones, etc. The general works include books on theory of electricity, electrical journals, etc. There are separate sections for dynamo machines, electric lighting, electric railways and tramways, transmission of electric force, and storage of electric force. The catalogue is properly indexed, and is divided into an authors' list, also a list of anonymous works and periodicals and subject list, and is by far the best production of its kind which has come under our notice.

New Issues.—The Charing Cross and Strand Electricity Supply are issuing 40,000 "City Undertaking" 4½ per cent. cumulative preference shares of £5 each. The business of the company is divided into two sections—namely, the City undertaking and the general undertaking, each having a share capital of £800,000. The prospectus states that the generating station at Bow and the sub-stations at Fenchurch-street, Upper Thames-street, and Ludgate-hill have been in partial use since May, 1902, and are now equipped with plant in full working order sufficient to give supply to 350,000 8 c.p. lamps. Supply is actually being given to 194,000 8-c.p. lamps, and other contracts have been entered into for 32,000 lamps. A fourth sub-station is being proceeded with. The gross revenue of the city undertaking in 1900 was £974, in 1901 £8,850, and last year £28,537.—Subscriptions are invited for a first issue of 15,000 shares of £10 each in the Havana Electricity Company, Limited, which has an authorised capital of £300,000. A concession has been granted for the supply in the city of Havana of electric current to the public, industrial concerns, and others for lighting and power purposes.—The Isle of Wight Electric Light and Power Company, Limited, are making an issue of 10,000 5 per cent. cumulative preference shares of £5 each and £50,000 4½ per cent. debenture stock at 102 per cent. The company was formed in 1897 with a share capital of £100,000, and has now acquired powers for supplying electricity in all the principal towns in the Isle of Wight. The supply will be given from four central stations, three of which have already been erected and opened. The profits for the past three years are reported to have been £1,117 in 1900, £1,323 in 1901, and £3,184 last year. Including the proceeds of the present issue, the company's assets are valued at £150,000.

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Trowbridge.—The Council have decided to apply to the Board of Trade for an extension for a term of two years, as the margin of the Council's borrowing powers until the completion of the sewage-disposal works now in progress cannot at present be ascertained. A draft lease has been sent to Messrs. Pressland and Fippard, the firm who desired to lease the order. The Urban District Council have replied to the Somerset and District Electric Power Bill Company, who wrote asking the Council to sign a petition in favour of the Bill, that the Council had their own provisional order.

Fareham.—The report of the Lighting Committee for the year ending March 31 last shows a credit balance of £128, which is to be carried forward to the reserve fund to meet contingencies. The cost of public lighting was fixed at £655. The mains are to be extended towards Catisfield as far as Heathfield. This will cost £250, but at any time the main can be further extended. The electric light department has made £108 more profit than last year, besides paying off £500 on the loan. Sanction is to be obtained to a further loan of £500 for an additional transformer and other matters.

Lowestoft.—The Electric Lighting Committee have offered the Coast Development Company to supply light to the Claremont Pier at the rate of £4 per quarter per lamp of about 1,000 c.p. each, including maintenance, the company to supply and fix all standards, globes, and fittings. The resident engineer's last report states that since his previous report 30 consumers had been connected to the mains, representing 247 8-c.p. lamps. The total of consumers is now 401, representing 13,639 8-c.p. lamps. The minimum charge for power purposes has been fixed at 10s. per quarter, exclusive of meter rent, and a minimum charge for ordinary lighting will not be made in future.

Newport (Mon.).—The Parliamentary and Improvement Committee of the Corporation on Tuesday again reported on the question of the proposed establishmeet of a third telephone system in Newport, with reference to which Mr. Bennett has been in communication with them for some time past. They recommended that the National Telephone Company be informed that any further wayleaves which they require from the Corporation will only be granted conditionally upon the right of intercommunication being allowed between the subscribers of the Post Office system and the National Telephone Company's system, and that if they are not prepared to assent to this condition the Corporation may be recommended to support the establishment of a new system.

London Gazette.—The Stewart Electrical Syndicate, Limited, is to be wound up voluntarily, and Mr. G. Stanhope Pitt, 140, Leadenhall-street, E.C., has been appointed liquidator. The English and General Tramways Company, Limited, is to be wound up voluntarily, and Mr. P. J. Brenchley, 1 and 2, Great Winchester-street, E.C., has been appointed liquidator. The estate of C. A. Church (trading as Henry Connolly and Co.), manufacturing electrical engineer, 42, Hampstead-road, London, has been released from bankruptcy. A first amount of 9d. per share in the estate of the Electric Lamp Regenerating Company, Limited, 3, Crown-court, Old Broad-street, E.C., will be paid any day (except Saturday) between 11 and 2 at the Official Receiver's Offices, 33, Carey-street, Lincoln's-inn, W.C.

Bournemouth.—With regard to the suggested municipal telephonic system, it has been decided to defer coming to any decision until certain further information expected from Portsmouth, Guernsey, and Hull has been received, it being left to the chairman and town clerk to obtain the information and fix the date of the next meeting. The borough electrical engineer in his last report says: "From the opinions expressed at the two towns visited by the deputation—viz., Portsmouth and Tunbridge Wells—by both opponents and supporters of municipal schemes, it would seem there is no doubt that a municipal telephone system in Bournemouth, with a scale of charges of £6 for an unlimited number of calls and £3. 10s. at 1d. per call and a minimum charge of £1. 10s. per annum for calls, would pay its way."

Wolverhampton.—The annual report of the Lighting Committee shows a gross profit of £11,697 and a net profit of £2,479. The committee state that the year's working has been most satisfactory. A debt of £2,929 on old engines has been extinguished, and the department will in future be relieved from a payment of £168 annually in respect of interest and sinking fund on that amount. Another feature of interest is that the change-over of the system of supply is now completed, and consequently the revenue of the undertaking will not in future be burdened by further charges in that respect. During the past year the output of electrical energy for motive power has increased by 160 per cent., but the output of electricity for tramway purposes has not been quite so large as was anticipated. The Town Council have obtained sanction to the borrowing of £14,000 and £1,000 for electric lighting purposes.

King's Lynn.—The electrical engineer in his last report states that applications had been received for 427 additional lamps of 8 c.p. or equivalent, making a total of 15,799 from private consumers. The applications include three motors of 2½ h.p. each. The total number of consumers is now 414. The total number of units generated for May was 22,856, as compared with 19,473 in May, 1902. The following figures were appended: units generated, May, 1903, 22,856; May, 1902, 19,473; units sold to private consumers, 7,603 (4,949); units sold at power rates, 3,427 (1,589); cost of fuel, stores, repairs, and wages at station, £119. 8s. 10d. (£116. 8s. 2d.); cost per unit generated, 1·25d. (1·43d.); wages of lamplighters and outside staff, £19. 19s. 7d. (£16. 19s. 7d.). An agreement is being entered into with the Midland and Great Northern Railways Joint Committee as to laying cables under their property. The electrical engineer has been instructed to prepare and submit to a future meeting a report on the proposed extension of plant.

Factory Plant.—The National Electric Wiring Company, Limited, 34, Victoria-street, S.W., have just put down a neat electrical installation for the confectionery works of Messrs. Geary and Co., Limited, at Limerick. The chief items of note are a 100-h.p. Duffs producer, two National gas-engines, two B.T.H. 30-kw. generators, three 10-h.p. and two 5-h.p. B.T.H. C.E.-type motors. The gas-engines are capable of developing 40 h.p. on producer gas. All the motors are bolted up to the ceilings in inverted position; starting panels are of enamelled slate and have double-pole switch and fuse, together with B.T.H. starting rheostats with no-volt release and overload circuit breakers. The main switchboard is made up of three panels bolted to angle-iron framework, and is 10ft. long by 4ft. high; the two outside are generator panels, and the centre is the distributing panel and consists of 12 change-over switches, with 'bus bars and fuses. There are also 240 lights and four arc lamps. We are informed that the whole plant has worked direct from the commencement without hitch, and has given great satisfaction. The cost of running is, as Mr. Geary states, very low, amounting to only ¾d. a unit generated, or about ½d. per horse-power hour.

Fulham.—The Borough Council have replied to the London County Council in reply to their letter stating that "assets represented by property can only be set against debt to the extent to which such property can be sold without impairing the ability of the Borough Council to continue its duties," that most of the property of the Borough Council is commercially realisable, and could be set against the debt of the Council without impairing its ability to continue its public responsibilities. They pointed out that the Council could sell the electricity undertaking to a public company at a higher price than would cover the whole capital indebtedness of the undertaking and leave a substantial sum to credit. With respect to the second point, "that there is a limit to which local authorities should borrow money and thereby throw burdens on posterity, although each individual item of expenditure may be defensible," the Council state that they share the anxiety of the County Council to spend only such money as is really necessary in the public interest and in the discharge of the public and statutory functions of the Council, but the great expansion of Fulham made it necessary for the Fulham Council to take a larger view of its responsibilities and public undertakings than it would otherwise do, and consequently its schemes and outlook were of necessity greater than when dealing with a merely normal or stationary population.

Hove.—The Hove Electric Lighting Company, Limited, have asked the Town Council to support their scheme for the lighting of Aldrington. The following report has been adopted: "The General Purposes Committee forwarded a report from the Works and Improvements Committee with reference to applications for consent to construct underground works in connection with telephones. They mention that they had an interview with representatives of the Brighton Corporation Telephone Committee and have also been in correspondence with the town clerk of Brighton on the subject, with the result that the negotiations have been reduced to terms, the principal ones of which have already appeared in these columns. The committee recommended that the application of the Brighton Corporation be granted in so far as will enable them to have the sole use of the ducts above referred to for carrying telephone wires for the period named subject to an agreement being entered into at the cost of the Brighton Corporation, embodying the foregoing terms, and such further details as the Council might be advised by their solicitors as necessary. They also mentioned that in communicating with the Brighton Corporation it had been stipulated that the Hove Council were to be at liberty to grant a similar concession to any other authority, and the committee further stated that they were corresponding with the National Telephone Company in reference to proposals for an agreement to be entered into between them and the Hove Council enabling that company to carry wires underground. With one or two additions the General Purposes Committee recommended the Council to adopt this report."

Hereford.—The Electric Lighting Committee in their last report state that the results for the last financial year are somewhat more satisfactory than for the preceding 12 months. The surplus profits for 1901-2, after paying interest, amounted to £407. 10s. 6d., leaving £392. 9s. 6d. to be provided out of the rates towards the repayment of capital of £800. For 1902-3 the surplus profits amounted to £673. 7s. 5d.; the repayment of principal, including the new loan was £920, a balance of £246. 12s. 7d. thus falling upon the rates. The financial results of the undertaking for the year ended March 25, 1903, are as follows: Total units sold 108,815, as compared with 95,892 units sold in 1901-2. Of these there were charged 79,087 units at 6d. per unit, £1,977. 3s. 6d.; 16,126 at 4d., £268. 15s. 4d.; 7,437 at 3d., £92. 19s. 3d.; 6,165 at 2d., £51. 7s. 6d.—total, £2,390. 5s. 7d.; less rebates on corrrection of consumer's accounts, £1. 11s. 9d.—total, £2,388. 13s. 10d.; less discounts, £188. 4s. 9d.—£2,200. 9s. 1d.; meter rents, £104. 13s. 4d.; sundry receipts, £7. 0s. 4d.—total, £2,312. 2s. 9d. The working expenses for the year (including wages, salaries, oil, stores, coal, repairs, taxes, etc.) were £997. 2s. 9d.; interest, £641. 12s. 7d.—total, £1,638. 15s. 4d., leaving a profit towards repayment of capital (£920) of £673. 7s. 5d. The lamps connected and applied for at present to be served by the new cable amount to the equivalent of about 400 8-c.p. lamps. The committee have examined the estimate of income and expenditure on the electric light works for the current year as follows: estimated expenditure, £3,097; estimated income, £2,530—balance to be provided, £567. This £567 includes an estimated sum of £300 for overhauling and renewing batteries, but the committee have since the estimate was prepared made arrangements which they anticipate will largely reduce this outlay.

Redditch.—The electric light undertaking has up to the present cost £20,000. The original estimates provided for an expenditure of about half this amount, with the likelihood of a small profit from the commencement of working. The area originally estimated to be covered has, however, been considerably exceeded. The scheme has, so far, entailed an annual loss of over £1,000, and at a public meeting of ratepayers in March last it was decided that an expert should

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be engaged to report upon the condition of the existing plant and machinery, and advise as to the future development of the undertaking. Subsequently Messrs. Burstall and Monkhouse, of London, made an inspection, and they have now reported that, in their opinion, an error of judgment was made in installing a high-tension alternating-current system. They say the continuous-current system would have been better, but the cost of changing the system from alternating to continuous would be now prohibitive. Of the four engines running at the station three were running satisfactorily, but the vertical engine was very unsatisfactory. The engineers note that the number of 8-c.p. lamps connected to the mains has steadily increased, especially since August of last year; also that there has been a steady decrease since 1901 in the "cost per unit sold." They are of opinion, however, that there is "room for further improvement in this direction." Not only is the consumption of fuel high, but the cost is too high. As regards the future prospects of the undertaking, it was evident that there had been many difficulties in the way of making the undertaking a commercial success. Now, however, these difficulties had been largely overcome, and, with the exception of one engine, the plant was in a better state than it had ever been. What the Council needed now was more customers. It has been decided to adopt several of the recommendations contained in the experts' report; other points contained in supplementary questions are to be settled at a conference to be held at an early date with the experts.

Workington.—Steps are being taken to obtain from the Board of Trade an extension or renewal of the provisional order for an additional two years. Mr. W. L. Eaglesfield has submitted to the Town Council the following report upon the practicability of employing the water of the River Derwent, or rather such part thereof as flows down the mill race, for the purpose of furnishing the necessary power required for working the generating station in connection with the proposed electric lighting scheme for the borough: "I find that the total fall of the bed of the race from the sluice at the Yearl to the bridge at the old sawmill at the head of the harbour is 16·96ft., and from the Yearl to the level of the River Derwent at the by-wash of the race at Workington Bridge is 11·46ft. The maximum fall which can be obtained for working the necessary turbines is only 13ft., and to obtain even this the bed of the race from the Yearl to Workington Bridge will require to be lowered to the level shown by the red line marked, between the points X to Y, on the section. The tail race, or that part of the race which conveys the water away after passing through the turbine, will discharge into the river at Workington Bridge, but the result of lowering the bed of the race will make it necessary to abandon the use of the race from Workington Bridge to the harbour. A wall would require to be built across the race at the Soapery to divert the tail water into the Derwent. From a gauging of the race on May 28 near the Hall Mill, at the point marked A B on the plan and section, the maximum velocity was found to be 2·4ft. per second, and the average velocity 2·01 per second. This gives a discharge of 2,624 cubic feet per minute, which, with a fall of 13ft., will furnish 49 effective horse-power. The minimum horse-power required to furnish the power requisite for lighting Workington will be about 800 h.p. Thus it will be seen that as the water at present coming down the mill race will only give 49 h.p., the source suggested will not furnish anything like the power wanted. In fact, the whole of the water coming down the river at the present date (June 23) would not yield probably more than 150 h.p. Of course the river is in an unusually low condition, but this is the state from which the calculations as to the power which can be relied upon should be obtained. I need hardly point out that great difficulties would present themselves if an attempt was made to divert for use the whole of the water flowing down the Derwent, owing to the several interests involved. After reviewing the results of the above I think you will see that the only course open is to obtain the power by the more prevalent method of steam."

Croydon.—The annual report of the Lighting and Electricity Committee is noted in another column. The committee are also considering a report presented by the borough electrical engineer on further extensions to buildings and plant as follows: "The scheme that I now have to submit is an inclusive one, arranged with a view to anticipating further extensions, and although it is not proposed at once to expend the money represented by the estimates which I now have to place before you, at the same time I have presented a complete scheme with a view to laying out the station and making provision for plant which will require to be installed within the next three years. Dealing with the engine-room plant, I have made provision in building capacity for additional machinery to the extent of about 3,000 h.p., and the proportion which I would suggest be installed before the winter of 1904 is two-thirds of this amount, or two sets of 1,000 h.p. each. One of these would be for the supply of direct current for lighting and tramways, and the other would be for the supply of alternating current for lighting only. In connection with the engine-room plant, I have also included in my estimate for substituting a new engine for that removed from No. 2 generator to drive the two continuous-current balancers. Provision has been made in the condenser house now being erected for condensing plant to deal with 4,000 h.p., which will work in conjunction with two of the generating sets included in the present estimate. A corresponding further addition should be made to the condensing plant to work in conjunction with the third set included in this estimate. This will not be required until the winter of 1906. A further installation of boilers will be required for the winter of 1904, and I would suggest that two boilers of the same capacity as those at present being installed—viz., an evaporative capacity of 12,000lb. of water per hour each—be erected in the boiler-house. The present extension of the boiler-house will be sufficient to house six boilers of this capacity, which will be ample to cope with the estimated load of 1906. I have included in my estimate in connection with the boiler-house provision for a conveyor plant and coal bunkers, and I desire that it should be clearly understood that the question of coal storage is one that must have attention, regardless of any considerations connected with mechanical stokers, railway siding, or other matters. It has been our practice hitherto to stack coal in the adjoining ground for six months in each year, and not only does this involve extra labour, but it also involves very serious depreciation in the calorific value of the fuel. It must be borne in mind, further, that within a comparatively short time the ground at present used will not be available for this purpose, buildings having been erected thereon; and if provision be not made at the present time for coal storage it will be very much more difficult to deal with the matter when, in a few years' time, it becomes necessary, as undoubtedly it will. Having realised the necessity for making provision for coal storage, the question to be considered is, Which is the most convenient method of doing so? The system of storage by means of overhead bunkers is, in my opinion, undoubtedly the most convenient and the one attended with the greatest efficiency. In conjunction with this scheme, I have also included the cost of the railway siding. The estimate is as follows: engine-room and boiler-house extensions, including stanchions for carrying coal bunkers and stanchions for overhead crane in engine-room (as per estimate by the deputy borough engineer), £15,000; six boilers, each capable of evaporating 12,000lb. of water per hour, £8,400; foundations and flues required in connection therewith, £2,400; filtration plant for hot-well water (including erection), £450; two feed pumps for boilers, £350; economiser, £1,200; coal conveyor plant and bunkers, £3,600; two 1,000-h.p. generating sets for alternating current, £14,000; one 1,000-h.p. generating set for continuous current, £7,000; foundations in connection with the above and also condensing plant, £1,350; condensing plant for the above, including new cooling tower, £3,500; one engine for No. 2 generator, £700; switchboard extensions, switchgear, instruments, cables, etc., £500; pipework, steam, exhaust, and drain pipes, £1,500; one 100-kw. 5,000-volt transformer, with switchboard, cables, etc., £350; railway siding, £4,200; contingencies (10 per cent.), £6,450—total, £70,950. The estimate set forth in the above list represents for the most part capital expenditure on buildings, machinery, and plant, the necessity of which has from time to time been impressed upon the committee. These will consist of simply an extension of the station on the same lines as hitherto in order to meet existing and future demands and provide for proper stand-by. A considerable expense, however, is represented by the two items—coal-conveyor plant and bunkers and railway siding—amounting in all to £7,800. In justification of this expenditure, I would point out that in addition to making the necessary provision for coal storage, the amount paid per annum for cartage from the coal depôt to our works—viz., £625—an amount which is continually increasing as years go on, exceeds the amount represented by interest and sinking fund on the capital cost of £7,800, which would only amount to £468. The saving in future years would be considerably greater, and I submit this scheme having given consideration to the benefits of the future as well as to present requirements. The committee recommend that the foregoing report and estimate be adopted; that application be made to the Local Government Board for sanction to the borrowing of £70,950, and that in the event of the sanction being granted it be referred to the Finance Committee to raise the necessary loan." The electrical engineer also reported as follows: Mains and sub-stations—Extension of mains St. James's-road to West Croydon Hall, 80 yards; extension of mains from Sydenham-road North to 203, St. James-road, 160 yards. The necessary alterations are being carried out in Station-road sub-station for the change over to direct current. Current sold, 1903: private lighting, 73,199 units; public lighting, 37,849 units; traction, 94,913 units.

PROVISIONAL PATENTS, 1903.

JULY 6.

14913. Improvements in electric arc lamps. Edwin Joseph Murphy and Arthur Townsend, 83, Cannon-street, London.

14946. A device for indicating or preventing the exceeding of specified speeds on dynamos, motorcars, and the like. Ernst Neuberg, 77, Colmore-row, Birmingham. (Complete specification.)

14963. An improved electric furnace. Percy Richard Julius Willis, Fife House, Kingston-on-Thames. (Ernst Adolf Sjosted, Canada.)

14979. Improvements in electricity meters. Herman Aron, 47, Lincoln's-inn-fields, London. (Complete specification.)

14980. Improvements in electricity meters. Herman Aron, 47, Lincoln's inn-fields, London. (Complete specification.)

14994. Improvements in or relating to a process and apparatus for obtaining a continuous electric current from a high-tension alternating-current source. Alfred Julius Boult, 111, Hatton-garden, London. (Franz Joseph Koch, jun., Germany.) (Complete specification.)

JULY 7.

15048. Electric signalling apparatus for railway trains. Arthur Bonemeyer, 115, Cannon-street, London. (Complete specification.)

15050. Improvements in or relating to the manufacture of galvanic batteries. William Phillips Thompson, 6, Lord-street, Liverpool.

15059. Improvements in electrical hauling apparatus. Siemens Bros. and Co., Limited, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Siemens and Halske Actien-Gesellschaft, Germany.) (Complete specification.)

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15065. Improvements in keyboard telegraphic transmitters. Maximilien Kotyra, 46, Lincoln's-inn-fields, London. (Complete specification.)

15076. Improvements in circuit make and break apparatus for electric induction coils. Lucien Legoy, 115, Cannon-street, London.

15077. Improvements in apparatus for telephone exchanges. Albert Parker Hanson, Norfolk House, Norfolk-street, Strand, London. (Date applied for under Patents Act, 1901, July 7, 1902, being date of application in United States.) (Complete specification.)

JULY 8.

15069. Improvements in electrically lit signboards and the like. George Smith, 57, Barton-arcade, Manchester.

15090. Improvements in insulators for electric telegraph, telephone, and other line construction. Charles Adams Randall, 56, Digby-mansions, Hammersmith, London.

JULY 9.

15186. An automatic electric welding machine. Sebastian Ziani de Ferranti, 18, Southampton-buildings, Chancery-lane, London.

15199. Improvements in induction coils for the ignition apparatus for motors. Marconi's Wireless Telegraph Company, Limited, Sidney Walter Ashley, and Karl Alfred Hinde, 24, Southampton-buildings, Chancery-lane, London.

15217. Improvements in apparatus for varying electrical resistance. George Lewis Hogan, 27, Chancery-lane, London.

15218. An improvement in or relating to electric cut-outs, contact breakers, meters, and similar electrical apparatus. Hugh Swanton, 70, Chancery-lane, London.

JULY 10.

15242. Improvements in means for automatically regulating electric currents generated by dynamos. Stephen Watkins, Prince's Chambers, Wolverhampton. (The Consolidated Railway Electric Lighting and Equipment Company, United States.)

15247. Improvements in electric incandescent lamp holders. Henry Mostyn Darrah and Lewis Arthur Hackett, 55, Market-street, Manchester.

15257. Improved means for operating the rail and condition points in electric tramway or railways. William Millar, 62, St. Vincent-street, Glasgow.

15266. Improvements in electrical switches. Charles Mark Dorman and Reginald Arthur Smith, Ordsal Electrical Works, Salford. (Complete specification.)

15286. Improvement in staples for use in electrical installations. Harry Richards and George Davis, 23, Coleman-street, London.

15317. Improved construction of apparatus for the electro-deposition of metals. John Henry Collis, Alfred Collis, and Walter Head, 173, Fleet-street, London.

15337. Improvements in magneto-electric igniting apparatus. Willy Roos, 115, Cannon-street, London. (Complete specification.)

15338. Improvements in magneto-electric igniting apparatus. Willy Roos, 115, Cannon-street, London. (Complete specification.)

JULY 11.

15345. Improvements in electric sparking plugs for igniting in spirit, gas, or oil engines. Henry James Cranfield, Faraday House, Avenue-road, Erith, Kent.

15364. Improvements in bars for protecting the openings in electric lift cars. William Sprowson, 21, Spring-gardens, Manchester.

15366. Improvements in electric safety fuses. David Martin, 11, Burlington-chambers, New-street, Birmingham.

15369. Improvements in and relating to the operating cords of the trolley arms of electric tramways. Abraham Taylor, William Moorehead, and Thomas Henry Kingscote, 55, Market-street, Manchester.

15403. Improvements in and relating to electric circuit controlling apparatus. Charles Cornfield Garrard and Ferranti Limited, 18, Southampton-buildings, Chancery-lane, London.

15420. Process for the electrolytic production of zinc. Karl Kaiser, 27, Chancery-lane, London. (Complete specification.)

COMPLETE SPECIFICATIONS ACCEPTED.

To be published July 30, 1903.

1902.

12900. Electrical conductors. Lake. (General Electric Company.)

15334. Conduits for electric or other cables. Cummings.

15470. Clip for electric lamp shades, candle shades, and the like. Holdgate and Commin.

15714. Electrical fuse-boxes or cut-outs. Burnet.

15764. Control of electric lifts. Stevens, Major, Stevens, and Stevens.

15795. Means for transmitting electricity to vehicles on electric railways. Beer.

17196. Electrical resistance devices specially applicable to electric heaters. Waterhouse.

17466. Electrodes for electric arc lamps. Blondel.

18087. Alternating electric current generators. British Thomson-Houston Company, Limited. (Reist.)

19564. Electrical switches. Lake. (General Electric Company.)

19565. Method of manufacturing insulating bushings. Lake. (General Electric Company.)

19567. Trolley wheels for electric traction. Lake. (General Electric Company.)

19568. Cooling of electric motors. Lake. (General Electric Company.)

19571. Systems of electrical distribution. Lake. (General Electric Company.)

21471. Electrically actuated and controlled clock. Carruthers.

25377. Arc lamps for electric lighting. Bowley and Walters.

1903.

11591. Signalling systems for electric railways. Gibbs. (Date applied for under International Convention, May 22, 1902.)

11634. Conductors and collectors for electric traction. Mégroz.

12629. Electric alarms. Grouselle and Manouvrier. (Date applied for under International Convention, March 5, 1903.)

12968. Portable electric lamp. Schwenke.

12983. Installations for starting and working a number of independent electric motors. Siemens Bros. and Co., Limited.) (Siemens und Halske Actiengesellschaft.)

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.		Last price
Commercial and Industrial.—	£		£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1	..	½-¾
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1	..	½-¾
British Insulated and Helsby Cables, Ord., 1-100,000	5	..	6¾-7¼
—— 6 per cent. Cum. Pref., 1-100,000	5	..	5¼-6
—— 4½ per cent. Mortgage Debentures	100	..	102-106
British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red.	100	..	104-106
British Westinghouse Elec. and Manuf., 6 per cent. Pref., 275,001-375,000	5	..	5¾-6
—— 4 per cent. Mortgage Debenture Stock	100	..	100-102
Brush Electrical Engineering, Ordinary, Nos. 1-105,731	2	..	¾-1¼
—— Non. Cum., 6 per cent. Pref.	2	..	1¼-1⅝
—— 4½ per cent. 1st Debenture Stock	100	..	99-102
—— 4½ per cent. 2nd Debenture Stock	100	..	87-92 xd
Callender's Cable, Debentures	100	..	105-110
—— Ordinary	5	..	11¼-12¼
—— 5 per cent. Pref.	5	..	5¼-6
Crompton and Co.	3	..	2-2¼
—— 5 per cent. Debentures	100	..	101-105
Edison and Swan United, "A" Shares, 1-99,261	3	..	¼
—— "A" Shares, 01-017,139	5	..	1¼-2¼
—— 5 per cent. Debentures	100	..	75-80
—— 4 per cent. Deb. Stock, Red.	100	..	71-75
Electric Construction, Limited, Nos. 1 to 112,100	2	..	1⅛ 1⅛ xd
—— 7 per cent. Cumulative Pref.	2	..	2¼-3
—— 4 per cent. Perp. 1st Mort. Deb.	100	..	99-102
Ferranti Limited, 5 per cent. 1st Mort. Deb. Stock, Red.	100	..	90-95 xd
General Electric Company (1900), 5 per cent. Cum. Pref.	10	..	9¼-10
—— 4 per cent. 1st Mort. Deb. Stock	100	..	99-102
W. T. Henley's Telegraph Works, Ordinary	5	..	14-15
—— 4½ per cent. Preference	5	..	5-5¼
—— 4½ per cent. Debentures	100	..	108-112
India Rubber, Gutta Percha, and Telegraph Works	10	..	18¼-19¼
—— 4 per cent. Debentures	100	..	100-103
Parker, Thos., Limited, Ordinary	10	..	14¼-15¼
Telegraph Construction and Maintenance	12	..	32-35 xd
—— 5 per cent. Bonds	100	..	100-103
Electric Lighting and Supply.—			
Blackheath & Greenwich District Ordinary 1,201-101,200	1	..	¾-⅞
—— 4½ per cent. Deb. Stk. Certs., Red. and Conv.	100	..	118-121
Bournemouth and Poole, Ordinary	10	..	12¼-13¼
—— 4½ per cent. Cum. Pref., 7,501-15,000	10	..	10-11
—— 6 per cent. Cum. Second Pref., 15,001-22,500	10	..	10¼-11¼
—— 4½ per cent. Debenture Stock, Red.	100	..	102-105
Bromley (Kent) Electric Light and Power Co., 4½ per cent. 1st Debenture Stock, Red.	100	..	102-105
Brompton and Kensington, Ordinary	5	..	10¼-11
—— 7 per cent. Preference	5	..	10¼-10⅝
Calcutta Electric Supply Corp., Ordinary, Nos. 1-40,000	5	..	6¼-7¼
—— Nos. 20,001-30,000	5	..	⅞-1
Cambridge Electric Supply Company, Ltd., £10 Ord.	8	..	14½
—— ,, ,, ,, £10 Ord.	6	..	10½
Central Electric Supply, Ld., 4 per cent. Guar Deb. Stock	100	..	106-109
Charing Cross and Strand, Nos. 1-70,000	5	..	9-9½
—— 4½ per cent. Cum. Pref.	5	..	5¼-5⅝
—— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000	5	..	4¾-5
—— 4 per cent. Debenture Stock, Red. (Prov. Certs.)	100	..	104-106
Chelsea Electricity Supply	5	..	6-6¼
—— 4½ per cent. Debentures	100	..	107-110
City of London, Ordinary	10	..	11¼-12 xd
—— 6 per cent. Cumulative Pref.	10	..	13-14
—— 5 per cent. Debenture Stock	100	..	121-126
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100	..	102-105
County of London and Brush Provincial, Ordinary	10	..	8-9
—— 6 per cent. Cum. Pref.	10	..	11¼-12¼
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	100	..	109-112
Edmundsons' Electricity Corporation, Ordinary, 1-50,000	5	..	6¼-7
—— 6 per cent. Cum. Pref.	5	..	5-6¼
—— 4½ per cent. First Mort. Deb.	100	..	107-110 xd
Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-30,000	5	..	3¼-4¼
—— 5 per cent. Debenture Stock, Red.	100	..	96-98
Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000	5	..	6-6¼
—— 4½ per cent. First Deb. Stock, Red.	100	..	102-105
Hove Electric Lighting, Limited, Ord., 1-13,000	5	..	8-9
Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000	5	..	11-12
—— 4 per cent. Debenture Stock Red	100	..	103-106

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Name.	Amount paid. £	Last price. £
Kensington and Knightsbridge and Notting Hill	100	103-106
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	9½-10½
London Electric, Ordinary	3	2-2½
—— 6 per cent. Pref.	5	5½-6
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	100-102
Metropolitan, Ordinary	10	17½-18½
—— 4½ per cent. First Mortgage Debenture Stock	100	108-112
—— 3½ per cent. Mortgage Debenture, Red.	100	97-100
Newcastle-upon-Tyne Electric Supply, Ordinary	5	100-103
—— Preference	4	102-105
Notting Hill Electric Lighting	10	13-14
—— 4 per cent. First Mort. Debs., Nos. 1-500 (Reg.)	100	99-102
Oxford Electric, Ordinary, 1-96 and 407-14,310	5	5-6
—— 4 per cent. Debenture Stock	100	97-100 xd
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100	100-102
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5	3-3½
—— 4 per cent. Debenture Stock	100	88-93
South London, Ordinary	5	3½-4
St. James's and Pall Mall, Ordinary, 101-20,080	5	15½-16½
—— 7 per cent. Pref.	5	8-9
—— 3½ per cent. Deb.	100	98-101
Urban Electric Supply Co., Ordinary, 8-30,007	5	5-5½
—— 5 per cent. Cumulative Preference, 50,001-80,000	5	5-5½
Westminster, Ordinary	5	12-13
—— 5 per cent. Cum. Pref., 110,101-138,251	5	6½-6¾

Electric Railways.—

Central London, Ordinary	100	104-107
—— 4 per cent. Pref.	100	101-104
—— ,, ,, deferred	100	107-110
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100	115-118
City and South London, Consolidated Ordinary	100	69-71
—— 4 per cent. Debenture Stock	100	116-119
—— 5 per cent. Pref. Stock '91	100	130-133
—— ,, ,, ,, '96	100	129-132
—— ,, ,, ,, '01	100	128-131
Liverpool Overhead, 5 per cent. Pref.	—	13-13½
—— Ordinary, 1-50,000	—	7⅞-8
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	—	102-104
Waterloo and City, Ordinary	100	98-101

Electric Tramways.—

Anglo-Argentine, 1-260,007	5	4⅛-4⅜
—— Permanent 6 per cent. Debenture Stock, 1888	100	124-129
Blackpool and Fleetwood Tramroad	10	13½-14½
Brisbane Tramway Invest., Lim., Ord., 1-75,000	5	2⅜-3½
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5	4⅛-4⅜
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100	100-103
British Columbia Electric Railway Co., Ord., Nos. 1-20,000	100	69-72
—— Non-Cum. 5 per cent. Pref., Nos. 25,001-38,600	100	92-96
—— 4½ per cent. 1st Mt. Debs., Nos. 1-6,250, of £40 each	40	104-106 p.c

Name.	Amount paid. £	Last price £
British Electric Traction, Ord., 1-300,000 & 60,001-90,000	10	12-12¼ xd
—— 6 per cent. Cm. Pf., 30,001-60,000	10	11¾-12¼
—— 5 per cent. Perpetual Debenture Stock	100	122-125
Buenos Ayres and Belgrano Tram., Ord., 1-100,000	5	2⅜-2½
—— "A" 6 per cent. Cm. Pf., 1-40,000	5	5¼-5⅜
—— "B" 6 per cent. Cm. Pf., 1-27,500	5	4⅜-5⅛
—— 5 per cent. Deb. Stock, Red.	100	105-108
—— Prov. Cert., all paid	100	97-100
Cape Electric Tramways, Nos. 1-480,000	1	2⅛-2⅜ xd
City of Birmingham Tramways, 5 per cent. Cum. Pref.	10	5-5¼
—— 4 per cent. 1st Mortgage Deb., 1-3,000 (1917)	100	99-102
Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red.	100	103-105
Cork Electric Tramways and Lighting Co., Ordinary	10	13-14
—— 5 per cent. Cum. Pref.	10	11-12
—— Debentures	100	96-99
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10	13½-14½
—— 6 per cent. Pref., Nos. within 1-60,000	10	15-16
—— 3½ per cent. Mort. Debs., 1-3,000, Red.	100	94-97
Imperial Tramways, Ordinary	all	22-22½
—— 6 per cent. Cum. Pref.	all	14½-15½
—— 4½ per cent. Deb. Stock	100	112-114
Isle of Thanet Electric Tramways and Lighting, 5 per cent. Cum. Pref., Nos. 30,001-60,000	5	4-4½
—— 4 per cent. Debenture Stock	100	82-85
Kidderminster and District Lighting and Traction, Pref.	5	3½-4
London United Trys. (1901), 5 per cent. Cum. Pref.	10	11½-12½
—— 4 per cent. 1st Mt. Db. Stock, Red.	100	106-108
Metropolitan Electric Trams., Deferred, 1,000,001-1,514,016	1	½-⅝
—— 5 per cent. Cum. Pref., 500,001-814,016	1	½-1⅛
New General Traction, Ordinary	5	½-1½
—— 6 per cent. Cum. Pref.	5	2-3
—— 5 per cent. Mortgage Debentures, 1-1,713 (Regd.)	100	88-93
Oldham, Aston, and Hyde Tramway, Ordinary	10	10½-10⅝
—— 5 per cent. Cum. Pref.	10	11½-12⅛
Perth Elec. Tramways (W.A.) 5 per cent. 1 Mort. Deb. Stk.	100	98-102
Potteries Electric Traction, Ordinary, 20,001-40,000	10	9½-10½
—— 5 per cent. Cum. Pref., 1-20,000	10	9½-10½
—— 4½ per cent. Debenture Stock	100	102-105
South Lancashire Electric Traction and Power Company—		
—— £250,000 Ordinary	1	1
—— £101,132 6 per cent. Preference	1	1
—— £528,093 4½ per cent. Debenture Stock	100 p.c.	100 p.c.

Telephones.—

National Telephone, Preferred	100	102-104
—— Deferred Stock	100	82-84
—— 6 per cent. Cum. First Pref.	10	13-14
—— 6 per cent. Cum. Second Pref.	10	12-13
—— 5 per cent. Non-Cum. Third Pref.	5	5-5¼
—— 3½ per cent. Deb. Stock, Red.	100	96-98
—— 4 per cent. Deb. Stock, Red.	100	101-103
Oriental Telephone and Electric Company	1	13/16-15/16

TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line	Traffic Returns for week: Ending	1903. £	1902. £	Increase or decrease: Week. £	Current year. £	Miles of single track open: 1903.	1902.	Accounts for past year: Ending	Total receipts £	Passengers carried.	Car miles run.	Receipts per: Pas-s'nger d.	Car mile. d.	Mile of track. £	Cost per car mile. d.
Aberdeen Corporation	June 27	1,247	1,295	− 48	+ 4,863	19½	17½	May 31	37,931	9,099,715	794,641	0·98	13·02	1,970	6·14
Ayr Corporation	—	—	—	—	—	8	6	Sept. 25	12,503	2,979,276	290,099	1·00	10·34	1,560	4·7
Birmingham Tramways	July 11	5,125	5,240	− 115	+ 6,452	6½	6½	—	—	—	—	—	—	—	—
Blackburn Corporation	June 26	909	1,195	− 286	+ 674	24	24	March 25 *g*	40,964	7,234,106	826,558	1·36	11·87	1,705	7·44
Blackpool Corporation	July 9	1,038	996	+ 102	+ 1,254	17½	16½	,, 31	211,168	6,169,121	784,443	1·52	10·8	—	—
Blackpool-Fleetwood Tramways	,, 11	811	714	+ 97	+ 149	16½	16½	Dec. 31	30,923	2,049,677	584,989	3·62	12·68	1,932	6·89
Bolton Corporation	,, 12	2,014	1,611	+ 403	+ 3,828	25	25	March 31	85,704	17,761,605	1,896,247	1·15	10·75	3,430	5·67
Bournemouth Corporation	,, 8	1,059	—	—	—	10½	—	—	—	—	—	—	—	—	—
Bradford Corporation	,, 12	4,025	3,616	+ 409	+ 6,649	39	—	—	—	—	—	—	—	—	—
Brighton Corporation	,, 12	982	1,003	− 20	+ 5,217	6½	—	,, 31	—	10,432,508	1,031,928	1·00	10·10	—	—
Bristol Tramways Company	,, 10	5,086	5,151	− 65	—	51½	51½	Dec. 31	223,480	41,192,899	5,724,114	1·30	9·38	4,348	—
Burnley Corporation	,, 11	852	784	+ 68	—	—	—	—	—	—	—	—	—	—	—
Cardiff Corporation	,, 11	2,600	1,584	+1,016	+10,715	—	—	—	—	—	—	—	—	—	—
Carlisle Tramways Company	—	—	—	—	—	—	—	,, 31	—	2,216,583	320,129*h*	—	—	—	—
Central London Railway	,, 11	6,924	6,847	+ 77	− 331*h*	6	—	,, 31	367,225	45,305,110	1,276,971*a*	1·87	66·6*a*	59,076	35·6*a*
City and South London Railway	,, 12	2,473	2,786	− 313	− 679	6¾	—	,, 31	165,003*a*	19,069,319*a*	—	—	—	—	—
Cork E. T. and L. Company	,, 9	686	764	− 77	− 15	—	—	—	—	—	—	—	—	—	—
Darwen Corporation	,, 10	220	243	− 23	− 113	7·23	—	March 31 *g*	12,341	2,360,735	254,279	1·25	11·65	1,707	9·36
Dover Corporation	—	—	—	—	—	3	—	—	—	—	—	—	—	—	—
Dublin & Lucan Electric Railway	,, 12	125	120	+ 4	− 20*h*	—	—	Dec. 31	5,796	364,796	102,087	3·81	13·62	859	7·68
Dublin U. T., electric cars	,, 10	5,575	5,203	+ 372	+ 401	46	46	March 31	126,121	24,553,133	3,429,356	1·23	8·82	2,741	5·05*h*
Dublin S. District, Electric	—	—	—	—											
Dundee City Tramways	,, 8	847	778	+ 69	—	22	22	May 15	35,874	9,084,522	752,814	0·93	11·276	1,630	—
East Ham Corporation	,, 11	743	506	+ 237	+ 3,238	10·75	7·52	March 31	25,341	9,971,337	650,224	0·61	9·35	2,357	—
Farnworth U.D.C.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Glasgow Corporation	,, 11	13,043	11,125	+1,918	+10,741	124	101	May 3	653,200	177,179,549	14,008,750	—	—	—	—
Halifax Corporation	—	—	—	—	—	30½	27¾	—	—	—	—	—	—	—	—
Huddersfield Corporation	,, 6	1,406	1,045	+ 361	—	34	35	March 31	56,631*h*	9,738,213	1,218,539	1·4	11·14	1,618	6·38
Hull Corporation, E. S.	,, 11	1,880	1,806	+ 73	+ 1,594	19	19	,, 31	87,707*h*	21,065,999	2,218,696	1·00	9·49	5,004	5·07
Ilkeston Corporation	,, 2	219	—	—	—	—	—	—	—	—	—	—	—	—	—
Kirkcaldy Corporation	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Leeds Corporation	,, 11	5,560	5,378	+ 182	+ 5,520	77	—	March 25	252,656	57,239,779	5,773,651	1·11	10·91	3,283	—
Liverpool Corporation	,, 4	11,121	10,484	+ 637	+10,361	101	95	Dec. 31	504,304	108,906,472	11,705,425	1·11	10·34	5,000	6·88
Liverpool Overhead Railway	,, 12	1,718	1,584	+ 134	+ 211	15½	15½	June 30	79,252	10,466,726	986,185*a*	1·82	19·30*a*	5,110	— *a*
Newcastle-on-Tyne Corporation	,, 11	3,235	2,695	+ 539	—	36	36	Dec. 15	127,852	28,411,899	2,767,444	1·08	11·09	3,561	—
Portsmouth Corporation	—	—	—	—	—	29	29	Sept. 30	47,651	9,168,137	868,157	1·24	13·17	1,643	—
Rochdale Corporation	,, 13	165	141	+ 24	—	4½	—	March 31	5,416	925,281	127,456	1·38	10·27	—	7·66
Salford Corporation	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Sheffield Corporation	,, 12	4,738	—	—	—	53½	46½	Mar. 25 *g*	216,709	56,812,049	4,926,083	0·904	10·428	7,510	7·03 *f*
Southampton Corporation	,, 9	1,122	1,091	+ 31	—	11	11	,, 31	35,874	9,084,522	752,814	0·946	11·436	3,760	—
Sunderland Corporation	,, 12	1,328	1,190	+ 138	+ 727	18·48	17·18	,, 31	59,930	13,987,121	1,270,957	1·03	11·3	3,243	6·43
Wallasey U.D.C.	,, 11	774	697	+ 76	+ 1,448	10·5	10·5	,, 31 *g*	31,307	5,690,378	654,560	1·32	11·47	2,981	6·97

Includes maintenance of permanent way and proportion of profits paid to the tramway companies for term of unexpired lease. *a* Train mile.
h Half-year's figures. *e* Include rail and tram. *f* Including one section of horse traction. *g* 1903.

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THE DESIGN OF EXTRA HIGH TENSION SWITCHGEARS.

BY W. E. WARRILOW.

(Continued from page 10.)

The Oerlikon Company are inclined to favour the assembly of this design of switch in pillar form, as

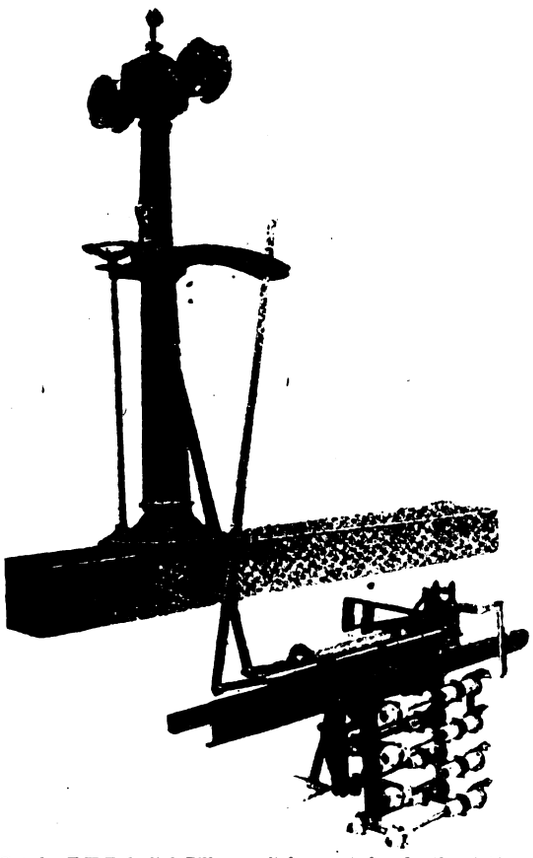

FIG. 4.—E.H.T. Switch Pillar; switch mounted under the platform (Oerlikon Co.).

Fig. 4 shows, and where galleries are available it makes a compact arrangement as far as the devices themselves are concerned, the principal trouble arising when the connections have to be considered. When it is required to operate the switch automatically, the same principle of breaking the circuit is employed, but a tripping solenoid (Fig. 5) is fitted, which actuates a motion connected to the main lever, this serving to withdraw the plungers from the tubes and open the circuit. It is interesting to note that no divisions are inserted between the contacts in any case, and this would tend to point to the confidence the makers have in the capabilities of the device. For very high potentials the switches are mounted high above the operating platform, as shown in Fig. 6, where the complete gear for a 30,000-volt installation can be seen, including transformers, connecting wires, and switch. This is well out of reach, but for the pressure employed the conductors seem very close together compared with some types of gear for lower voltages. The manner of assembly of one of these boards can be gathered from

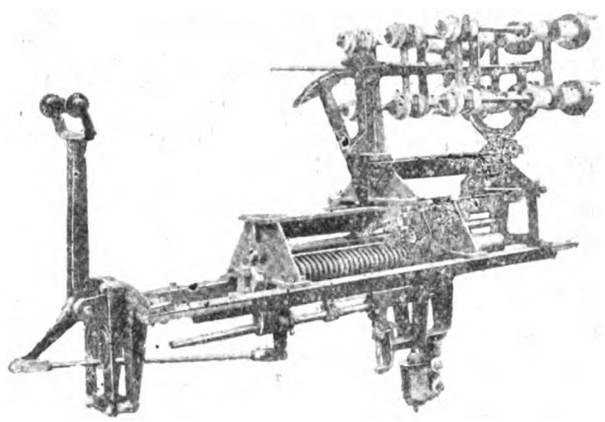

FIG. 5.—E.H.T. Switch, with Tripping Device (Oerlikon Co.).

Fig. 7, which clearly shows the mounting of the switches and their operating levers. All conductors are supported on porcelain insulators fixed to the iron framework which makes up the skeleton of the gear, and great care is taken in the running of all connections to ensure absolute safety from short-circuit, though the attendant may not be so immune from danger as would be supposed at first sight when the front of the gear is examined.

An oil break fuse by the same company, suitable for dealing with pressures up to 10,000 volts, is illustrated in Fig. 8, this indicating the complete device in its terminals. It is designed for bolting up in the most convenient position on the board, and cable terminals are provided above the insulators for connecting purposes. The fuse proper comprises a porcelain tube with clip contacts at each end, the

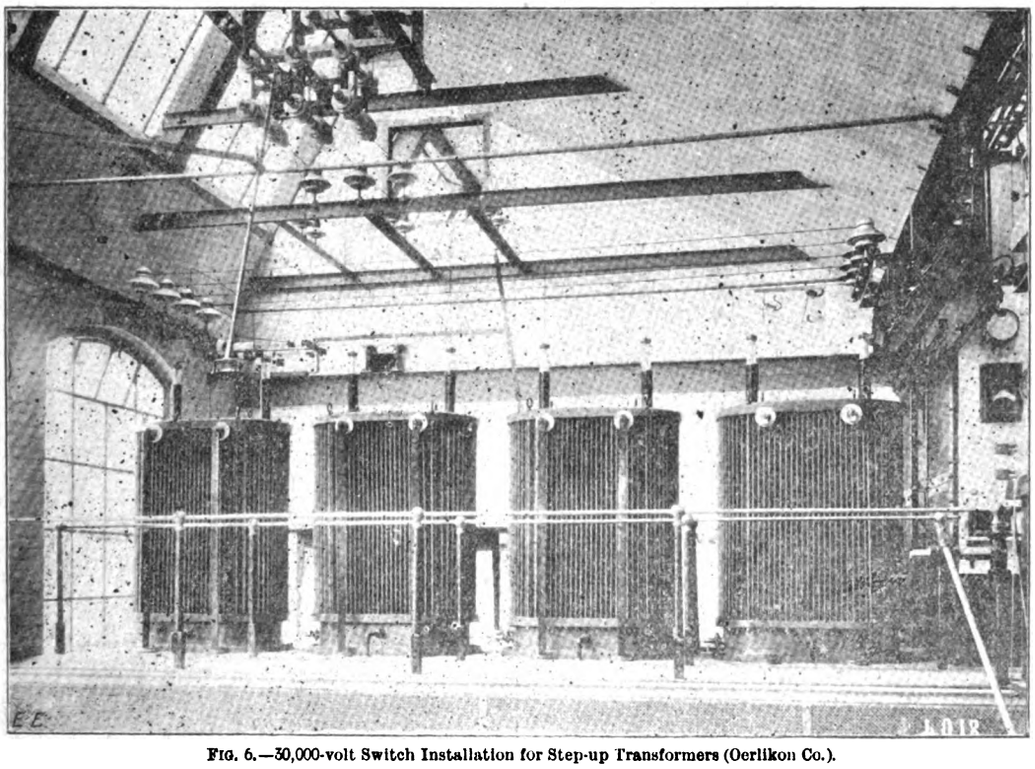

FIG. 6.—30,000-volt Switch Installation for Step-up Transformers (Oerlikon Co.).

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lower one being fitted with hinge pins, which enable the fuse to be used as a switch for closing the circuit. The fuse wire is stretched between the top and bottom terminals, the arc on opening circuit being quenched by the oil in the tube. A similar device, but for a 20,000-volt circuit, is represented in Fig. 9, the principal difference noticeable being in the creeping surface of the insulators.

the re-fusing of the holder, the binding screws being exposed on the withdrawal of the cap. Upon fusion of the wire, the vapours given off by the combustion of the metal cause the expulsion of the carbon balls into the cavities, A, thus sealing the ends of the tube and cutting off the arc. The gases arising from fusion pass out of the holder by way of perforations at the end of the barrel,

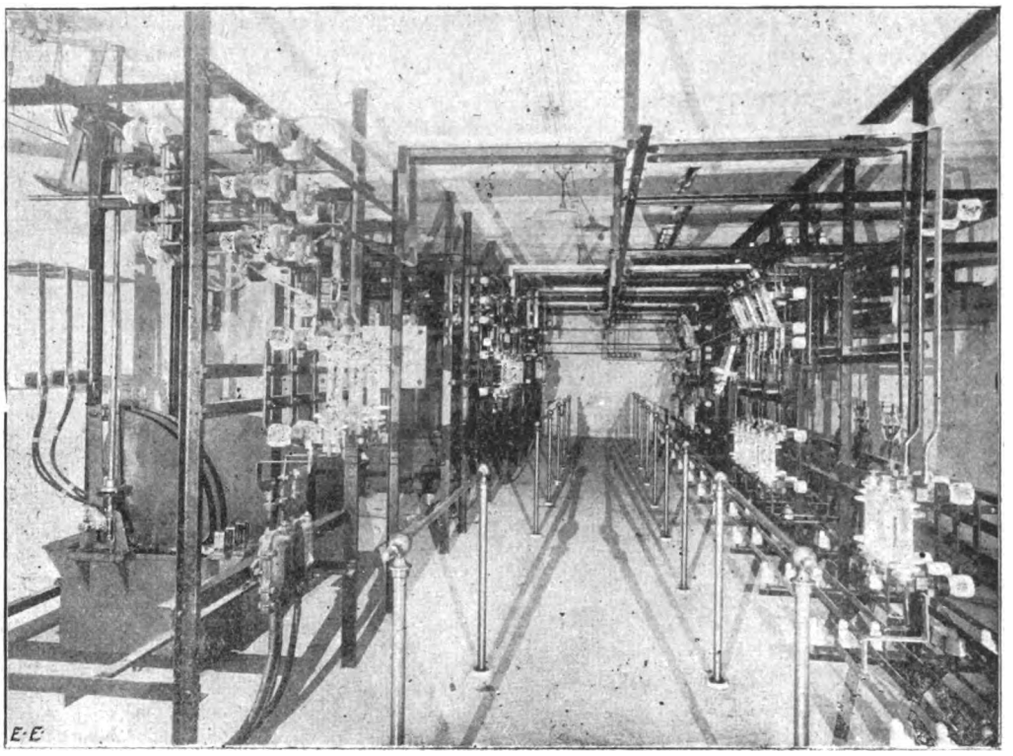

FIG. 7.—Back View of E.H.T. Gear, showing Mounting of Switches (Oerlikon Co.).

The designs above described meet with considerable favour on the Continent, and are in extended operation there on some very large schemes, giving, according to the makers, every satisfaction. With such designs, the space occupied per kilowatt controlled is apt to be rather large, as the various devices are fixed in the most convenient positions on the iron framework, quite apart from any consideration of ease in operation or economy in attendance. The connections also tax the ingenuity of the electrician to arrange neatly and safely, though these items have not in any way proved obstacles to the employment of the gear.

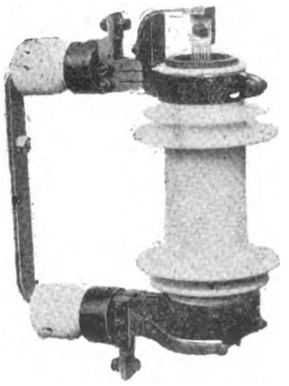

FIG. 8.—E.H.T. Fuse, 10,000 volts (Oerlikon Co.).

An interesting form of enclosed air break fuse, made by the Stanley Company, of America, is shown in Fig. 10. This is known as the "ball" fuse, and is employed on pressures up to 30,000 volts with every success. The device is made up in plug-handle form, and the two views in Fig 10 show sections through the fuse before and after blowing. Referring to the figure, C is a chamber containing a small carbon ball, B, which permits of the passage of the fuse wire into the tube, F, to the opposite end of the handle, which is also provided with a similar chamber and ball. Clamping washers are fixed to terminals at each end, and over these the cap and contact jaw, G, make a tight fit. A slight twist of this cap permits of its removal for

the top end being provided with a small aluminium vane, which is puffed up from a horizontal position to a vertical one where it can be seen by the attendant, indicating to him that the fuse has blown. This device has been submitted to very severe tests by the makers, and is stated by them to have continually broken successfully a 30,000-volt circuit of 50 amperes capacity. It is fitted to the

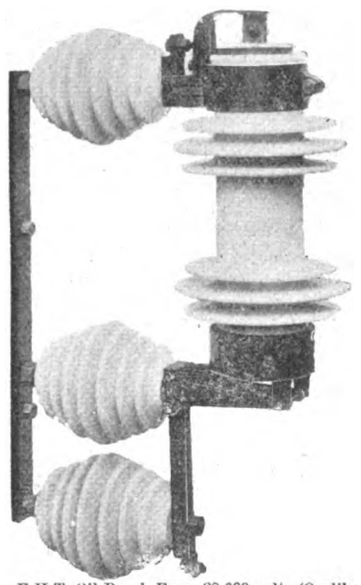

FIG. 9.—E.H.T. Oil-Break Fuse, 20,000 volts (Oerlikon Co.).

front of gears, and the connections for insulated cable are at the back of the supporting slab. For 20,000-volt circuits the length of the fuse tube is 21½in., and for isolated use this would be mounted on a marble base 28½in. by 26½in. In all the switchgears which this company make, the connections and the majority of the actual apparatus are all arranged behind marble slabs fixed in an iron framework. This type of board seems to have come into common use in America, and as a consequence the wholesale standardisation of apparatus has been possible, the firm in question

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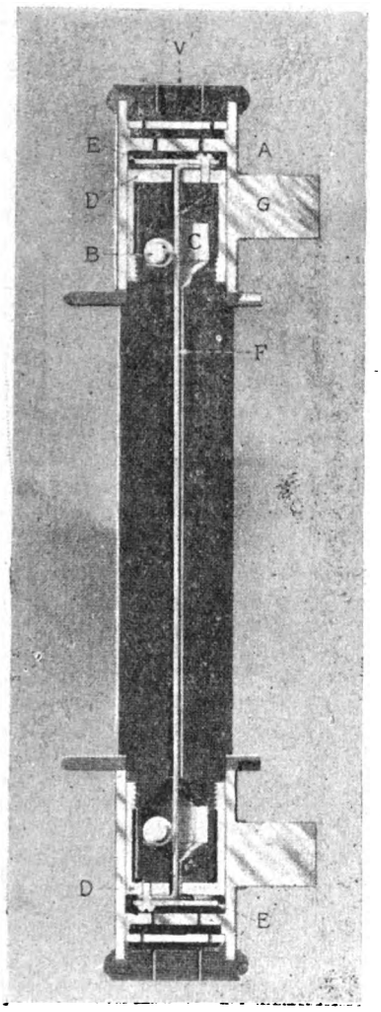
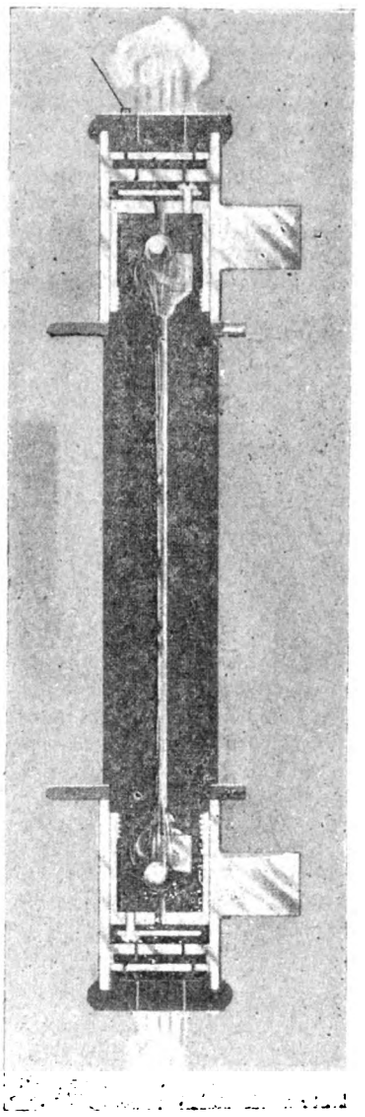
having a series of designs which can be employed for a great variety of purposes.

The oil switch is made use of for heavy currents at high voltages, and a design which meets a number of conditions is shown in Fig. 11, this being a section through a three-pole switch, or it may be employed as three series switches for extra high voltages. The contacts are mounted on marble slabs forming the lid to a tank which is filled with oil, and which can be lowered without disturbing the connections. The operating mechanism is also fitted to the top slab, and the entire combination is linked up by a number of rods terminating in a lever projecting from the front of the gear. The moving element of each switch comprises a metal arm pivoted about three-fourths down its length, the longer portion being tipped with hard wood into which the connecting blade is fixed. This is zinc tipped, and merely serves the purpose of closing the circuit through two fixed contacts, and when the switch is open it forms no part of the line whatever. For triple-pole work or series switches the arms are all linked up to a common bar, upon which the main operating rod is mounted. The terminals, which provide for the reception of cable connections, are covered by small cherrywood boxes, which protect them from being touched when charged. Each combination has its own tank, and this has the advantage of being oiltight, as there are no joints under oil, and no part of the mechanism is connected with the tank in any way.



BEFORE BLOWING.



BLOWN.

FIG. 10.—Stanley "Ball" Fuse, pressures to 20,000 volts.

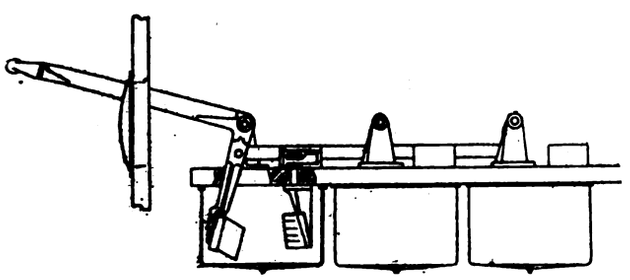


FIG. 11.—Stanley Three-Phase Switch.

(To be continued.)

ELECTRIC TRACTION ON RAILWAYS.

At the recent engineering conference of the Institution of Civil Engineers the two following papers were read in Section VII. and were discussed together :

High-Speed Electric Traction on Railways.

BY J. W. JACOMB-HOOD, M.I.C.E.

The introduction of this subject would appear to be the duty of an electrical specialist, but inasmuch as the difficulties are to a large extent practical, the notes of a mere general practitioner in railway work may be acceptable. The problem thus offered for discussion must first be defined. It must not be confounded with the problems in short distance and omnibus traffic that have alone been dealt with hitherto in this country, nor must existing practice under steam be allowed to limit the imagination as to possibilities of service by electricity. As the question develops, it becomes clear, in the first place, that the existing adaptations of electricity to traction are not altogether suitable for general railway business, including economical high-speed services; and, further, it is practically certain that the substitution of electricity for steam as a vehicle of power will of itself produce a change of general ideas and of general methods.

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The term "high-speed electrical services" may be defined as representing frequent communication, without intermediate stops, between busy centres that are widely separated. The speed expected will certainly not be less than 60 miles an hour, and the cost of service per ton per mile must not be more than that of existing steam services. Means that are adopted for such high-speed services must be equally available for a modified stopping service, as well as for freight and shunting services, because it is inconceivable that railway companies will be tempted to electrify their lines for their high-speed services alone, and there must be no interference with the free use of lines by steam locomotives.

As some slight indication of the amount of work done by railways to-day, a diagram of actual services performed on a typical section of line, about 80 miles in length, on one of the busiest days of last year, is exhibited. Assuming fixed average loads for the various classes of service, the total train resistance has been calculated and plotted as a load curve. This will give a good general idea of the bulk of the business that electricity may some day be called upon to undertake. It will be seen that the peak of the load occurs before mid-day, and involves a consumption of energy estimated at 661 millions of foot-pounds per minute, or very nearly the equivalent of 26,500 h.p., or 19,800 kw. The high-speed trains—defined as those travelling at a speed of 40 miles an hour and over—are marked on the diagram on the wall by thick lines. This class of traffic is practically confined to the hours between seven o'clock in the morning and eleven o'clock at night, and the load curve is seen to be affected in consequence, but the proportion of high-speed trains to the total service throughout the 24 hours is only as 1 to 3.

It would be well if discussion on this subject were to avoid any general comparison of steam and electrical railway services, for while the advantages of electrical service are admittedly considerable for many conditions of traffic, a wholesale conversion of steam services is so difficult a financial problem as to be practically impossible, even if proved desirable. It may be granted that conversion, in the case of services where electricity can with certainty compete economically with steam, will come; and that any new railways, built to connect large centres of traffic with a high-speed service, will, without much doubt, be equipped electrically, and the time at the disposal of the conference will, therefore, be spent to the best advantage if the leading features of an electrical equipment that will meet the needs of high-speed and general services are alone kept in view. Above all things, it seems to be essential that as railway companies must for the public benefit continue to exchange rolling-stock, the principles of any system must be acceptable to the whole body of railways before they can be adopted. The ground for discussion being thus limited, the subject divides itself conveniently as follows: (*a*) generation; (*b*) consumption; and (*c*) transmission, distribution, and collection of current.

Generation of Current.—Of all the vital questions connected with power stations, perhaps none is more important, although diverse opinions have been expressed, than the economical limits of size of steam or gas generating sets. In this country one or other would be, in nearly all cases, the only alternatives. The possible positions of generating stations relative to the railway will frequently decide cases; but, assuming that the power capacity of stations will, on occasion, be determined chiefly by the limit of economy in generation, it is important that the subject of the most desirable maximum sizes of steam or gas sets for power stations should be well ventilated. After taking account of the increased cost and losses in extended transmission lines, reason would seem to dictate that the power stations should be as widely separated and as few in number as possible, to ensure a steadier load and a better load factor. Power-station practice is rapidly becoming standardised in detail, so that it can be foreseen with some confidence that moderate-speed engines, directly coupled to alternators generating in single or multiphase form at tensions as high as circumstances allow, will be used. An economy in every detail will have to be studied, it may be that gas-engines in connection with a producer plant will prove the ultimate solution.

Consumption of Current.—Without invading the territory of the electrical engineer it is possible to bring forward one point of practical importance in connection with motor design. The practice of to-day seems to be almost universally in favour of a direct-current series-wound motor, with automatic field regulation, which will run economically at any speed up to a maximum. On the other hand, there is the alternative, with some economical advantages to recommend it, of a system that involves the use of smaller high-tension currents, used in alternating single or multiphase motors, that are limited to one or, at most, two economical speeds. Opinions differ widely as to the class of traffic for which invariable speeds are suited; and it must be confessed that it is extremely difficult to foresee the effect that invariable speed would have upon the conduct of general railway business. It is, however, tolerably clear that for any class of business variable speed is to be preferred. Such points as the position and individual power of motors are all interesting, but inasmuch as motors arranged on a multiple-unit system to ensure minimum train weight and maximum weight available for adhesion, will almost certainly be employed for high-speed railway service, whilst electric locomotives of high power capacity for freight, shunting, and other general business will also be required in the railway business of the future, time need not be employed in discussing them.

Transmission, Distribution, and Collection of Current.—The principles of generation and consumption of current being determined, systems of transmission, distribution, and collection must to a large extent follow. But it is here that the practical difficulties present themselves most formidably to the railway man. With all the complications due to dense traffic within a very limited construction gauge, and with the imperative need of safeguarding life and limb, it is difficult to see how any system of distribution is to be carried out without serious objection. This part of the problem needs the fullest consideration that the conference can give. Transmission, perhaps, has the fewest difficulties. In view of the urgent need for economy in first cost, it is to be hoped that we may in time accept the Continental methods of using bare overhead transmision lines for carrying current at high voltage rather than incur the heavier expense of cables.

So far as existing practice is a guide, a system of distribution to feed a third conductor rail will appear to meet the needs of the case. There are in existence cases of railways where large currents are being collected from a third rail at speeds approaching 50 miles an hour, and experiments in this direction indicate that still larger currents than these can be taken at speeds up to 70 miles an hour. But the existence of a third rail at all, in any position, introduces troubles in the upkeep of the road and in other directions that are better avoided if possible. An overhead conductor system would probably be less unwelcome to the maintenance engineer, and from some points of view it has advantages over any ground collecting system. But here, again, if the system is one of high-tension triphase current, the duplication of conductors presents another difficulty.

It will be interesting to watch the developments in the United States of the experiments about to be made with single-phase alternating currents, involving only one overhead conductor. The difficulties in the way of collecting a comparatively heavy current from an overhead equipment appear to have been to some extent overcome on one of the North Italian railways, and developments in this direction may be of assistance. Systems that have been advocated of collection from the primary conductor for use in a motor-generator on a locomotive seem attractive, and inasmuch as they would do away with sub-station difficulties and expenditure, the problem may thus be solved. Inasmuch as pure accumulator systems, although they may be useful and economical for light branch services, are not thought to have any promise for heavy general railway work, no further mention of them seems called for.

In these notes the author has attempted to put forward in the briefest possible manner some of the main points

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that demand the consideration of all who are interested in this important subject.

The Position and Protection of the Third Rail on Electric Railways.

BY WILLIAM E. LANGDON.

In view of the fact that modern arrangements now propose to provide a "return" rail, independent of the track or wheel rails, it would, perhaps, have been more correct if the title of this paper had been "the position and protection of the conductor rails." It will, however, I hope, be quite understood that the consideration of the subject embraces the provision of both the third and fourth rail. By the third rail is meant that rail which conveys the current to the motor, and by the fourth that which returns it to the generator; and in order to avoid confusion of terms it is hoped it may be found convenient to regard the rails which carry the traffic as the *wheel* rails, and those which convey the electric current as the *conductor* rails.

There is ample evidence that we have now arrived at a period when surface lines of railway—lines of ordinary construction for steam haulage—have to be considered in relation to their operation by electrical agency. Tube lines will no doubt, where they have means for doing so, form connection with near surface lines for the purpose of ready interchange of traffic. And when to this we add that it is understood all of the main lines are considering the propriety of electrically working portions of their systems, the question of arriving at a decision as to the position of the conductor rail is, in the interest of all, most desirable, for whether the equipment of trunk lines is for a long or a short time deferred, there can be little doubt that what may be termed the residential lines will seek to avail themselves of the advantages to be obtained from electric traction, and as many of these may intersect one another, a recognised standard will become an absolute necessity.

Conductor Rail.—There appears to be no uniformity of practice in determining the position of the conductor rail. This, so far as this country is concerned, is probably to be accounted for by the fact that the progress of electrically-driven railways has been mainly confined to underground routes, the only exception being that of the Liverpool Overhead Railway, a line which, although exposed or open to climatic influences, is inaccessible to trespassers, and free from other inconveniences common to the ordinary surface railway. The practice with the earlier lines operated by electricity has been to lay the third rail between the wheel rails, and to employ the wheel rails, duly bonded, to form the return conductor. For the Mersey Tunnel, the Metropolitan District, Metropolitan, and other electrical lines, in contemplation or under construction, an insulated rail is used for the "return." The potential conductor is placed at a given distance outside the wheel rails, and the return rail between them. It is considered that this practice—viz., the provision of an insulated, or, at all events, of an independent return rail—will be found in future constructions. The object in thus employing conductors independent of the wheel metals will be obvious. It avoids any interference therewith, and ensures, as far as possible, perfect continuity. It will also be helpful in preventing trouble with the telegraph service. In all instances the conductors are, whether insulated or not, laid upon the sleepers which serve the wheel rails, and this appears to be the practice in America as well as here; but in the States, where the sleeper employed is not so long as those used in this country, every fifth one, or thereabout, is made longer for the purpose of providing for the support for the third rail. By the courtesy of the British Westinghouse Company I am enabled to furnish the appended details of the position of the conductor in relation to the wheel rail on lines in the United States, as also a scale drawing (Fig. 1), showing the position of the positive and negative conductor rails as adopted by that company. From this list and from other data, it is clear that the only uniformity attained is that all alike make use of the sleepers which carry the wheel rails for the support of the conductor rail or rails, as the case may be. The object, no doubt, is to secure parallel conditions between the different sets of rails.

Protection of Conductor Rail.—There is, of course, no absolute necessity for the protection of the return conductor, but for the third rail—viz., that which forms the potential conductor—protection is desirable, and has in some instances been provided. This protection usually consists of a vertically-arranged plank on one or both sides of the rail, as shown on one side only in Fig. 1, the upper edge of the plank being somewhat higher than the top surface of the rail, so that anything falling across it may not form contact with the conductor. It is suggested that this affords no protection from weather, and but an imperfect protection against accidental contact. The conditions that will attend surface lines are very different from those which will apply to tube lines, or lines which are not open to trespassers. Climatic conditions will be found to be far more troublesome. Snow, rain, and fog are enemies which

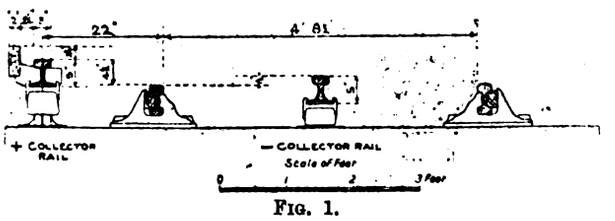

FIG. 1.

have little, if any, effect upon a covered line. It would, therefore, appear desirable that the most complete protection of the conductor rail, both with respect to climatic effect and accidental or intentional interference, should be provided for. This, it is thought, may be better obtained by adopting a roof cover as shown in Fig. 2, the roof extending so far beyond a vertical line drawn from the edge of the rail as would prevent a person standing against it, or an implement placed against it, from touching the conductor. We have to bear in mind that workmen will, in the discharge of their duties, be frequently moving about in the immediate neighbourhood of the conductor, and that such a guard as that suggested would unquestionably be more effectual than the vertical planks which leave the top of the rail exposed.

Points for Consideration.—Two important questions present themselves—viz.: (1) the distance which should supervene between the near wheel rail and the conductor or between the latter and the return rail; and (2) whether the sleepers which carry the wheel rails should be used for the conductor rails. It is probable that the first of these two important questions will only be determined

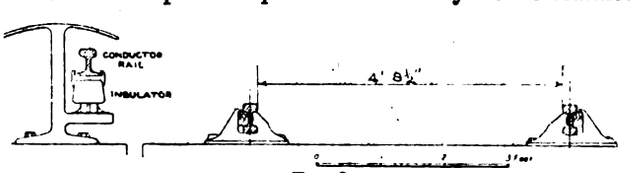

FIG. 2

after experience of the climatic effects to which they will be exposed has been obtained. With respect to the second question, however, the subject can at once be considered, and no better opportunity than the present could arise, when it may be expected that engineers of permanent way are present. In considering it we have to bear in mind: (*a*) that the permanent way must be constantly patrolled; (*b*) that packing and drainage of the sleepers are essentially an everyday occurrence; (*c*) that renewals of sleepers and rails, replacement of defective sleepers, broken chairs, etc., must be provided for; (*d*) that when laying out stores for any of these works the off-side of the line is almost invariably used; (*e*) that the off-side of the line is also used by workmen and others when walking the line.

All these conditions, it is thought, suggest the propriety of confining the conductor rails to the "six-foot," and dissociating them entirely from the sleepers which carry the wheel rails. This would, inasmuch as structures would at points narrow the space, and for other reasons, necessitate the use of a flexible collector, which ought not, however, to prove an insurmountable obstacle. It would also

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entail, where a fourth rail is employed, the provision in the 6ft. space of a structure which would accommodate both the potential and the return rail, either vertically, one above the other, or on practically the same level—side by side. It is evident this would prove more complicated than the provision shown in Fig. 1, but it is also clear that it would be largely to the convenience of the electrical as well as the permanent-way engineer, and that it would aid each in the effectual maintenance of their respective responsibilities. It would also claim consideration in dealing with crossings. With a multiple-unit train no trouble would arise, but with a train worked by a locomotive it would be necessary to supplement the *collectors* on the locomotive by *collectors* on the next vehicle, which would ordinarily be the guard's van or brake.

APPENDIX.—PLANTS ALREADY INSTALLED.

The following table gives the location of the positive collector rail where electric traction has already been installed on a number of main-line steam railways, and interurban, elevated, and underground electric railways. In Column A the distance is from top of positive rail to top of track rail; and in Column B from track gauge line to centre of positive rail.

Main-Line Railways, Electric and Steam Service.

	A. Inches.	B. Inches.
Baltimore and Ohio Railroad, Baltimore, Maryland (old location)	1¾	24
Baltimore and Ohio Railroad, Baltimore, Maryland (new location)	3½	30
Albany and Hudson Railroad, New York	6	27
New York, New Haven, and Hartford Railroad, Connecticut	1½	Centre.
Paris-Orleans Railway, France	7⅞	25⅝
Gallaratte, Italy	7½	26⅝
Mersey Railway, Liverpool	4½	22
North-Eastern Railway, Newcastle	—	—
Lancashire and Yorkshire Railway, Liverpool	—	—

Interurban Railways, Electric Service Only.

Aurora, Elgin, and Chicago, Illinois	6⅝	20⅛
Columbus, Buck. Lake, and Newark, Ohio	6	27
Columbus, London, and Springfield, Ohio	6	27
Lackawanna and Wyoming Valley, Pennsylvania	6	20⅜
Grand Haven, Grand Rapids, and Muskegon, Michigan	6	20⅜

Elevated and Underground Electric Railways.

Metropolitan West Side Elevated Railway of Chicago, Illinois	6¼	20⅛
Lake Street Elevated, Chicago, Illinois	6½	20½
South Side Elevated Railway, Chicago, Illinois	6¾	20⅛
North-Western Elevated Railway, Chicago, Illinois	6½	20½
Brooklyn Elevated Railway, Brooklyn, New York	6	22
King's County Elevated Railway, Brooklyn, New York	5¼	19½
Manhattan Railway, New York	7½	20¾
Rapid Transit Subway, New York	4½	22
Central London Railway, London	1½	Centre.
Liverpool Overhead Railway	1½	Centre.

It will be noted that there is a wide variation in the dimensions, but in general the main-line steam railways of America and the Continent have found it necessary to place the rail at a greater distance than 24in. from the gauge line. This is due to the width of steam locomotives and heavy goods cars, and to the specially long and low double-bogie stock for transporting bulky apparatus and machinery, such as car bodies, flywheels, generator frames, etc.

DISCUSSION.

Mr. Langdon said at the time he presented his paper he was not aware that some meetings had been held by the railway companies, and that practically some agreement had been arrived at as to the position in which the conductor rail should be placed, and he understood that the decision come to was that these conductor rails should be placed upon the sleepers, the same as had been done in other countries. He could not, personally, help thinking that there would be found a greater convenience in carrying out the permanent-way duties with four rails being placed together on the same sleepers, and he would urge the desirability of their being placed quite independent of the wheel rails.

Mr. Aspinall said the position of the third rail was a question of very great importance, and it was one that had been discussed at three meetings which were held by the railway companies at the Railway Clearing House with a view of arriving at a standard position which they could all agree on. The difficulty, however, of adopting the dimensions in the diagram shown in the paper was that they were dealing with existing railways, which had all sorts of obstructions in the way, and all these had to be considered. Another point was that it was desired to get the third rail, or the live rail, upon the existing sleepers in order to save the expense of putting in additional new sleepers, and it was desirable to have that at such a point that the insulator could be properly fixed upon that sleeper. It would be possible, according to the diagram, to go out a little bit beyond that—perhaps an inch or more—but all sleepers were not exactly a standard length, and they would not be able to get the insulator well bedded upon the sleeper. It was decided at the railway conference to place the third rail 3ft. 11½in. from the centre line of of track. He spoke of it as from the centre line of the track, because that was more or less a variable figure. It was also decided that the third rail should stand up 3in. above the track rail; and, further, that if it became necessary to put any protection bars they should be put 8in. apart. The dimensions practically accepted by the conference were 3ft. 11½in. centre line of rails, 3in. high for live rail, and 8in. apart for protecting bars. They must keep the rail a fair distance above the track, because the shoes must pass over any crossings in complicated existing crossings of rails, and they would of necessity have a certain amount of spring in order to keep them in contact with that rail, and they must, further, allow for the rise and fall of the vehicles due to their springs and the wear and tear of the tyres which was always taking place.

Mr. A. P. Trotter (electric adviser to the Board of Trade) said Mr. Hood's paper should prove of great interest to those who were looking forward to the equipping of the main-line railways for high speed, but they had to walk before they could run, and no doubt the smaller lines would be the first to be worked electrically. Mr. Langdon spoke of an insulated rail. Engineers would have to settle for themselves whether they found it worth while to put an insulated rail for the "return." Experience only could show what degree of insulation was arrived at for the return rail, and what difficulties were likely to arise from leakage. With regard to the question of trespassers upon the line, he fancied that point largely determined the desirability for guard rail. The hood over the conductor rail appeared to be difficult to realise on account of the load coach.

Mr. Portheim said Mr. Trotter had remarked that they must walk before they ran. In this country he thought they walked rather too much, and gave the public too much evidence of walking whilst they were trying to run. Mr. Hood's paper referred to the variation in speed on the three-phase overhead system. There was no difficulty as regards variation of speed if they had them in multiples. The great plea in favour of the overhead system, which must appeal to everybody, especially financiers whose object was to find money for the lines, was the cost.

Mr. Ross said he, personally, should like to get the conductor rail off the permanent way, and if it could not be put in the six-foot he should prefer that, instead of being on the sleepers, it would be on standards immediately between the sleepers, with a regulating screw or something with which they could keep the relative levels. He did not see how the difficulty of the roof cover for the rail could be got over. It was most desirable that it should have a cover. He was rather disappointed that the authors did not refer to the subject of capacity.

Mr. Worthington said, with regard to the point as to whether the electrical appliances should be fixed on the same sleeper as the running rail, he thought the advantage was in favour of putting the whole thing on one sleeper if you could be sure that the sleeper always kept at its level; but sleepers would go up and down. If they did not have a bar rail attached to the sleeper, they would have a varying depth over which the sleeper would have to rise and fall. Of course, it would not be a very large amount. It would be a great advantage that the two rails should rise and fall together. With regard to an insulated fourth rail, it would enormously complicate the difficulties in points and crossings if they had got a rail in the four-foot standing up 1½in. above the surface of the running rails, especially when they considered the rise and fall of the carriages on their springs. There was a very narrow margin to be left between the sleeper and the running rail when the electrical train was running on a worn rail, and he could not help thinking that would create a difficulty.

Mr. Fletcher, Mr. Winder, Mr. F. Fox, Major-General Webber, Mr. Gates, Mr. Roger Smith, Mr. Scott, and Mr. Cottrell also spoke, and the authors having replied, a hearty vote of thanks was passed.

CHLORINE SMELTING, WITH ELECTROLYSIS.*

BY JAMES SWINBURNE, VICE-PRESIDENT.

ARGUMENT.

Chlorine smelting, a new process covering wide domain in metallurgy. Present processes, furnace reductions. Costly and give impure metals. Can only treat certain ores. Chlorine process treats pure sulphides, and gives still better results on mixed or refractory sulphides. Process is in three stages; writing Zn for zinc and M and N for other metals. (1) $ZnS + MS + NS + 3Cl_2 = ZnCl_2 + MCl_2 + NCl_3 + 3S$. (2) $ZnCl_2 + MCl_2 + NCl_2 + 2Zn = 3ZnCl_2 + M + N$. (3) $3ZnCl_2$ electrolysed $= 3Zn + 3Cl_2$. More detailed description. Working cost of process. Capital cost. Antimony. Arsenic. Bismuth. Cobalt. Copper. Gold. Iron. Manganese. Nickel. Silver. Tin. Zinc. Rule for capital.

PRESENT PROCESSES.

It will seem rather late in the history of metallurgy to bring forward a scheme which aims at nothing less than a complete revolution of the major part of the art of metallurgy, but this is a new society, and it is but fitting that a new process be brought before it for discussion and probably criticism, but I hope for and expect help in the way of suggestions and information from many of the members who are especially qualified to give it. At present we may take it the normal process for obtaining a metal is to convert it into oxide and reduce the oxide by carbon. Iron is a good example. It occurs as oxide, and is reduced by carbon or its monoxide. The result of this process is a metal which is very cheap, but very impure. The economical

* Paper read before the Faraday Society.

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value of pure iron is unknown. It may be very high. More will be said about that presently.

Zinc is obtained purely by reduction, though work has been done on its extraction by electrolysis, especially from aqueous solutions. The bulk of the zinc of the world is obtained by a very crude method of reduction by carbon. Copper involves a furnace reduction process which may be partly classed as carbon reduction, and partly as a direct action analogous to the alternating reduction of lead sulphide. Tin is reduced by carbon. Electrolysis has come to the front, however, in the reduction of sodium and aluminium. The great drawback to the carbon reduction processes is that the metals so obtained are always impure, the refining often being exceedingly expensive; there is a great deal of waste, and many mixed, or so-called refractory ores, cannot be treated at all. Electrolysis provides an admirable means of getting many of the metals down, but the difficulty is generally in getting the metal from the ore to a suitable condition for electrolysis. Thus copper is very easily deposited from, say, copper sulphate solution, but it is by no means easy to prepare a copper sulphate solution economically from a copper ore. There is also difficulty as to the anodes. Carbon is corroded, and lead or antimonial lead needs a still higher E.M.F. Aqueous solutions of lead salts cannot be made economically from lead ores, and their electrolysis gives rise to lead sponge, which cannot be dealt with. Zinc gives similar troubles. What is wanted to displace furnace reduction of oxides and sulphides is to convert the ores into salts of the metals that can be easily and cheaply electrolysed, and to do this simply, efficiently, and economically.

The Chlorine Process.

The process I have the honour to bring before the society is simplicity itself. The sulphide ore is treated with chlorine so as to displace the sulphur and absorb all the chlorine. The chloride is then electrolysed to get the metal and recover the chlorine. This is the process in its naked simplicity. When all the details necessary, even in connection with complex ores, are considered, in comparison with existing methods, the process is exceedingly simple. As a good example, suppose pure galena is to be smelted. The galena is treated with hot chlorine so as to form lead chloride and sulphur. The sulphur is condensed as brimstone, and the lead chloride is electrolysed in the fused state, producing lead and chlorine. If there is silver or gold present, the fused chloride of lead is treated with metallic lead. This replaces any gold or silver there may be, and the precious metals alloy with the remaining lead, so that ultimately a bullion is produced as rich as may be desired, the only limit being its melting point, which must not be too high. The cost of desilverising by the ordinary processes is thus saved. This process thus recovers all the lead, all the silver and gold, and nearly all the sulphur. If the electrolyte vats were so tight that no air got in all the sulphur would be saved, but in practice a little sulphur is always burned into SO_2. Pure or nearly pure lead sulphide is easy to smelt in the ordinary way, but this smelting does not separate the silver, and is thus incomplete. In time, therefore, the chlorine process is likely to replace the present methods, even for pure ores. Take another example—pure zinc sulphide. The process is exactly analogous to that for pure galena. But in practice zinc blende contains gangue and generally iron, and these must be separated.

One of the great advantages of the chlorine process is that it is applicable to mixed ores, which are often absolutely refractory and useless otherwise. This process makes concentration quite unnecessary, unless merely for eliminating gangue, as the presence of several metals gives rise to no difficulty. In no case has one metal to be lost in order to extract another, and in no case is a metal brought out impure or needing refining. Take, for example, a mixture of sulphides of lead, zinc, and iron, with some silver. An immense amount of work has been done on this class of ore, and great progress has been made in concentrating, so that one part will leave enough zinc to be worked, and little enough lead not to interfere with the metallurgy, and the other part will leave enough lead and little enough zinc. Each portion is smelted for one metal only, the other being worse than wasted, as it is a nuisance. An intermediate ore, often a large proportion, is thrown away. The new process takes the ore just as it comes from the mine, without any previous treatment; or, better still, it takes the slimes, such as the Broken Hill slimes, which are at present accumulating as a monumental memorial to the barbarity of present smelting processes. The slimes contain zinc, lead, iron, silver, and gangue. Hot treatment with chlorine converts the whole of the metals into chlorides, producing a broth of mixed fused chlorides and gangue. The silver is extracted by substitution of lead, the lead is extracted by substitution of zinc, and the iron is thrown out as ferric oxide, not as metal, zinc oxide being used as substitute, and the gangue is got out by filtration. We have then nothing left but zinc chloride, and this is electrolysed to yield zinc and chlorine.

The process thus consists of three essential elements: treating the ores with chlorine; chemical treatment of the mixed chlorides by substitution, so that all the chlorine is combined with zinc; electrolysis of the zinc chloride to extract the zinc and recover the chlorine. One of the chief merits of the process is that it is so perfectly cyclical. The chlorine merely goes round and round. The works take in ore and electrical energy, and turns out metals, sulphur, and gangue. In treating sulphide ores with chlorine, as in analysis, or in the action of chlorine on sulphides generally, chloride of the metals and chloride of sulphur are produced. This is the reaction described in most text-books of chemistry. The formation of chloride of sulphur would be fatal to the process, however, as we should lose both the chlorine and the sulphur, and there is no convenient way of getting rid of large quantities of this offensive compound, far less of recovering the chlorine and sulphur. Decomposing with water is not a cyclic or a practical process. The discovery that sulphide ores can be decomposed on the large scale by chlorine so as to give off sulphur and not its chloride is, if we may say it with modesty, a possible turning point affecting a vast realm of metallurgy. The middle parts of the process, by which the mixed chlorides are converted into chloride of zinc by substitution and elimination of the other metals and of the gangue, involve ordinary chemical engineering only, though there is considerable room for ingenuity in inventing and working out the methods on a large scale. The electrolysis of zinc chloride is supposed to be very difficult or impossible. We have overcome any difficulties. Zinc is chosen as the final metal to be separated from the chlorine for two reasons: because is is chemically easy to substitute it for all the metals we want to extract, as it is very electropositive, and because it is easy to extract by electrolysis.

Smelting Lead-Zinc Bluestone.

The actual process, as applied to some particular ore, may now be described. The Broken Hill slimes may be taken as a good example. The crushed ore is run into a transformer. This looks like a small blast furnace made of fireclay with iron outside or of lined iron. It runs continuously, and we may start our description at a stage when a tapping has just taken place. The transformer then contains about 1cwt. of fused chlorides and gangue. The gangue almost floats in the chlorides. If much lead is present much of the gangue floats, so there is no caking or silting up. The top of the transformer has a cone like a little blast furnace. Ore is poured into the fused chlorides, and at the same time chlorine is blown in. The chlorine enters at the bottom by a sort of tuyere, which is a carbon tube. The cold part of this tube is connected to an iron pipe, which brings the chlorine. Dry, cold chlorine is easy to handle. It does not touch metals, and iron can be used freely. The chlorine bubbling through the fused bath displaces the sulphur, which comes off and is condensed. The action of chlorine on the sulphides in question evolves a great deal of heat, so that the transformer is self-heating, and there is no coal or coke firing or outside heating of any sort. The temperature is controlled by the rate of admission of chlorine. If the temperature is too low, chloride of sulphur may be formed. This may also be formed if there is a deficiency of ore supply. On the other hand, if the chlorine and ore are supplied too quickly, the transformer will get too hot, and some of the chlorides will distil over and be condensed with the sulphur. By running the transformer fast the temperature can be got so high that all the chlorides distil over, leaving only the gangue. The bulk of the transformer gives easy regulation. The temperature is the main consideration in determining the size of the transformer. It must be of such a size that when running at its normal rate the heat is conducted through the lining and radiated from the surface at such a rate that the contents keep at the right temperature. There is considerable margin allowable in temperature, and the temperature is under control by regulating the flow of chlorine and of ore. The temperature can always be lowered by running in a little extra ore or reducing the chlorine; but the chlorine feed depends on the electrolytic vats, and is practically constant. The larger the transformer the longer it will preserve its temperature with any fluctuations of chlorine supply, and the cheaper the pumping, labour, etc. It is therefore best to have large transformers. We have so far used a 10-ton, but a larger size with thinner lining will probably be better. The amount of gangue in the ore is important. As the gangue is about the same density as the chlorides, a large amount may be present without inconvenience as to fluidity. It is, of course, an advantage to be able to work on ores with little metallic content. It is quite easy to work with the metallic contents only half the ore, or even less. Poorer ores can be made workable by addition of those with more metal. The temperature depends on the metals in the ore too. Thus blende heats much more than copper sulphide; so that, other things being equal, a copper ore with little zinc should be run through faster, or mixed with, say, a zinc-lead ore.

To return to the working of the transformer, it is started with the remains of the last charge, and then chlorine and ore supplied till it is full. The regulation needs no skill. A hole can be opened at the top of the transformer, and as it is connected through the sulphur chamber to a chimney there is a

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general suction. This draws air in at the hole, which burns the sulphur vapour. The blue flame shows there is enough ore. If too little is fed, fumes of ferric chloride fill the top of the transformer and pass into the sulphur. This is to be carefully avoided, and there should be excess of sulphides in the transformer until the end of the charge. At the end the ore feed is stopped, and the transformer run till brown fumes appear. These are by-passed round the sulphur chamber. The charge is then run out, and allowed to cool. At first great difficulty was expected in pumping the chlorine, as a pressure of some 10lb. to 15lb. on the inch is needed when the transformer is nearly full. The pumping presents no difficulty, and a chlorine pump will run night and day continuously without trouble. The well-known patented method with sulphuric acid flooded pumps would have been available, but such complications are quite unnecessary with dry chlorine. The dryness is of vital importance here.

We now come to the intermediate or chemical stage of the process. This varies with the ore used. We may take the Broken Bill slimes, and imagine there is copper too. This would be about as troublesome an ore as we could have. We have used the Broken Hill ore and mixed it with a Tasmanian copper ore, but we have chiefly worked on it alone. The fused mass from the transformer consists of chlorides of lead, zinc, iron, manganese, copper, silver, and gangue. It is run into water and through a filter press when cool enough. This takes out the gangue and lead chloride, carrying most of the silver. The gangue is easily separated from the lead and silver chlorides, and these chlorides are then dried and fused in contact with lead, which extracts the silver and any gold, and then with zinc, which gives lead, practically pure, and anhydrous neutral zinc chloride, which is ready for the electrolysis vats. The filtrate from the press contains a little lead and silver in solution, and copper, iron, manganese, and zinc. The lead and silver are taken out with spongy copper. The copper is taken out as sponge or "cement" by zinc, and we have left iron, manganese, and zinc chlorides. The iron is chlorinated up to the ferric state, and zinc oxide is added to cause precipitation. This throws down hydrated ferric oxide. This is the base of iron paint, and is marketable, its value depending on the colour obtained. The solution is further chlorinised in presence of more zinc oxide, and the manganese goes down as peroxide.

We have now substituted zinc for all the other metals in their chlorides, and have nothing left but zinc chloride. This is evaporated down carefully and fused. This decomposes some of the chloride, and makes an oxychloride. Steinhart evaporates *in vacuo* to produce neutral anhydrous zinc chloride. We have not done this; we find that with cautious boiling down there is not much oxygen in the final result. This is got rid of in open preliminary vats, which use inexpensive anodes, which are gradually used up. The consumption is less than if all the oxygen went off as monoxide. The anhydrous neutral chloride from these vats is then added to that from the lead chloride substitution, and is taken to the final electrolysis vats. The electrolysis vats are internally heated, as in the case of aluminium. The cathode is fused zinc, and the anode is carbon. Some makes of carbon do not stand well, but suitable carbons serve to stand permanently. Of course, chlorine has no action on the carbons. The vats are kept under a very light suction, so that if there are any leaks air goes in instead of chlorine coming out. The carbons are not hot enough to be burnt by this small admission of air. As the vats are kept warm by the excess of the electrical power over the chemical, the larger the cell the lower the E.M.F.; so that if the cell were large enough we could get down nearly to the E.M.F. corresponding to the heat of formation of zinc chloride at that temperature. So far 3,000 amperes has been the current used, but this means a very small vat. The output of fused salt vats is enormous in comparison with aqueous work. A 10,000 vat is now being tried. Above that size the current will be inconvenient. With the small vats four volts per cell is needed; with 10,000 amperes three should do. It is best to count on four; this allowance ought to cover the power for the preliminary electrolysis, too. The current efficiency is practically unity. Zinc smoke is, of course, formed if the temperature is too high. The vats are very simple—merely iron cases lined with firebrick. The chloride soaks into the porous brick and solidifies somewhere, so it is really a vat with zinc chloride walls.

Cost of Process.

As to costs of the process, the first thing to realise is that it smelts for all the metallic contents of the ore, not for only one; that all the metals are completely extracted. There is no waste by fumes or imperfect extraction, and there is no slag. The gangue looks like river sand. There is no room for loss. All that comes into the works is ore and electrical energy; all that goes out is pig metal, sulphur, gangue, and oxides. The chlorine goes round and round. There is no room for appreciable waste of chlorine either. A leak that would show in the balance-sheet would make the works uninhabitable. There is, however, a trace of chlorine in the iron oxide, as it is apt to contain a little oxychloride. There is also a loss in collecting the hydrochloric acid from the boiling down of the zinc chloride. A little chlorine must therefore be added to the stock. This can be done by buying crude zinc chloride, or galvanising pickle, or precipitating calcium chloride with zinc sulphate. In out-of-the-way places it is much simplest to buy zinc chloride, as it is more portable than hydrochloric acid.

It may be said that a process for such a problem must be a maze of chemical operations, and when you come to the end you have to begin again. This is not the case here at all. The process has only three simple stages: (1) transforming sulphides into metallic chlorides and sulphur; (2) substituting zinc for all the other metals in the metallic chlorides; (3) electrolysing out the zinc and recovering the chlorine. Compare this with ordinary metallurgy. To describe the metallurgy of a single metal at all adequately requires a book. Try and explain even most superficially the metallurgy and refining of argentiferous lead, zinc, and copper to anyone quite new to the subject in the few pages here devoted to description, and it will be seen how simple the new process is. Add to the description of the metallurgy of these metals an account of the refining of copper and zinc and refining and desilverisation of lead, and even then you have only half done. To make the comparisons on all fours you must give an account of the concentration and separation of refractory ores, and give a description of methods for dealing with a mixed ore of lead, zinc, silver, iron, and copper. There can be no doubt that though the steps in the new process sound unfamiliar to ordinarily trained metallurgists, it is in comparison ludicrously simple. But there is even more than this. The new process treats ores whose smelting by ordinary processes cannot be described, even with unlimited complications, because they are at present untreatable.

As to costs, everything depends on what ore is used and where it is used. The most obvious course is to work on refractory ores which are otherwise valueless, but leave large metal contents. The cost of the ore delivered at the works is then known. Thus, even in England bluestone ore can be bought and delivered at from £2. 10s. to £3 a ton, ready for running into the transformer. The metal content is £8. 16s., taking zinc at £20, lead at £12, and silver at 2s. If higher prices can be maintained for pure metals, of course the content must be taken at a higher value. This figure includes all valuable contents. The cost of the intermediate process is difficult to state, as it is a question of locality and labour. The capital in this part of the process is small, but in the estimates heavy allowance has been made for deterioration, and all other contingencies. On the other hand, the conversion, which alone is a new sort of chemical experience, is extremely simple and easy. The intermediate processes depend on the ore. Thus, if there there is no copper, part is cut out altogether. If there is no iron, by which I mean not even enough to hurt the zinc, the transformer product would not be dealt with in the wet way at all. The wet way is to get rid of iron and manganese, and to get out copper. Lead and silver can be got out by substitution in the fused state with great ease, but copper has too high a melting point, and is therefore taken out by the wet process.

To make a very safe shot, the cost of all the process except the energy for electrolysis may be taken at a rough figure of 30s. per ton of ore. This will easily cover all depreciation, a small percentage on capital, all labour, and management. As the process uses ores with about half the contents metallic, though it can work with half sulphides, this means about 30s. per ton of chloride of zinc handled. Most of this work is pure circulation, agitation, and filtration, all cheap processes. The solution is not bulky, as it is used as strong as the filter press cloths will stand. Evaporating down and preliminary electrolysis are the most expensive parts of the process, and they are not serious. The loss of chlorine, which has not yet been determined, may be taken as costing about 1s. a ton of ore for every 1 per cent. of chlorine wasted, if it is made up by buying chloride of zinc. If it is made up by hydrochloric acid or calcium chloride, which is far cheaper where there is no carriage difficulty, the cost is about half that of zinc chloride. This loss of chlorine is included in the 30s. a ton of ore, and in the estimates to follow, as power is taken at prices in England, where it is not cheap, we may assume we can get calcium chloride cheap. This does not complicate the estimate by showing a zinc output a little higher than the intake in the ore.

The cost of energy is very easily determined. If it is generated by steam-engines of high grade in this country in a convenient district it may be taken as 0·25 per kilowatt-hour, including depreciation, coal, oil, repairs, labour, and management, and a small interest on capital. This is a close estimate, but one which can be realised on large plants running day and night on uniform full loads. The cost by producer gas and gas-engines is somewhat uncertain. It may be taken at 0·125, though that is probably a very tight figure. Water power in a favourable situation may be taken at 0·085. This refers to water powers such as on the way down from the American lakes to the sea. It is for a works planted close to the generators, and does not cover rotary transformers or step-down plant.

(*To be continued.*)

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NOTES.

Poldhu Station.—Last Saturday Mr. Marconi was honoured by a visit from the Prince and Princess of Wales to the wireless telegraphy station at Poldhu. The Royal guests were interested with what they saw.

Tantalum.—The electrical furnace is greatly enlarging our range of metallurgical knowledge—thus tantalum was hitherto known as a more or less pure powder, with a density of about 10·50. By heating 10 minutes in a very powerful electric arc, M. Henri Moissan has succeeded in reducing tantalic acid with powdered carbon, and has obtained the metal in a fused state. It has a brilliant metallic appearance, and a density of 12·79. It is very hard, easily scratching glass and quartz, has a crystalline fracture, and is infusible in the oxyhydrogen blowpipe. Certain reactions class it with the metalloids rather than with the metals proper.

Motorcar Dangers.—In view of the crusade which has been organised in certain of the daily papers against motorcars, it is interesting to read a letter from Mr. W. Rees Jeffreys, the administrative secretary of the Automobile Club. He comments on the fact that during the automobile fortnight in Ireland over 1,000 cars were used on the roads of that country, and that speed limitations were disregarded by tacit arrangements with the police, who confined themselves to regulating the traffic in towns and villages. In spite of the legal speed limits being frequently exceeded, not a single accident by which any person has been seriously injured has been recorded.

Great Gooseberries.—The gooseberry season for the daily Press is fast approaching, and we were recently asked to believe one of French origin. It was stated, under the head of "Electricity in War," that a well-known scientist, Dr. Le Bon, in the course of experimenting with a powerful electric coil was suddenly enveloped in flames. These flames he therefore predicts will be of service in burning up collections of shells, gunpowder, cartridges, and battleships. The only criticism that we think it worth while to make is that the flames which completely enveloped Dr. Le Bon do not seem to have injured him, and we are not aware that a battleship is so much more combustible than a professor.

Electric Signalling.—The Great Western Railway have adopted the Miller signalling system for the Severn Tunnel, which is 4 miles and 600 yards in length. With the new signalling system the tunnel will be divided into sections of 1,200 yards length, thus permitting more than one train on the same line in the tunnel at the same time and with perfect safety. The usual semaphore signals at the sides of the line will be supplemented by "repeat" signals indicated in the cab of each locomotive before the eyes of the driver. This system, which can only be used in connection with electrical track circuit signalling, is in successful operation in the Park-avenue Tunnel of the New York Central Railway. We published a full description of this system when it was being tried on the Great Central Railway at Woodhead.

Continental Electric Railway.—The first electric railway in the Austrian Empire has been opened between Tabor and Bechin, in Bohemia It is 15 miles long, and, according to a Vienna correspondent, the maximum speed attained is only 19 miles an hour. That passenger traffic is strictly limited in this district of Bohemia may be essayed from the statement that a train consists of only two cars, with a carrying capacity for 40 passengers and 36 tons of goods. The new railway has a special interest from the fact that we believe it to be the first line to be entirely regulated by the telephone. The correspondent in question states that there are no signals, the telephone being used by the driver in all cases to ascertain whether the line is clear. Each car is fitted with a portable instrument, which may also be used by the passengers.

St. Marylebone Electric Lighting.—The special meeting, held last week, of the St. Marylebone Borough Council did not disclose on discussion much unanimity on the vexed question under discussion. A number of members advocated that the Council should go on their knees to the Metropolitan Electric Supply Company and ask for the best terms on which they can be allowed to repent of their absurd desire to purchase the St. Marylebone portion of that company's undertaking. Alderman Sir Thomas Brooke Hitching, who in years past was the strongest advocate for purchasing this undertaking, now advises that a 3d. rate would be preferable to completing the purchase. The general conclusion, however, of the meeting was that the matter must be carried through, and that the money would have to be obtained. We are afraid that the St. Marylebone Council have not shown reasonable business capacities over the electric lighting question, and that the ratepayers will long have reminders at intervals that this has been so.

Electrical Work in India.—Our contemporary *Indian Engineering* for June 27 congratulates in a leading article Lord Curzon's Government on the enthusiastic encouragement it has extended to electrical developments. The language of the article is almost beyond us at times; for instance we read that "the company promoter is an unavoidable excrescence of present-day commercialism, and the opportunity to exploit the unwary, which the electrical activity of municipal India affords, is much too good to be neglected. It behoves the authorities therefore to exercise a wise discrimination in placing contracts." The rest of the leader is devoted to a strong recommendation of a trust formed by Messrs. Marshall, Sons, and Co. and Messrs. Crompton and Co. for the laying out of electric stations in India and for financing the same. The particulars given of this combination will cause much blushing in Salisbury House. From the same issue of our contemporary we gather that schemes are on foot for the electric lighting of the towns of Hyderabad and Chudderghaut.

Overhead Wires.—On Monday last Mr. Markham, M.P., in the House of Commons asked the President of the Board of Trade whether, seeing that the Governments of America, France, Germany, Switzerland, Italy, and other countries have, during the last 10 years, passed laws regulating the methods of distributing high-tension current by overhead wires, which has resulted in a widely employed use of electricity for industrial purposes, he would say whether there was a single case in Great Britain or Ireland where high-tension current overhead wires had been installed. Mr. Gerald Balfour, in reply, said there was no case in the United Kingdom or Ireland where bare overhead wires have been used for the transmission of electricity at high voltages for industrial purposes. The Department had not been asked to sanction this method of supply until quite recently, and was quite ready to give favourable consideration to each application. The matter had his personal attention, and he begged to inform the hon. member that the Board of Trade had been, and still are, prepared to consider each case on its merits without reference to any model regulations. In the cases now under consideration the electrical adviser will prepare special regulations applicable to the circumstances of each case. It remains to be seen how far the Board of Trade, after examination of special cases, will allow of complete

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equipment for the proposed additional technological teaching and research are provided to a value of not less than £500,000, the Council will be well advised to contribute, out of the moneys annually placed at its disposal under the Local Taxation (Customs and Excise) Act of 1890, a sum not exceeding £20,000 per annum towards such part of the work as falls within the statutory definition of technical education, subject to the following conditions: (*a*) that a scheme be prepared to the satisfaction of the Council for the constitution of the governing body, and the adequate representation of the Council thereon; (*b*) that financial arrangements, adequate to the whole maintenance of the proposed work, are made to the satisfaction of the Council; (*c*) that, in view of the national scope and utility of the proposed work, substantial contributions towards maintenance be made from funds of a national character; (*d*) that due provision be made in the scheme to prevent overlapping and secure co-ordination of the work already carried on by the University College, polytechnics, and other science and technological institutions, and the proper connection of the whole with the university; (*e*) that a sufficient number of scholarships, including free places, be placed at the disposal of the Council; (*f*) that it be considered whether other counties and boroughs should not be invited to contribute towards the maintenance, receiving in return the right to send their picked scholars for instruction under the proposed scheme."

Rubber Cultivation.—In the past six or seven years rubber cultivation has been taken up in the Malay Peninsula with considerable zest. The credit for this is not due so much to the progressive spirit of the planter out there as to the force of circumstances which compelled him to look about for other cultivations than the coffee tree when the decline in price of that article of commerce followed the high prices ruling for coffee in 1896. Since that year the cultivation of the rubber tree has received great attention, and an authoritative estimate states that at the present time in the Malay Peninsula there are at least 12,000 acres planted with Hevea Brasiliensis, the tree furnishing the Para rubber of commerce. This acreage represents about 1½ millions of trees, presumably the whole being the progeny of the trees originally introduced by the Government of India in the seventies. Some figures have been published by Mr. Stanley Arden, the superintendent of the experimental plantations in the Malay States, showing the cost of opening and maintaining a plantation until it is productive. These are very encouraging to the planter, although he must not look for profits until about the sixth year, which may be taken to be the first productive year. Assuming a plantation of 500 acres, Mr. Arden estimates the total expenditure for the first five years at nearly £6,000, or an average of about £12 per acre, to which must be added the interest on all money expended. The yield per acre in the sixth year would amount to 25lb. of rubber, and, taking an average selling basis of 2s., the commercial value would be £2. 10s. The average cost per acre per annum for upkeep being £1. 16s, it appears probable that, after deducting all expenses in connection with the preparation and marketing of the rubber, the return during the sixth year would leave a small margin of profit. By the time the trees are six years old, 75 per cent. should give an average yield of 12oz., which is equal to 56·25lb. per acre. Valued at 2s per pound, this gives a gross return of £5. 12s. 6d. per acre, so that, after deducting the cost of harvesting and marketing, there is every prospect of a fair return on the capital expended during the seventh year. By this time the cost of upkeep should have reached a very low figure, while the yield should increase year by year, and should average at least 150lb. of rubber per acre by the time the trees are nine years old, and the following year probably 200lb.

Submarine Electric Power Cables.—A paper on the above subject, recently presented by Mr. G. U. G. Holman, of Quebec, to the Canadian Electrical Association, is interesting reading, as showing the difficulties which have been met with in carrying power cables 3,400ft. across the bed of the St. Lawrence River at Quebec. The cable, which supplies 1,000 h.p. to the Quebec Railway, Light, and Power Company, is used for two-phase currents, and was laid in December, 1901. This cable is composed of four 19-strand conductors, each of an equivalent of 2-0 solid copper. Each conductor is covered with a 40 per cent. Para rubber compound to the thickness of ⅛in., and then wrapped with one layer of 3in. black insulated tape. The four conductors are twisted one revolution in 4ft. about a common jute centre with four No. 14 B. & S. gauge solid copper rubber-covered wires as pressure wires, laid in between the four heavy conductors on the periphery of the cable. The whole was then covered with heavy rubber-filled tape, and served with two layers of tarred jute. An armour of 30 No. 6 B.W.G. galvanised steel wires were spirally laid over the cable. The weak point was early shown to be the pressure wires. One of the wires open-circuited in June, 1902, six months after the cable was put in service. In August, 1902, a second one open-circuited, and in October of the same year a breakdown in the cable occurred, which showed itself on one of the pairs of conductors." It will be remembered that in England "pressure wires," or, as we call them, "pilot wires," have been the cause of the breaking down of a good many electric lighting cables, and that the practice of laying up pilot wires in multiple-core cables has been largely discontinued in consequence. In a new cable Mr. Holman is laying across the St. Lawrence these pilot wires are being omitted. The new cable will also be twice as heavily armoured. In the latter part of his paper the author comments on the smoothing out of the voltage variations produced by these cables. He says that, due to condenser action, the output end of the cable presents a smoother record curve than the input end. The evidence of this we should like to see, as attempts to get oscillographs of this phenomenon in this country have not been very successful. In laying such cables in rivers where ice difficulties in spring are as serious as on the St. Lawrence, care should be taken to keep the line of the cable at the shore ends as nearly as possible along the line of ice flow.

High-Tension Training.—At the recent meeting of the Canadian Electrical Association, a paper was contributed by Mr. Paul Lincoln on "The Training of the High-Tension Engineer." In this comparison was made between college training and practical experience. We think that our readers will all agree with the author, and will be pleased to read the following extracts from his accumulated wisdom. He says, for instance, that the graduate of a college "has learned how to make accurate measurements of power, but finds after he has been up against it that it is easier to measure power than it is to persuade the customer that his power is being accurately measured." Also, "the newly made graduate usually has a high opinion of efficiency and can calculate the economy of a transmission to an excessively small fraction. When he becomes responsible for the operation of a transmission line, however, it does not take him long to find out that efficiency is a vanishing quantity when compared to continuity of operation, and that economy is not to be considered as being in the same class as good service. The

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technical graduate, in short, may have knowledge a-plenty, but his wisdom is to come" The author rightly points out, however, that the great advantage of the technical education is that it gives the man proper equipment for overcoming the difficulties with which his experience is bound to bring him into contact. It gives him, as nothing else will, the power of initiative—that most valuable quality that a high-tension engineer can possess. There is nothing like the college education to equip a man for making every accident a lesson in how not to do it, and every failure a stepping stone to success. Take, for instance, the recent accident to the Niagara plant, in which a fire destroyed the cables on the bridge connecting the power-house with the transformer-house. The lesson to be drawn from this accident—so plain that he who runs may read—is that where many cables are run together, extreme precaution should be taken to protect against danger of fire. Before the occurrence of this fire there was little suspicion that the insulation of cables when lead-covered or protected by fireproof braid—as was the case at Niagara—is sufficient to maintain so fierce a blaze without the aid of some other combustible beside the insulation. One accident of this kind should suffice not only for the Niagara Falls people, but also for any others who have occasion to run many cables together. It takes a considerable time for the accumulated knowledge of practice to get introduced into technical courses at colleges, and hence we are strongly in favour of special courses of lectures being given at these colleges by practical experts. The author rightly concludes that students should not be afraid of making failures, as, as Mr. Roosevelt rightly says, "absence of failure accompanies only lack of effort."

Sodium Alloys in Cathodic Polarisation.—In this paper, which is abstracted in the current number of the *Journal* of the Chemical Society, the author discusses the production of hydrogen in the electrolysis of alkali solutions and concludes that it is formed both primarily and secondarily. Lead and tin cathodes were polarised in a 3N-solution of sodium hydroxide and their potentials measured against a mercury electrode. It was found that the steady evolution of hydrogen from these cathodes is connected with a loosening of the material of the cathode, and this is attributed to the formation of alloys with the sodium. These alloys are then decomposed by the water. When lead and tin are intensely polarised in this solution, a metallic cloud is formed. It has been proved that alloys of these metals rich in silver are decomposed by water with production of this cloud. With lead, the loosening of the metal and steady evolution of hydrogen take place when the cathode potential is about 0·7 volt, and with tin at 0·4 volt, referred to the potential of hydrogen in the same sodium hydroxide solution as zero. The cloud effect in the case of lead is produced at the potential 1·3 volts, and of tin at 1·4 volts, referred to the same standard. Zinc and platinum give rise to no cloud effect, but the metals become loose and porous on the surface. With platinum and lead, the metal is changed to a much greater extent in acid solutions than in solutions of alkalis. As this change of the metal is due to the action of the cathion, it appears that hydrogen permeates the metal more easily than sodium, and at the same time it definitely proves the secondary character of the hydrogen evolution at the cathode in the electrolysis of alkali hydroxide solutions. The potential of sodium alloys with lead, tin, and mercury was measured in a methyl alcohol solution of lithium chloride at −80deg. The results indicate that the alloy becomes covered with a layer of the pure metal (lead or tin). When the potentials are plotted against the atomic concentrations of sodium in the alloys, the changes in the direction of the curve indicate the existence of the compounds Pb_2Na and Sn_3Na. In the same way, the existence of definite compounds of mercury and sodium are indicated. The results taken together show that these definite compounds are formed during the electrolysis of alkali solutions and are then chemically decomposed by the water present. Based on the rule that when solids are diluted with solids to produce solid substances the heat change is equal to the free energy, the author has calculated what the potentials of the sodium alloys should be from the heat change and the potential of sodium in the methyl alcohol solution of lithium chloride, and finds values in good agreement with those observed.

Durability of Manganin Resistances.—Some time ago a number of German electrical and engineering concerns, the Imperial Standardising Commission of Vienna, and the Physical State Laboratory of Hamburg—10 bodies altogether—resubmitted, on the invitation of the Reichsanstalt, manganin resistances which had been in use for periods varying between two and four years. There were 31 resistances—manufactured by O. Wolff, of Berlin (25); Hartmann and Braun, of Frankfurt (3); and Siemens and Halske, of Berlin (3). They had been tested at temperatures of about 20deg. C, and the new results were reduced to the original temperatures. The temperature coefficient of manganin is small; in these cases they were mostly positive. The maximum value recorded was $+42\times10^{-6}$; the average would be below 10 ($\times10^{-6}$) however. The redeterminations of these temperature coefficients showed hardly any change. Eleven of the resistances were of 0·001 ohm, 12 of 0·001 ohm, and 8 of 0·0001 ohm. The determinations were made by comparison with standard resistances of these magnitudes. Some of the 0·01 ohm resistances had had to stand currents of 50 and 75 amperes; some of the 0·001 ohm resistances, currents of 700 amperes for two hours; some of the smallest resistances, currents of 2,000 and 3,000 amperes; a few had served for occasional control only. Most of the manganin foils had been kept in petroleum while under current. It results that 25 of the 31 resistances had changed by less than 0·05 per cent.—that is to say, had practically remained constant, since the changes lay within the limits of the reliability of direct reading instruments. Of the 10 resistances which had changed by more than 0·02 per cent., seven were box models of large size, which had had to bear hard usage, being under current every day for three hours at the time. Only two resistances were judged to have failed to pass, having changed by more than 0·1 per cent. One 0·01 ohm resistance had decreased by 0·12 per cent. in $4\frac{1}{3}$ years. The reasons are not clear; the manganin had turned brown, but did not otherwise appear to be affected. The other case was that of a 0·001 ohm resistance which had increased by 0·23 per cent. within $2\frac{1}{2}$ years. In this instance the petroleum had attacked the manganin, which was coated with a brown mud and crust. This latter resistance had been used pretty badly, the former not. On the whole, however, the behaviour of the manganin had been excellent, and the experiments bring out another satisfactory feature. The gauging of the resistances by the manufacturers had proved correct within 0·05 per cent. in all but two cases. Twenty-one, in fact, were correctly estimated within less than 0·01 per cent., and Dr. Lindeck, in his report on the matter, adds that the firm of O. Wolff supplied a resistance of 0·00002 ohm, which was found correct within 0·01 per cent. It is, therefore, quite permissible to gauge very small resistances by comparison against one-ohm standards.

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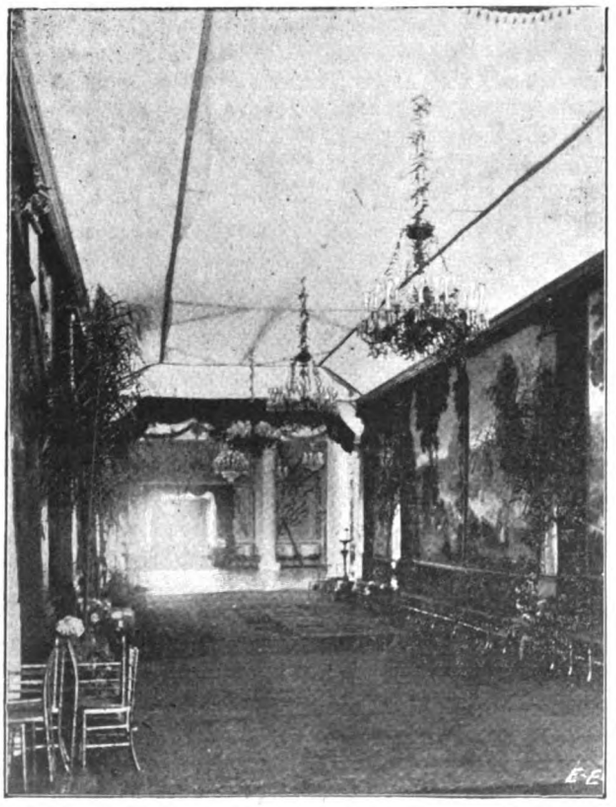
TEMPORARY INSTALLATION AT MARLBOROUGH HOUSE.

Although it took weeks to build instead of a night, the contractors (Messrs. Simmonds Bros., Limited, of Newton-street, High Holborn) have considerably taken the shine off Aladdin's lamp by raising on the lawn of Marlborough House a temporary palace—consisting of ballroom, smoking-room, supper-rooms, galleries, etc.—a temporary erection which for size and brilliancy has never been equalled in this country. The whole structure covered 17,555 square feet, and about 1,700 electric lamps were used to illuminate it. A carriageway was outlined to it by 18 16-c.p. lamps, and 2,000 bucket lamps were distributed in the grounds. The main hall or ballroom proper was 130ft. long and 60ft. wide, divided into a centre hall and two side aisles by 18 Gothic columns, which glittered like white marble The ceiling rose to 30ft. from cornices 21ft. above the ground.

Ball Room.



Main Corridor.

Supper Room.

These cornices or entablatures were outlined with 340 5-c.p. lamps. The centre bore five electroliers of pure

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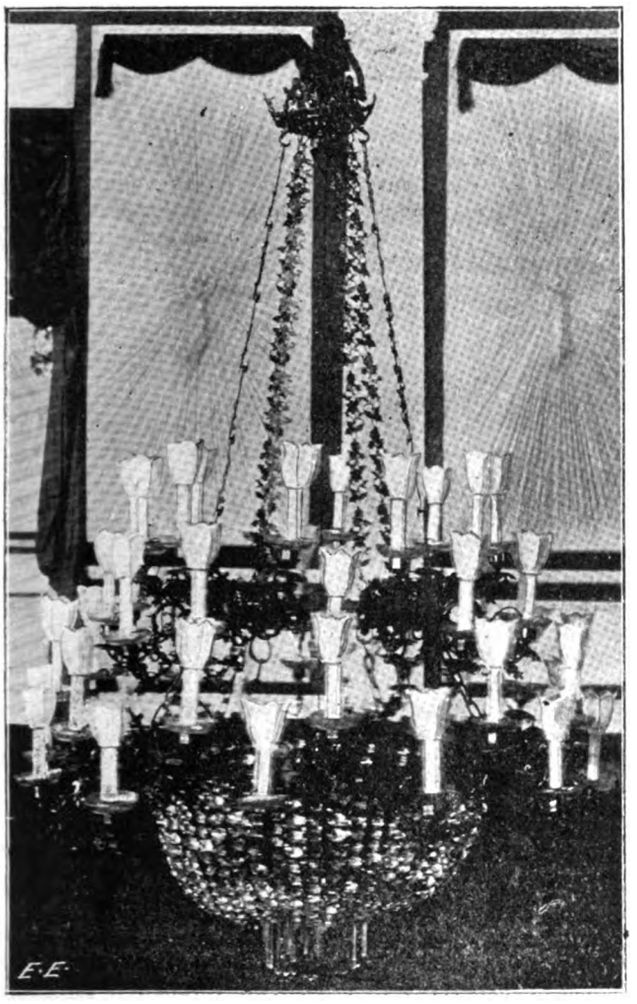
crystal, each fitted with 60 electric candles with white silk shades, prettily draped with pink geraniums and smilax. In addition, there were 16 similar six-light fittings suspended from the ceiling, and 15 six-light electroliers of Louis XV. style in the aisles, making a total of 602 lamps for the room. Eight 12in. fan motors were fitted in special cup-



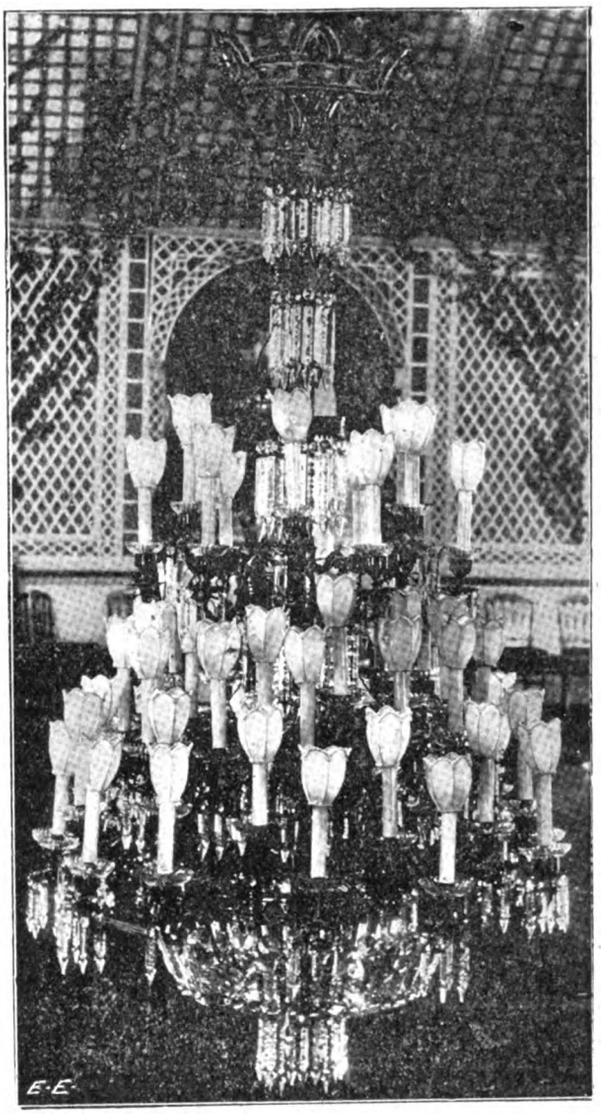
48-Light Electrolier from Supper Room.

boards in the walls. The floor was a beautiful teak and oak parquetting laid down in yard squares. Handsome

6-Light Electrolier from various parts.

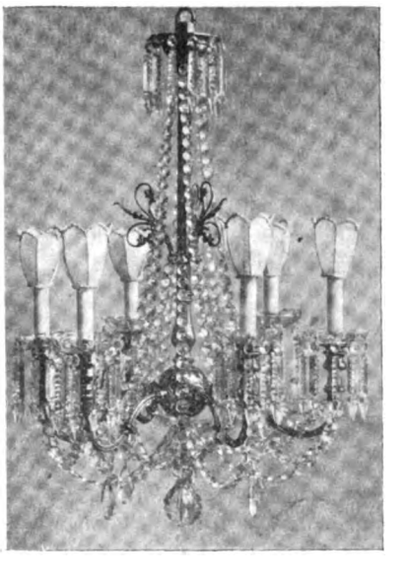
carpets, green and white silk curtains, and a profusion of flowers completed the truly magnificent arrangement. The bandstand was almost hidden amongst flowers,

like a balcony in Piccadilly in the height of the season. On one side of the room French casements led on to the



60-Light Electrolier from Ball Room.

lawn, squares of trelliswork upon which ivy was trailed in a most natural manner filling the interstices between them. On the opposite side large pier glasses, similarly draped, made the counterpart.



6-Light Electrolier from Ball Room.

The supper and buffet rooms were similarly lighted and decorated—the larger in cream and yellow, the smaller in green and white. The smoking-room affected

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Oriental splendour. The entablature in the supper-room was also outlined with 280 5-c.p. lamps, and four 48-light and 10 6-light electroliers of remarkably handsome designs were suspended from the ceiling. There were ample corridors connecting the various apartments, and others leading to Marlborough House itself; the larger gallery, with its oak pilasters and almost priceless Gobelins, lined with satin-covered gilt settees and chairs, draped and filled with flowers and palms, making an ideal sitting-out place.

The electric current was obtained from the St. James's and Pall Mall Electric Company's system by a special main from the street at 214 volts pressure, everything in the installation being controlled by a 300-ampere switch on the same. Three $^{19}/_{14}$ cables were laid all through the house, running to a central part in the marquee. In the switchroom there was an 80-circuit switch and fuse board, made by Messrs. Simmonds Bros. There was also a sub-main double-pole switch and fuse board of four circuits, the whole being controlled by a second main switch on the same board. Throughout the installation every wire was kept apart, thus making the job as safe as if it were meant to be permanent. The cables used were Glover's (600 megohms). The switchroom was well ventilated with fans. There was a two-pole fuse and a one-pole switch to every 20 circuits, connected with a two-pole main fuse and one-pole main switch on the same board.

The whole installation was sub-divided into three-ampere circuits, with a switch and double-pole fuse to each circuit. The total of 1,700 lamps included five electroliers of 60 lights, four of 48, four of 24, one of 12, 48 of 6, and two of 8 lights, and 14 three-light brackets, besides the 620 cornice lights, etc., already mentioned. All these fittings were wired with a special plug adapted recently patented by Mr. H. Stokes, A.M.I.E.E., the electrical engineer of Messrs. Simmonds Bros., who was in charge of the work, having Mr. White as foreman. The bandstand in the ballroom was connected with electric bells with that in the supper-room. There were in all 16 ventilating fans to cool the atmosphere of these tent buildings.

THE PRODUCTION OF PULSATING CURRENTS BY MEANS OF A MICROPHONE.*

That a pulsating current can be set up by bringing a telephone receiver and a microphone, connected up in the usual manner, into close proximity has long been known. The current becomes noticeable by a more or less loud humming of the telephone. No actual practical use has yet been discovered for this phenomenon, though many suggestions have been made.†

The necessary connections for obtaining a continuous note are shown in Fig. 1, where M is a Berliner microphone, S a small sheet of iron about ·1mm. thick, E an electromagnet with 300 turns, A a battery of accumulators, and T a key. It will be seen that every change of the microphone membrane, which produces a corresponding change in the resistance of the microphone, also produces changes in the magnetic field acting on the membrane. If, for instance, the current increases due to any cause, there will be a downward motion of the membrane and an increase in the microphone resistance. If the circuit considered were a non-inductive one, this increase in resistance would produce a simultaneous fall in current, and the membrane would, in consequence of the reduced magnetic pull, soon come to rest. Since, however, this case never occurs in practice, as the self-induction of the circuit always produces a time lag between the phase of the membrane motion and the corresponding current phase, a continuous vibration of the membrane occurs. The frequency of this vibration is such that the time lag between the two phases becomes equal to a quarter of the wave-length of the resulting pulsating current.

Since this necessary condition of continuous vibration is fulfilled, and yet the phase difference between volts and amperes can never quite equal 90deg., in consequence of the ohmic resistance of the circuit, the action must be aided by the mass of the membrane and other circumstances.

Experiments have, moreover, shown that the phase difference between current and voltage is nearly 90deg, so that Helmholtz's formula is applicable for the approximate determination of the frequency. In accordance with this formula, the time of swing is

$$t = \frac{4\,L}{W} \log_\epsilon \frac{J'}{J},$$

where L = the coefficient of self-induction;
W = the resistance;
J' = the current amplitude corresponding to the maximum change in resistance;
J = the difference between J' and the real current amplitude.

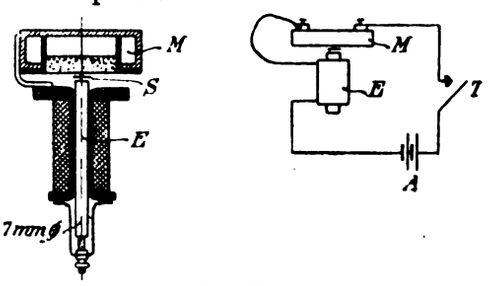

FIG. 1.

It will be seen that the time of swing is a simple function of the self-induction of the circuit. It follows, therefore, that the frequency of the note set up with the above described arrangement of apparatus will also be a function of the self-induction, although the connection is much more complicated in this case, owing to other interfering actions.

Experiments carried out with apparatus such as that shown in Fig. 1 indicated that the range within which the frequency could easily be varied was about 300 to 1,000 vibrations per second.

The experimental arrangement allowed a series of different self-induction coils, l_1 l_2 . . . (Fig. 2), to be inserted into the microphone circuit by means of the key-board, t_1 t_2 . . .

The notes thus produced were readily heard in a telephone, T, connected to the circuit through a secondary winding, and they could easily be made audible in a large hall by means of a so-called loud-speaking telephone.

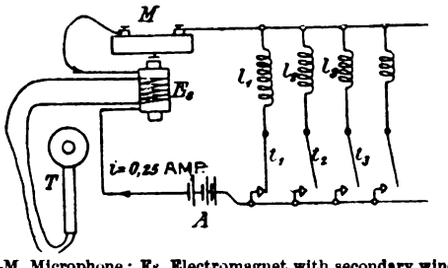

FIG. 2.—M, Microphone; Es, Electromagnet with secondary winding; T, Telephone; A, Accumulators; l_1 l_2, Self-Induction Coils; t_1 t_2, Keys.

The coils employed were equal in size, the length of winding space being 26mm., the inside diameter of the coil 15mm., the number of turns 500, and the approximate resistance 3·4 ohms. The value of the self-induction of the different coils was determined by the section of the iron cores (iron wires). When notes whose vibrations exceeded 600 per second were required, it was necessary, so as not to weaken the field acting on the membrane, to reduce the original self-induction. This was accomplished by connecting a capacity (small Leyden jar) in the secondary circuit.

It seemed impossible to obtain vibrations lower than 300 per second because of the large self-induction and, consequently, great throttling action on the current amplitude.

The simple manner of varying the frequency and the sinusoidal character of the current waves are great advantages in favour of this arrangement as compared with

* Translation of an article by E. von Lichen and E. Reisz in the *Elektrotechnische Zeitschrift* for June 25, 1903.

† *e.g.*, Siemens and Halske's German patent, No. 107,839 of 1898.

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tuning-fork and stretched-string interrupters. On this account the method may find advantageous use in Mercadier's multiplex telegraphy. In a slightly modified form it might also be employed for measuring purposes, such as the comparison and measurement of self-induction coefficients, etc.

MUNICIPAL ELECTRICAL ASSOCIATION.

The meeting on Thursday, July 16, was held in Newcastle-on-Tyne. The members were welcomed by the Mayor, who in his speech referred in most complimentary terms to the municipal tramways and to the tramway manager, Mr. A. E. Le Rossignol. Speaking as the manager of the Newcastle and Gateshead Gas Company, he had no objection to municipal competition all the time the Bermondsey clause was adhered to and the rates were not called upon to make up the deficits.

Mr. Gerald Stoney, as chairman of the Local Section of the Institution of Electrical Engineers, also welcomed the members.

Alderman G. Pearson's paper was then read on

The Sphere of Utility of a Power Company.

BY ALDERMAN G. PEARSON, HON. SOLICITOR, CHAIRMAN OF THE BRISTOL ELECTRICAL COMMITTEE.

In the face of the fact that power companies are with us, and are apparently come to stay, it is, the author thinks, the duty of an association such as this to carefully consider the extent to which they may be utilised in the interests of the municipalities and other local governing bodies of this country whose electrical interests are generally in the hands of gentlemen who are members of this association. Those who see in power companies the panacea for all the trading ills to which the municipal and manufacturing flesh is heir are, the author thinks, wrong, and are only a little more wrong than those who see nothing worthy of support in power companies, and look upon them all as the natural enemies of all municipalities. The truth in this, as in so many other questions, lies in the mean. Power companies may be useful to some municipalities, whilst in the case of others their services are not required.

Within the recollection of most of us, companies were formed for the purpose of exploiting every suitable and unsuitable area for electric lighting purposes, and most of the companies came to an untimely end, and all the shareholders obtained for their money was the honour of holding the shares and paying the calls upon them, and they were seldom worried by considering the particular rate of dividend with which they would remain satisfied. We see the same feverish state of pushing in the case of power companies at the present time, and we may reasonably ask whether the result will or will not be the same. The whole of the large towns are now occupied either by municipally-owned works or works owned by companies, by far the larger proportion being owned by municipalities. The promoters of the earlier Power Bill did not err on the side of modesty. They certainly asked for all even they could reasonably or unreasonably ask from Parliament, with the result that their Bills were opposed and thrown out by parliamentary committees. Later Bills were more astutely drawn, and some show of respect for the rights of persons in possession was evinced; but still the claim to enter large towns already covered by a municipally-owned undertaking was insisted upon, but the result has been that all large towns have as yet been excluded from the operation of the power companies, as will be seen from the accompanying list, which gives the title of the Act and the towns excluded therefrom:

County of Durham, 1900.—South Shields and Sunderland. Also Felling and Hebburn, except for passage through district.

Lancashire, 1900.—Manchester, Stockport, Liverpool, Bootle, Salford. Part of Bolton excluded for all purposes, and no right of passage through district.

North Metropolitan, 1902.—Willesden.

South Wales, 1900.—Cardiff, Newport, Swansea, Neath, Barry, Rhondda, Briton Ferry (excluded for four years), Abercarn, Abertillery, Ebbw Vale, Margam, Mountain Ash, Tredegar.

Clyde Valley, 1901.—Paisley and Hamilton, except for passage through district; Glasgow for all purposes; Partick (Beauchief and Norton parish excluded); Kinning Park, Govan, and extensions of Govan, Port Glasgow.

Derbyshire and Nottinghamshire, 1901.—Nottingham, except as to right to pass through; Derby, as at passing of the Act, and also as to contemplated extensions.

Yorkshire, 1901.—Bradford, Leeds, Sheffield, Barnsley, Batley, Brighouse, Dewsbury, Doncaster, Keighley, Morley, Ossett, Pontefract, Pudsey, Rotherham, Todmorden, Wakefield, Shipley, Huddersfield, Halifax.

Gloucestershire, 1902.—Cheltenham and Gloucester.

Leicestershire and Warwickshire, 1902.—Leicester, Coventry, Sutton Coldfield, Aston Manor, Rugby, Royal Leamington Spa; Loughborough (including Nanpantan, Thorpeacre-cum-Dishley, Hathorn, and Woodthorp), Erdington, Nuneaton, Chilvers Coton, Market Harborough, also part of area of Midland Electric Light and Power Company.

Kent, 1902.—Dover River, Ewell parish, and Isle of Thanet.

In some few instances towns have been included by negotiation, but the general result has been the exclusion of the large towns possessing their own supply; but in the present session of Parliament the House of Lords Committee has decided that the city of Bristol shall be included within the area of supply of the Somerset and District Power Bill, and that the large towns shall be included within the area of supply of the North-Western Electricity and Power Gas Bill, and it remains to be seen whether the Committee of the House of Commons will follow the lead of the Committee of the House of Lords in this respect. The general scheme of a Power Bill is to cover a large area, to distribute at high tension to large individual consumers for power purposes, or to "authorised distributors" or "authorised undertakers" for power or light. They claim economy of working, cheapness of coal supply, and purport to offer a supply at a cheap rate. Below is given a list of some of the power companies and their authorised charges.

AS TO PRICE AND DIVIDENDS IN ACTS.

Title of Act.	Hours of supply per quarter.	Price.	Reduced Price.	Dividend	Standard Price regulating Dividend	Increased Dividend.	Reduced Dividend.
County of Durham, 1900.	100 over 100 over 200	4d.	2d. 1d.	£8	4d.	5s. for 1¼%	None
Lancashire, 1900.	100 200 over 400	4d	2d. 1d.	£8	4d.	5s. for 1¼%	None
North Metropolitan, 1900, 1902.	100 over 200	4d.	2d.	£8	4d.	5s. for 1¼%	5s. for 1¼%
Newcastle-on-Tyne, 1900, 1902.	00 under 400	7d. 6d.	1d.	£8	7d. 2½d.	4s. for 1¼%	4s. for 1¼%
South Wales Elec. Power Co., 1900, 1902.	400 over 400	3d.	2d.	£8	2½d.	5s. for 1¼%	5s. for 1¼%
Walker & Wallsend Gas Company, 1899.		7d.		Sec 72 £5	7d.	5s. for each ½d	5s. for each ½d
Clyde Valley, 1901.	400 over	3d.	2d	£8	2½d.	5s. for 1¼%	5s. for 1¼%
Cleveland & Durham 1901.	400 over 400	3d.	2d.	£8	2½d.	4s. for 1¼%	4s. for 1¼%
Derbyshire and Nottingham, 1901, 1902.	400	3d.	2d.	£8	2½d.	4s. for 1¼%	4s. for 1¼%
Shannon Water, 1901	200 under 400 over 400	3d. 3d.	2d.				
Yorkshire, 1901.	Charges per quarter 10s per E.H.P. plus 3d. per B.O.T.U. first 5000 2¾d. 10,000, 2½d. 20,000, 2d 50,000, 1½d. 100,000, 1d. 200,000, and over 200,000 ¾d., transformed, if necessary add 20% for supply to other than A U.			£8		4s. for 1¼%	4s. for 1¼%
Cornwall, 1902.	200 200 to 400 over 400	3d. 2d 1d		£10 £20	3d.	5s. for 1¼%	5s. for 1¼%
Gloucestershire, 1902.	400	4d	3d.	£8	2½d.	5s. for 1¼%	5s. for 1¼%
Kent, 1902.	200	4d.	3d.	£8	3d.	4s for 1¼%	4s. for 1¼%
Leicestershire and Warwickshire, 1902.	400 ver 40	3d 3d.		£8	2½d.	4s. for 1¼%	4s. for 1¼%
Somerset Bill, 1903.	400	3d.	2d	£10	3d.	5s. for 1¼%	5s for 1¼%

The next table gives a list of large companies now at work showing the charges they are now making for power and light, from which we give the following extracts of lowest figures:

City of London and Electric Corporation.—Lighting: March and December quarters, 8d. for first six per 8 c.p., 2d. after; June and September quarters, 8d. for first three per 8 c.p., 2d. after. Power: 2½d. first 250 units each quarter per kilowatt of maximum demand (1d. unit in excess net) on a three years' agreement.

Newcastle and District Electric Supply Company.—Lighting: 4½d. maximum charge, 5 per cent. off accounts paid by March 10 follow-

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ing issue. Power: 2½d. first 200 hours per quarter, 1d. after on maximum demand system; 1½d. flat rate if desired.

Newcastle Electric Supply Company.—Lighting: 4½d. and 1d. on the maximum demand indicator system. Power: 1½d. per unit flat rate.

Trafford Park.—Lighting: 4d. up to 400 hours per annum, 1½d. for all in excess. Power: 1½d. for first 1,200 hours per annum, ½d. for all in excess.

From the corresponding list of large towns with municipal supply we take the following:

Bradford.—Lighting: 4½d. per unit, less 2½ per cent. discount and free supply of incandescent lamps. Power: 1d. per unit net continuous use during working hours per day; heating and intermittent power, 2d.

Bristol.—Lighting: 5d. per unit evening, 3½d. other times, subject to sliding scale of discounts up to 30 per cent. on quarterly account of £500 in winter, £250 in summer. Power and intermittent power: 1½d., subject to discount up to 20 per cent. on quarterly account of £600.

Edinburgh.—Lighting: 3½d., consumers using 1,000 units and above are entitled to rebates up to 25 per cent. for 60,000 units or over. Power: 1½d. net, with minimum charge of 40s. per annum if energy is measured by separate meter; or 1d. per unit for power used continuously, with the exception that if used during the hours of maximum load for the four winter months, the price then is to be at the lighting rate.—A minimum rate of £20 per annum will be charged in the account for the term ending May 15 to consumers whose consumption during the preceding 12 months does not exceed 604 units for lighting purposes.

Hammersmith.—Lighting: 6d. first hour, 3d. for all additional consumption; 2½d. per unit, with rental charge of 1s. 3d. per quarter per 8 c.p., minimum charge 13s. 4d. per quarter. Power: 1½d. all current consumed daytime; if used between the hours of 6.30 p.m. and midnight a further charge of £1 per month per kilowatt demanded during those hours is made; 2½d. per unit flat rate; heating, etc., 2½d. flat rate.

Liverpool.—Lighting: 3½d. up to 3,000 units per quarter, and 3d. in excess. Power: 2d. up to 3,000 units per quarter; 1½d. in excess of 3,000 units per quarter.

The following are the charges now being made by the few power companies now in operation for the supply of power, so far as it has been possible to ascertain them:

Durham.—4½d. and 1½d., with discounts according to the load taken up to 41 per cent.

Gateshead and Jarrow.—4d. and 1½d., with discounts according to the load taken up to 41 per cent.

Midland Power Company.—1½d., or on the Wright system 3d. for the first hour and ·825d. after.

North Metropolitan.—7d. first hour, 1½d. after, with discounts.

South Wales Power Company.—Under 100,000 units per annum, 1⅞d.; 100,000 to 150,000, 1¾d; 150,000 to 200,000, 1⅝d.; 200,000 to 250,000, 1½d.; 250,000 to 500,000, 1⅜d.; 500,000 to 750,000, 1¼d.; 750,000 to 1,000,000, 1⅛d.; and over 1,000,000 per annum, 1d.

From these tables it will be seen that the municipalities are supplying current for power and light at a much cheaper rate than the average company, and the author sees no reason why, when municipal power loads grow, they may not supply current for power purposes cheaper than a power company, as they now supply cheaper for lighting purposes than the average lighting company, and as they are now supplying at a much cheaper rate than the authorised price given to companies; but it may be properly said that the power companies never hope to obtain the prices they fix as their maximum, but if this is the fact, it may reasonably be asked, Why fix the price so high? what possible use is it to fix a large price and take the discredit of doing so, when you know that you can never in the course of your business get it? A little further consideration will show why this is done; there is a "sliding scale" to be considered.

The author's idea of the proper function of a sliding scale is to induce company directors to secure an economical and efficient management, whereby the consumer obtains the article he requires at the cheapest possible rate, and the shareholders of the company participate in the economies by receiving an increased dividend as the price of the article is reduced; but if you wish to avoid responsibilities and still secure increased dividends you have only to fix your "standard price" sufficiently high to secure expensive and inefficient management and still high dividends to the shareholders. The author puts the case with which he is most familiar, that of the Somerset and District Electric Power Bill of this session, in which case he thinks the financial clauses are unsatisfactory.

Power is taken to issue £750,000 ordinary shares of £1 each, and also to borrow £250,000 under conditions to which it is unnecessary to refer. The dividend is limited to £10 per cent. per annum on the "*capital of the company*," but the company may in addition to the dividends authorised under the Act make good any deficiency in any previous dividends which have fallen below the standard rate of dividend.

Power is taken to divide the shares into "*preferred half shares*" and "*deferred half shares*," thus securing the benefit of preference shares to the serious injury of the customers of the company, because, as the £10 per cent. dividend is payable on the capital of the company, the company can charge £10 per cent. on the whole capital, including the "preferred half shares," as against the customers of the company, although it does not pay it to the holder of the "preferred half share," but applies it to increase the dividend of the "deferred half share." The result of doing this business in this way is to charge the consumer £10 per year for each £100 of the capital of the company, whilst if the capital was raised by means of preference shares and ordinary shares the preference shares would receive, say, £5 per cent., and the ordinary shares would receive £10 per cent., and assuming both classes of shares to be equal, it would cost the consumer £7. 10s. for each £100 of the capital, subject to a slight variation if a greater number of one class shares than the other were issued. The extra £2. 10s. per share interest will increase the dividend on the "deferred half shares" to £15 per cent. per annum, instead of £10, as stipulated in the Bill. This increased charge of £2. 10s. per cent. to the consumer means that before he can claim a reduction in the price for the current, he must pay at the rate of £25 per 1,000 extra for the capital of the company, which will amount, when the whole £750,000 of the capital is called up, to an extra charge of £18,750 per year on the users of the current. In addition to this, the arrangements proposed as to the "relations between price and dividend" are, the author thinks, unsatisfactory. The standard rate of dividend is fixed at £10 per cent., and the standard price at 3d. per unit (these figures were altered by agreement to £8 for standard rate of dividend and 2½d. standard price.)

Provision is then made for an increased dividend of 5s. per cent. in respect of each 1¼ per cent. by which the average price charged by the company has been below the standard price. Putting it shortly, the dividend is increased £1 per cent. for each £5 per cent., the price charged by the company is reduced below the standard price of 3d.

If the company succeeds in selling its current at the price now charged by Bristol (omitting all reference to discount)—namely, 1½d. per unit—the actual price would be £50 per cent. below the "standard price" authorised; and as the shareholders are entitled to £1 per cent. dividend for each £5 per cent. reduction in the price charged, they will be entitled to a £10 per cent. dividend in respect of the reduction of 50 per cent. They would thus be able to obtain an additional £10 per cent. dividend on the whole capital of the company; and as none of this additional interest would be payable to the holder of the "preferred share," it would be sufficient to double the £10 per cent. interest on the "deferred share" and increase it to £20 per cent., in addition to the £15 per cent. secured, as I have before explained, thus securing a right to receive £35 per cent. and not £10 per cent. dividend as stipulated in the Bill.

We have here the sliding scale at its best in the interests of the company, but can the same be said for the consumers; and it is fair to the promoters of this Bill to say that they are not much worse than their fellow-promoters. Parliament, in its wisdom or otherwise, has reduced the sliding-scale system to the point of absurdity.

A large town having a large demand may and does, as a rule, run its undertaking at a cheaper rate than a company, as will be seen from the table below, and it generally runs it at a profitable rate also.

RETURNS OF METROPOLITAN ELECTRIC UNDERTAKINGS.

Extract from *Electrical Engineer*, Oct. 17, 1902.

Cost of plant to companies, 19·2 per cent. more than municipalities.

Charges by companies to consumers, 32 per cent. per unit more than municipalities.

Costs of production, 8·8 per cent. more than municipalities.

RETURNS OF PROVINCIAL ELECTRIC LIGHTING UNDERTAKINGS.

Cost of plant to companies, 25·5 per cent. more than municipalities.

Charges by companies to consumers, 41·4 per cent. per unit more than municipalities.

Costs of production, 33·6 per cent. more than municipalities.

It will, the author thinks, be clear from the foregoing remarks and the figures quoted that, so far as large towns are concerned, a power company has nothing to offer in the best interests of the consumers.

There are many reasons for this: first, corporations pay in cash, and therefore get cash terms, companies frequently do not; secondly, corporations are not tied in any way to manufacturers as companies sometimes are; thirdly, corporations have no watered capital, usually represented by promotion and other expenses in companies' accounts; fourthly, the credit of corporations is firmer and capital is raised cheaper by them than by companies—indeed, the relative decline in municipal credit is not so great as the decline in the national credit as represented by consols, even allowing for the reduction in the rate of interest on the latter; fifthly, corporations always can and generally do command the best engineering talent in the market. In the face of these facts the figures given before cause no surprise; we might legitimately express both surprise and regret were it otherwise.

It must not, however, be assumed that because a large town

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with a large demand proves a success that every small town can of necessity do the same with a small load, and here the author sees a sphere of utility for a power company while confining its attentions to the power load. It may, by linking up a number of small towns and supplying them in bulk for lighting, leaving them to distribute, be useful to the towns and profitable to themselves; and if with a power load supply a traction load can be obtained, whether running upon rails or not, and if in addition their traction cables could be used for the supply of small motors to small factories or private houses situate on the route of the cables, the company may be still more useful to the district in which it works and profitable to themselves. If they are to do this successfully, there must be an end of the attempts to obtain lighting powers by a side wind, as is now so often done, and companies must accept the position of wholesale dealers only, and not seek to become retailers in addition, in opposition to the local authorities; it should seek the good-will of localities and work with them by supplying in bulk, rather than against them by attempting to obtain lighting orders themselves; if companies went on these lines, useless and expensive parliamentary fights would be avoided.

It is idle to disguise the fact that the author approached the consideration of this question from the municipal side, and makes no pretence of being able wholly to get rid of his natural prejudice in favour of the work in which he is engaged, but he has endeavoured to place this question fairly before the association as it strikes him at the moment, leaving the discussion in their hands, with a view of assisting, if possible, in finding some common ground of agreement between power companies and municipalities, whereby they may be able to avoid competition, which may become injurious to municipalities and ruinous to companies.

Mr. A. B. MOUNTAIN, of Huddersfield, agreed with the author that in large towns the local stations could supply electrical energy quite as cheap as a power company—in fact, he thought past experience proved that they could supply more cheaply. With regard to the smaller towns, it was a moot point whether the local interest secured by municipal ownership should not more than compensate for the advantages claimed by private enterprise.

Mr. R. S. PORTHEIM said that as the paper showed cables were the greatest outlay the power companies had to incur, with overhead lines they could reduce the cost of trunk mains from £6,000 to £600 per mile. He looked upon this as being the crux of economic power distribution.

Major-General WEBBER said that in 1830 an Act was passed to facilitate the construction of direct railway lines from coal-pits to large consuming districts. This Act had been scarcely used at all, but he thought a similar Act was required to enable electric power mains to be carried out radially from power stations to large consumers. An examination of Ordnance maps would show that a straight line drawn through a county in England crossed, as a rule, six or seven fences in a mile. This meant three supports for the cables in the average field, which could not be looked upon as being obstructive to agriculture.

Owing to the paper having been taken as read, the discussion was then adjourned until Friday to give members a chance to peruse it.

Mr. J. J. STEINITZ opened the discussion in Middlesbrough. He asked on what grounds companies should be excluded from towns when they only asked for permissive powers to supply. Those towns which gave a cheap supply of electrical energy had nothing to fear. He was pleased to say that the West Ham Corporation, which might rightly be considered an extremely liberal one, did not hesitate to give a power company this permissive right. As regards the figures of cost of supply, he said that the Newcastle-on-Tyne Supply Company received only 1·85d. per unit, while the County of Durham Power Company only obtained on the average 1·43d. These were below the average prices for large towns, and he thought that the people should be allowed to have the cheapest supply.

Mr. R. A. CHATTOCK, of Bradford, said there was a strong objection to allowing the streets to be pulled up by the power company when these streets were already well filled with other mains. He thought the corporations did not object to cheap supply, but that the other objections to the power company was such that if these companies could not show considerably reduced charges, it would be inadvisable to admit them into the town.

Mr. ROBERT HAMMOND informed those present that the Somerset Electric Power Bill had been passed by the committee of the House of Commons. It was a curious fact that until recently no concurrent powers had been given against municipalities, who thought they had protection as long as they did their work well. He suggested that this competition was equally inadvisable with electric power as it had been proved to be with gas supply. The comparison Mr. Steinitz had made between the average figures and those for Newcastle-on-Tyne was not fair. They must also remember that the power companies were able to offer under their Bills discriminating rates, which was not the case under an electric lighting order.

Mr. W. L. MADGEN said that the North Metropolitan Electric Power Company had contracts in hand for furnishing 15,000,000 units per annum at rates from 1d. up to 1·4d. It was unfair to compare figures in the schedules as Alderman Pearson had done. There were certain municipal stations in London, such as those of Islington and St. Pancras, which were not any too successful, and which did not supply at cheap rates. He noted that Alderman Pearson said that corporations could command the best engineering talent. Companies could not issue royal commands in this way, but they enlisted the services of good engineers.

Bailey MACLAY, of Glasgow, urged those present to do good work, and not to waste time in fighting against invidious articles in the Press.

Mr. R. C. QUIN said that they must do justice to the power companies, and he did not think the paper before them was quite fair. They must remember when comparing figures as to capital cost that the pioneering work of electric lighting was done in London. In the country, on the other hand, all the best towns, from an electric supply point of view, were in the hands of the municipalities, who ought to be ashamed if they could not do better than electrical companies in small towns. He quite agreed that electrical companies could buy for cash more cheaply than municipalities, owing to the stringent labour and other clauses which corporations inserted in their specifications for plant. In any case, he thought that electric energy should be supplied from large stations in the future, and it might well be that municipalities would join together in establishing such stations. In any case, wholesale supply must come.

Mr. J. E. EDGCOME, of Kingston-on-Thames, said that it was not right for Parliament to first give powers to corporations and then, after a supply has been established, to let the companies come in and take over the best consumers.

A vote of thanks was then given to Alderman Pearson for his interesting paper.

The following was the next paper taken

Electric Traction as Applied to the Newcastle Tramways.

BY A. E L. ROSSIGNOL, GENERAL MANAGER AND ENGINEER, NEWCASTLE CORPORATION TRAMWAYS.

Every system of electric power supply is influenced in its general design by the requirements of the system it has to supply with power, and by the local conditions affecting the sites available for the power station, their position with reference to the system to be supplied, and also to the supply of fuel and water supply for condensing purposes. The site finally adopted does not as a rule fulfil all the ideal requirements, but is generally the result of a compromise which forces the power station to develop along certain lines and lays down definite limits of economy of working costs, and these limits can only be altered by extra expenditure of capital. The latter may overcome some of the difficulties presented by the position of the site and enable greater economy to be attained than would otherwise be the case, but at the same time involves extra charges against revenue on account of interest and redemption. Ultimate real economy can only be obtained if these extra charges are less than the working costs which would otherwise be necessary if this extra capital expenditure had not been made, and the author thought it might be of interest if in this paper he attempted some investigation into the influence of such additional capital expenditure on the cost of current at the tramway power station in Newcastle. He proposes to take as a basis an output of 7,000,000 units per annum, which will be approximately the output for the present year, and to show on that basis the influence of the different factors on the cost per unit.

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The town of Newcastle is built on the north side of the River Tyne, and the tramway system is, therefore, fan-shaped in outline, corresponding with the development of the town along the river bank. The Corporation possessed land practically at the centre of the fan, and this land, consisting as it did of an old valley filled in with loose earth, was not of great value for building purposes, and so was handed over to the Tramways Committee for the power station site. It had the advantage of being nearly at the centre of gravity of the system, so that direct current at 500 volts could be used with very little loss in feeders, but it had the disadvantage of being a quarter of a mile from the river and at a height of some 80ft. above low-water mark, so that condensing water would be costly to obtain, and it had also the disadvantage, though alongside the railway, of being situated at one of the busiest parts of the line, and, therefore, it would be difficult to arrange shunting facilities for the coal wagons. Still another disadvantage lay in the fact that the land was all filled in ground, and therefore expensive foundations were necessary; but, on the other hand, its value was low for the same reason. The foundation for the chimney was effected by excavating a space 30ft. square and driving piles to the number of 49 over this area. These piles only penetrated some 20ft. through the earth, and there is every reason to believe their further progress was stopped by an old stone-paved road which formerly existed in the valley at this spot. On the top of these piles a block of concrete was formed, 15ft. deep by 30ft. square, and on this the octagonal brick chimney was erected. The foundations for the rest of the buildings consisted of blocks of concrete interlaced with steel rails, which were bolted together throughout their length to give strength, and these blocks, one for the boiler-house and one for the engine-house, practically float across the former valley on the soft filled-in earth. Where some of the original hard ground of the sides of the valley was encountered at the ends of the engine-house block, it was excavated and filled in soft so as not to convert the block of concrete into a huge girder, resting on supports at its two ends, should the ground in the centre of the valley subside in any way. The buildings erected on these foundations consist of steel stanchion frameworks, on which the roofs were erected first of all and the sides afterwards filled in with brick walls; the engine-house first erected, being large enough for three times the present output, and built so as to be capable of easy extension, whilst the boiler-house was only large enough for the present output, and is now being extended. As the firing floor level is considerably below the railway level and parallel with it, the steel framework of the building was extended along the site so as to form a double-track viaduct for the accommodation of trains of coal wagons, and to enable easy extensions of the boiler-house to be made by the filling in of this framework with walls, roofs, and coal bunkers.

In the present boiler-house eight Lancashire boilers, 30ft. by 8ft. 6in. diameter, were installed together with superheaters to three boilers and an economiser of 480 pipes, whilst the water-feed arrangements consist of a Weir pump, injectors, and a double-armature three-throw electric pump, with specially large feed-water tank as a reserve in case of a failure of the water supply. Above the firing floor is a large self-trimming coal bunker, so arranged that the oldest coal discharges first, thus avoiding as much as possible the risk of self-combustion to which the small Northumbrian coal used is very liable if stored for any length of time. The railway wagons are handled on the tracks above the bunkers by an electric locomotive, and discharge direct through their trap doors into the bunker below. From the bottom of the bunker the coal falls through an automatic weighing machine above each boiler, and is delivered by that machine as and when required into the hoppers of the automatic stoker below. The ash and clinker raked out of the fires falls into small wagons in the ash space below the firing floor, and is wheeled along to an electric lift and elevated into a bunker from which it is discharged into carts. Lancashire boilers are very satisfactory for use with a tramway load, as they contain at all times a large reserve of power in the shape of water heated to the steaming pressure, but their efficiency and life depends on the care taken of them, and, therefore, each boiler is thoroughly cleaned once in eight weeks, inside and out, mountings overhauled, and flues cleaned.

In the engine-house there are four generating sets, whilst a fifth one of 3,000 h.p. is being added; the present sets are all vertical engines, coupled direct to compound-wound direct-current dynamos. One engine is of triple-expansion high-speed type, giving an output of 400 kw.; two others are of compound slow-speed type with Corliss gear, each giving an output of 635 kw.; and the fourth is of triple-expansion slow-speed type with Corliss gear, giving an output of 1,300 kw. From the dynamos the current passes by the ordinary type of traction switchboard to the various feeders for tramway and lighting work. In the engine-house there is also a motor-driven booster for charging a battery of 1,500 ampere-hour capacity placed at the top of the office block. For securing an ample supply of water for the surface of condensers attached to each engine, the following special arrangements were adopted. The whole of the river bank at this part is occupied by a wharf, at the back of which a site was obtained, excavated to about high-water mark, and concrete retaining walls, and roof formed for a pump-house. Two 15in. suction pipes lead from apertures pierced through the quay wall below low-water mark, across the wharf to the pump-house, where two high-lift centrifugal pumps draw the water from the river and force it through a 24in. pipe to the power station. After passing through the surface condensers there it returns by another 24in. pipe to the pumping station, where the water passes through a turbine on the end of each centrifugal pump shaft, and returns to the pump about 50 per cent. of the power used to pump the water up, the remainder of the power being supplied by an electric motor mounted on the same shaft.

From the foregoing description it will be seen that an attempt has been made to get over the two chief disadvantages of the site—namely, the difficulty in the supply of fuel and in the supply of condensing water—by the expenditure of additional capital, and the author has worked out in the following table the total cost of producing energy, including all capital

TOTAL COST PER UNIT FOR GENERATING ENERGY, INCLUDING ALL LABOUR, MATERIALS, MAINTENANCE, CAPITAL CHARGES, DEPRECIATION AND MANAGEMENT EXPENSES.

	ITEMS OF EXPENDITURE.	COST PER UNIT in pence, based on an output of 7,000,000 units per annum.
PART A. Total Charges for supply, handling, and disposing of Fuel 0·194.	Capital Charges on cost of Land for Siding ..	0·003
	,, ,, Bunkers and Siding .	0·010
	,, ,, Automatic Weighing Machines and Stokers	0·006
	Annual Charges for Maintenance and Repair of above	0·002
	Cost of Fuel used	0·140
	Labour and energy handling Coal Trains, and cost of Terminal Charges	0·008
	Labour and energy for Stoking	0·018
	,, ,, disposing of Ashes	0·007
PART B. Total Charges for Steam Generating Plant 0·055.	Capital Charges on cost of Boilers .. .	0·017
	,, ,, Feed Arrangements .	0·007
	,, ,, Superheaters and Economisers ..	0·003
	Annual Charges for Maintenance and Repair of above	0·011
	Labour and Material for cleaning Boilers & Flues	0·007
	Cost of Feed-water used	0·010
PART C. Total Charges for Current and Generating Plant 0·188.	Capital Charges on cost of Engine and Dynamo Plant ..	0·068
	,, ,, Switchboards and Connections ..	0·007
	,, ,, Battery and Booster	0·031
	Annual Charges for Maintenance and Repair of above	0·021
	Labour running Engines	0·035
	Oil Waste and Stores	0·020
	Storekeeper and Clerking work	0·006
PART D Total Charges for supply of Condensing Water 0·056	Capital Charges on cost of Surface Condensers .	0·007
	.. .. Pumping Station and Pipes	0·024
	Annual Charges for Maintenance and Repair of above	0·006
	Labour running Pumping Station .. .	0·009
	Energy for running Pumping Station	0·010.
PART E. Total General Charges on Undertaking 0·301	Capital Charges on cost of Land for Power Stn.	0·034
	,, ,, Foundation for Power Station ..	0·027
	,, ,, Buildings for Power Station ..	0·059
	Labour Charges on Cleaning and Maintenance of above	0·007
	Engineering Superintendence of Plant	0·040
	Management and Office Expenses if run as a separate concern	0·035
	Rates, Taxes, and other charges	0·069
0·794	Total Charges of all kind	0·794
0·086.	Depreciation and Reserve Fund	0·086
0·880.	Total Cost per Unit	0·880

charges, depreciation, taxes, etc., and has added management expenses, assuming that the power station was run as a separate concern. If the extra capital expenditure on the siding and coal bunkers had not been made, it is, of course, only possible to estimate what effect the carting of fuel and hand firing would have had on the cost per unit, but from enquiries the author made at the time, the cost would not have been less than the following revision of part A of the table of costs shows:

Cost of fuel used	0·180
Labour, trimming coal	0·005
Labour, stoking	0·029
Labour and energy for disposing of ashes	0·007
	0·221

as against a cost for part A in the other table of 0·194, or an increase of total cost of 0·907d. per unit. Had the extra expenditure for the condensing plant not been made, part D of the table of costs would not have existed, but the coal consumption and water consumption would have increased, and, in addition, the plant would not have been capable of giving the same output that it gives at present. On one

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occasion, when one of the circulating water mains broke down, the engine plant was running non-condensing for five days, and it was found that the coal expenditure had increased 50 per cent. over any five similar days, therefore the costs would not have been less than the following:

Increase in cost of fuel	·070
Increase in cost of water	·003
	·073

a total increase of ·073d. per unit against a saving of 0·056 by the abolition of the condensing plant, or an increase of total cost to 0·897d. per unit, whilst in addition the plant would not have been running under such favourable conditions or have been capable of giving the same output.

Mr. ROBERT QUIN opened the discussion, and commended the author for the very clear paper he had presented. It would have been even more interesting if they had seen the station before hearing the paper. Considering the difficulties of the site, the scheme seemed a very courageous one, and these difficulties had by the author's showing been successfully overcome. To work a condensing plant from a water supply half a mile away with 88ft. rise was quite an undertaking. He did not like the piling as described by the author, as it seemed to him the chimney was resting on an old road, the foundations of which might give way. He quite concurred with the author in the use of Lancashire boilers.

Dr. PANTON, of Bolton, said he was much interested in the paper, the figures in which would be of great service to those who had to advise as to the prices to charge for electrical energy for tramways when supplied from a combined station. It seemed to him that the figures for rent, rates, and taxes were low, as was also the management charge. He would like to know where the energy was metered, and if the mains were included in the capital charge on the station.

Mr. R. A. CHATTOCK, of Birmingham, said the condensing plant was a most interesting one Some years ago he had seen something of the same sort attempted, in which the water falling 26ft. into a river assisted a circulating pump. Mr. Le Rossignol's scheme went farther, and he congratulated him on the results. He would like to know what was the load factor at the station and what was the loan period. He should think that the items for repairs would increase in the future.

Mr. R. BIRKETT, of Burnley, said that he had gone into the question of charges for tramway current, which might be 1·5d. per unit if no cables were required, but with the cost of cables to supply the tramways added, the charge would rise to 1·78d.

Mr. H. COLLINGS BISHOP, of Newport, also criticised the item for repairs as being too low.

Mr. LE ROSSIGNOL, in reply, said that it was only a supposition that the piles were stopped by an old road. The old maps indicated that there had been a road under the site, but were not exact enough to determine its position. The fact that the piles could not be driven further showed, he thought, that a satisfactory foundation had been obtained. The thermal storage of energy in the large amount of water in the Lancashire boilers was a great assistance to a tramway plant in meeting sudden demand for more output. The figures of cost per unit were those of last year, when the output was 6,000,000 units. The capital charges worked out at just over 7 per cent. As regards cost of repairs, he had divided up the items, which totalled ·04d., not ·02d. The mains had cost £10,000. Their maximum load was 2,920 kw., and the average load 800 kw., which gave a load factor of 28 per cent. The current was measured at the switchboard in the station.

A vote of thanks was then passed to the author for his paper.

The meeting on Saturday at Sunderland was a business one only, being the annual general meeting of the association. The election of officers resulted in Mr. T. P. Wilmshurst, the senior vice-president, being unanimously elected president. Following the usual precedent, the next convention will be held at Derby—*i.e.*, the town in which Mr. Wilmshurst holds office. Messrs. F. A. Newington and R. A. Chattock were elected vice-presidents. Alderman J. Pearson was re-elected hon. solicitor, and Mr. J. H. Rider was re-elected hon. treasurer. Mr. E. T. R. Murray retired from the position of hon. secretary, and the vacancy was filled by the unanimous election of Mr. J. E. Edgcome.

The President then presented the prizes won by the associates for papers on subjects connected with municipal electrical engineering. The first prize—a case of instruments worth £5. 5s.—was won by Mr. C. L. E. Stewart; and the second—books to the value of £3. 3s.—was won by Mr. F. W. Hewitt. Mr. Stewart, in returning thanks, expressed the opinion that the prize papers should be open to discussion.

The Hon. Treasurer submitted the annual balance-sheet, which showed that there was a credit balance on the year's working of £8. 16s. 11d., notwithstanding the adverse balance of £50 with which the year was commenced. The total balance to the credit of the association was £183. 0s. 7d.

The balance-sheet was adopted.

The annual report of the council stated that there had been a satisfactory increase in the membership, which had reached 356. Of these 65 had been elected since the last convention. Seven members and four associates had resigned, 16 memberships, two associate-memberships, and six associateships had lapsed, and four members had been removed from the roll.

Guard Wires.—The proposed "emergency rules" as revised at the last convention had been forwarded to all municipal tramway committees and engineers, asking for their suggestions with a view to further revision. A number of suggestions were received and adopted, and the revised rules again circulated for final consideration before being submitted to that annual meeting. The following are the revised rules:

1. In the event of telephone or telegraph wires falling and making contact with the overhead trolley wire, or in the event of the trolley wire itself or its guard wires falling, all traffic in the close vicinity of the wires should be stopped, and the public prevented from approaching the fallen wires.

2. The fallen wires should on no account be interfered with by the police or any unauthorised person unless for the purpose of saving life or protecting persons from being injured, as explained in Rule 5.

3. Notice should be at once given to the nearest car driver, inspector, or other tramway official, who will take steps to cut off the current. If such official is not available, notice should be at once sent to the nearest tramway depôt by telephone or messenger in a cab with a request for someone in authority to proceed at once to the spot to deal with fallen wires. These depôts are as follows: (Here will follow list of depôts.)

4. Drivers of cars should not be called upon to interfere with the fallen wires, unless it is for the purpose of saving life or preventing persons from being injured.

5. If the fallen wire is in contact with any person, and it is necessary to remove it at once in order to save life or prevent injury, the following points should be remembered: The person removing the wire should (*a*) never touch it with his bare hands or damp gloves. (*b*) Never touch the person in contact with it, except as mentioned in (*c*). (*c*) Use a dry stick, dry rope, or article of dry clothing, or indiarubber gloves if available, to drag the wire away, or to drag the person away from the wire. Note that it is very important that any article used for this purpose should be dry; a wet article will convey the electric current, and may give the person handling it a severe shock. (*d*) In case it is impossible to get the wire away from the person, the wire should be dragged to the nearest tramrail, and held down upon it, in order to discharge the current from it. A considerable amount of flashing may be caused when the wire touches the rail, but this will not cause injury in any way.

6. Each car will carry a pair of indiarubber gloves, and these should always be used.

7. Animation can often be restored by treating persons suffering from electric shock in a similar way to persons rescued from drowning.

The Postmaster-General has since intimated a desire to

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have these rules printed and distributed for the use of the Post Office engineering staff. It was intended to send a deputation from the association to the Board of Trade and the Post Office with a view of obtaining some modification in the proposed regulations as to overhead wires, but on the understanding that these regulations were already under revision, and likely to be practically identical with the views of the association, it was decided not to proceed in the manner proposed, but to send to both authorities a copy of the following resolution: "That, in the opinion of this association, experience has proved the use of guard wires to be a source of danger to the public, and as there are other and more satisfactory means of protecting telegraph and telephone wires, that the use of guard wires should be abolished wherever possible." The Board of Trade afterwards determined that, among others, the following members of the association should be consulted with reference to the proposed revision of the regulations: Messrs. W. A. Chamen and A. B. Holmes, and the council agreed to their representing the association. It is understood the regulations when revised will not be of an inflexible character, but open to alteration from time to time, as circumstances may require. In September last a parliamentary committee was appointed.

The council had had under consideration a suggestion made by Mr. T. D. Clothier at the last convention with regard to the advantages to be derived from affiliating the students in technical colleges with the association. The council did not see its way to putting the suggestions into practice, but thought it was a matter which might well be taken up by electrical engineers locally, and dealt with individually.

The council recorded with satisfaction the increasing support given to the association by municipal electrical engineers and electricity and tramways committees, the membership being the highest yet recorded.

The PRESIDENT moved the adoption of the report, with the addition of a recommendation that only members of the association and invited guests should be eligible to attend future meetings and functions. He pointed out that the association was growing in membership, and it was becoming a great tax upon the corporations of the towns in which they held their meetings, although he agreed that there was no need for such entertainment by any town to which they might go in the future.

The report was adopted.

The election of the council resulted as follows: Messrs. J. Christie, Brighton; H. Kilgour, Cheltenham; J. K. Brydges, Eastbourne; J. Talbot, Nottingham; Alderman Dowson, Doncaster; Captain Davison, Harrogate; Alderman Smith, Barrow; Bailie McKenzie, Edinburgh; and Dr. Panton, Bolton.

The Parliamentary Committee of the association in their report recommended, among other matters, that the proposed Bill as to tramway workers' hours of labour should be opposed. The Bill provides that no tramway worker shall in any one day of 24 hours be employed for a period exceeding eight hours, and that the period should be continuous, and include such a reasonable time for one meal as may be fixed by the Board of Trade.

The adoption of the report having been moved,

Mr. A. ELLIS, of Cardiff, spoke of the many advantages which tramway employés had under a corporation as compared with a company, and said the continuous adding to these advantages was going to have a serious effect upon the municipalisation of tramways and electric light. At Cardiff the men had advantages which he believed obtained in no other town in the United Kingdom. For instance, a man was not compelled to work on Sundays if he stated that he had a conscientious objection. Consequently in the summer months it was almost impossible to get sufficient men to run the service. Then they had to pay men time and a half for Sunday. He could not see why this should be done, for though a tramway was essentially a seven days' undertaking, it did not necessarily follow that the men should work seven days. They could have a day off during the week. The Corporation was not allowed to work the men more than 54 hours a week, and on Bank Holidays and national holidays they received double pay if they worked, and the surplus receipts that were depended upon were thus taken away. In addition to this, the men who did not work got a day's pay, so they were practically paying men to take holiday. One really did not know where the conditions of employment were going to end. He then criticised the provisions of the Act. He did not think any man should be compelled to stand on the front of his car for eight hours on end, and if the men had to get their meal on the car the service would be spoilt by the men rushing their cars to the termini in order that they might sit down inside and take their food. He hoped the Bill would be opposed.

Dr. PANTON, of Bolton, expressed the opinion that they, as an association, could not oppose the Bill. They were not tramway people, and all they could do was to express the opinion that it should not be passed.

Another member said he could not pledge his corporation in the matter.

Mr. ELLIS said that he did not desire that the association should go beyond its powers. He simply wanted it to do what it could against the Bill.

The report was adopted.

Votes of thanks were accorded to the president for his services during his term of office, and it was agreed to forward letters of thanks to the corporations and firms who had extended their hospitality to the association during the week.

Thus ended a most successful meeting, and one for which Mr. Snell and the North-country electrical engineers are to be congratulated.

QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any questions should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

603. Why do some firms use a star and mesh starting switch on squirrel-cage three-phase motors, and does star coupling increase the torque and reduce the current taken for a given starting torque, or is the torque greater when mesh coupled, the turns per phase being the same in each case?—W. A. S.

604. Describe how the two motors on an electric tramcar are connected up when braking with rheostatic brake, giving sketch showing path of current.—O. J.

ANSWERS.

Question No. 595.—(1) Discuss by aid of diagrams an arrangement whereby sections of a low-tension three-wire network may be readily isolated from one another in the event of a fault occurring on any one of them, it being understood that each section is fed by a feeder; (2) in reference to above, when the sound sections are fed from a common discharge bar, would anything unusual occur on the distributors should the faulty section be dealt with on a spare bar, considering that the outers only were disconnected and that the middle wire was continuous throughout?

Best Answer to No. 595 (*awarded* 10*s.*).—(1) There are several methods of arranging for isolating or disconnecting the various sections of a three-wire network. In nearly all cases, however, it is the practice to make the middle wire continuous, or put in links, which can only be taken out by hand. It is usual to put fuses at intervals in the outers of the distributors, and fix disconnecting boxes at the branching points. These disconnecting boxes are usually made with links, though in some cases fuses are put in the outers and a link in the middle wire. Where the latter system is adopted, in the event of a "fault," say an "earth" or a "short," occurring on a distributor, the fuses at each end of the faulty section would blow,

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owing to the excessive current, and cut off supply, the advantage in this case being that only a short section of distributor is affected by the fault. The system referred to in the second part of this question would appear to be one in which the distributor is split up into large sections by fuses on the outers at rare intervals, each section being fed by a feeder (see Fig. 1). The writer does not in this matter consider three-wire feeders, but assumes that the middle wire is connected to the supply station at two or three points, and that the middle wire is earthed at the works. In this case, should a fault occur, say, at F, then the excessive load put on A feeder will either blow the feeder fuses, or cause such a large drop in pressure on the same feeder that the fuses at each end of the faulty section will blow owing to the excessive current flowing from the two other sections. Should this happen, it would probably be best to connect the A feeder to a separate supply bar, though in many cases the fault would be of such a nature as to make it impossible to maintain the supply on that section of distributor. In any case, it would probably be advisable to disconnect the middle wire at both ends of the faulty section, if possible, for the reasons given later, though this could not be done if there was no middle-wire feeder connection on the damaged section.

2. Assuming that the "fault" is of such a nature as to allow of maintaining the supply on that section of distributor (as would be the case with a slight "earth," say on the +), then if the outers of the distributor are disconnected at each end the pressure could be increased on A feeder to meet the abnormal load on the + side. The middle would, however, have to carry the excess current returning from the faulty section, or, rather, the difference in current of the + and − sides, which would be great owing to the partial "short" on the + side. If the spare feeder bars could have a balancing set connected to them and the middle-wire feeder connected as shown, then the + balancer, B, would supply the extra current, and the sound distributors need not be affected, except in so far as the middle wire would be rather heavily loaded as far as the point O.

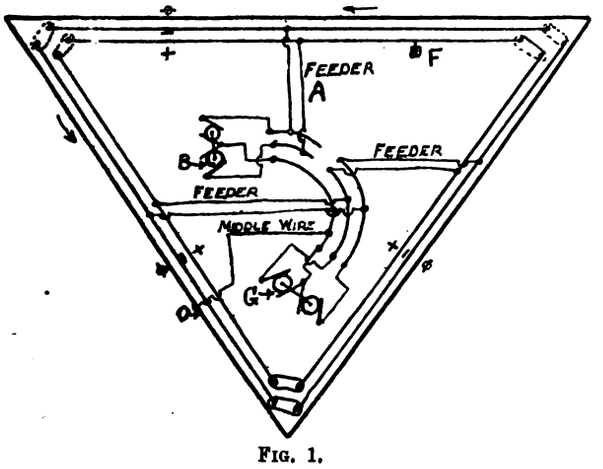
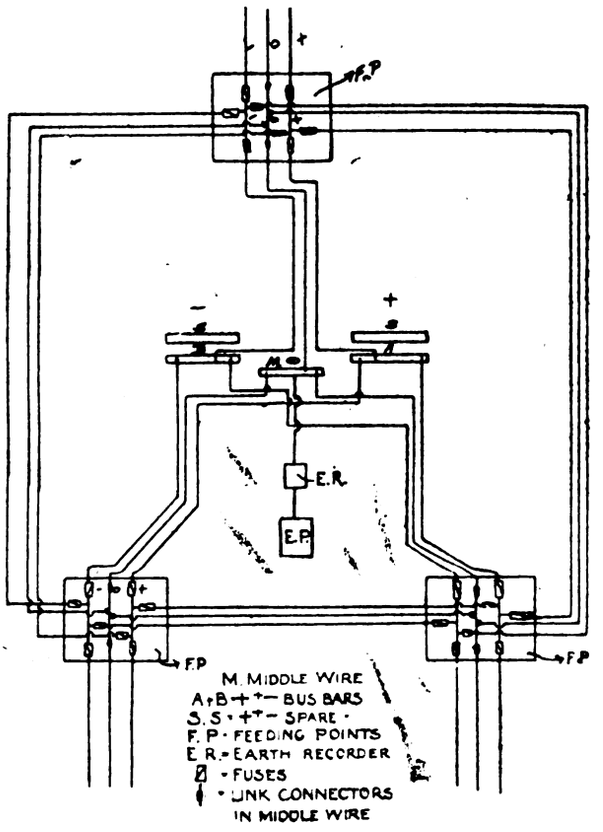


FIG. 1.

Supposing, however, that a balancing arrangement could not be connected to the spare feeder bars, then the balancer, G, would take up the extra current from the middle-wire feeder, and the result would be that the pressure on the + side of the sound distributors would be high. In the event of a "short" occurring between the outers of a section of distributor, as soon as this section is cut off from the remaining portion and supplied from separate feeder bars there will be no effect on the sound portions.—S. A. C.

Answer to No. 595 (*awarded* 7*s.* 6*d.*).—The accompanying diagram shows a three-wire low-tension network, arranged so that in the event of a fault on any one section the faulty section may be quickly removed. A and B are the positive and negative 'bus bars from which the supply is normally given, and S S are two spare 'bus bars for dealing separately with any section should it be required to do so. M is the middle-wire bar. The feeding cables are taken to the three feeding points, F P, F P, F P, as shown. They are here connected to their respective 'bus bars, the outers through fuses and the middle-wire feeders direct. The middle-wire feeders must never on any account be connected through fuses, as should these fuses blow disastrous consequences would result, should one side of the section be much more heavily loaded than the other.



The distributors are also taken off the 'bus bars through fuses in the case of the outers, and through a solid link in the case of middle-wire distributors, the same rule, of course, as to fusing the middle wire holding good for both the feeders and distributors. The three feeding points are connected by distributors, and on examination of the diagram it will be seen that any feeder can be dispensed with if faulty, the only drawback being that the drop of pressure will be greater than if all three feeders were in use. Should a bad earth develop on any section, and it is desired to keep running on that section without upsetting the rest of the system, all that is necessary is to isolate that particular section from the network, and feed it from the spare bars, S S, by connecting the particular feeder to the spare bars. In order to keep a balance on the faulty section the battery could be uncoupled from the outers, A and B, and connected to the spare bars, S S. Nothing unusual would happen by doing this and keeping the middle wire continuous throughout the system, as any current to earth from one of the outers on the faulty section would seek a return path through the earth to the station as long as the insulation of the middle wire was intact.

For the sake of simplicity in making and reading the diagram, the disconnecting boxes at the feeding points have been shown of the type built into brick pits, and containing the 'bus bars run in with bitumen, the connections to feeders and distributors being made by means of easily fitting links. But in the writer's opinion a feeding pillar equipped with the necessary 'bus bars, to which connection is made by means of switches capable of being opened whilst heavy currents are flowing, are far better, the objection that the switches will become stuck fast and corroded through damp and disuse being overcome by a *little* judicious attention at the time of inspecting the various feeder pillars.—W. T. W.

Answer to No. 595 (*awarded* 5*s.*).—Undoubtedly the best arrangement for isolating different sections from one another is to have sectionising fuse boxes inserted between each section, so that when one section breaks down the section connected to it may be worked all right after taking the "links" or fuse holders out between it and the faulty section. Suppose a fault suddenly occurs in network shown in Fig. 1. The switches at the station controlling feeders A and B must be taken out, and the fuse holders

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at sectionising fuse box then taken out, and the switches at the station put in again (lightly fused) to see in which section the fault is, and the switch to the faulty section taken out again. Suppose the fault is on section D. Feeder B and section D are now dead, and the links should be taken out at feeder box B, and the feeder and section D tested separately to see in which the fault lays. If the fault is in the feeder, then the sectionising fuses should be put in again, and the two sections, C and D, both fed through feeder A.

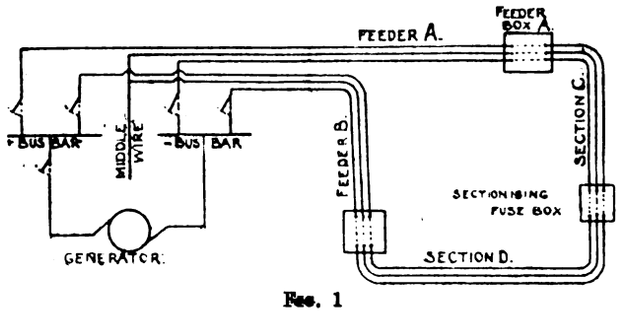

Fig. 1

With regard to the second part of the question, nothing unusual would occur, for the middle wire is always kept at earth potential. Suppose that if the fault, instead of being in the feeder (above), is found to be in section D, and the negative and middle wires are dead shorted. Then, of course, since the middle wire is at earth potential, the negative conductor would also be at earth potential, and the faulty section could be dealt with on a spare 'bus bar by a separate machine running at half the proper voltage across the outers. The negative and middle wire of the feeder supplying the faulty section must be joined together at the station. In this case only the installations tapped off the positive and middle wire would be able to get light. If the positive, negative, and middle wire of the faulty section are all dead shorted, then, of course, the section cannot be worked at all, unless it is divided up into two or more lengths with disconnecting link boxes between each length, in which case that part of the section found by testing to contain the fault can be isolated, by taking out the links at each end of it. The other parts of the section may then be dealt with through one or the other feeder, according to the position of the faulty length.—G. N. W.

Question No. 596.—A feed tank is situated some distance from the well from which it is to be filled. Two electrical pumps are to be installed (one being a stand-by) to fill the tank. Give a method of calculating best size of pipe (for a given discharge of water) to connect pump and tank.

Best Answer to No. 596 (*awarded* 10*s.*).—Such a case as the above is one which requires the consideration of all details. There are certain factors which have to be taken into account in the calculation of the best size of pipe to be used in the above connection. The best size of pipe is the one, of course, which will give the best satisfaction as regards working, and produce good results in efficiency and economy. It is assumed that the distance between the tank and the pump is known, as this is an essential factor to be considered. The water should be forced through the pipes by sufficient power to provide for useful work being done, and also for losses in the pipe. The losses occurring are due chiefly to the friction of the fluid upon the solid surface of the pipe, but this friction is independent of the pressure, depending chiefly on the hydraulic mean depth of the pipe, and within all ordinary limits may be taken as proportional to the square of the linear velocity. This linear velocity should, therefore, not be so great as to cause an enormous loss due to friction of the fluid upon the solid surfaces of the pipe, as all losses have to be paid for. A good average velocity of the water in pipes is 3ft. or 4ft. per second, or 180ft. to 240ft. per minute, and even this might, with satisfactory results, be generally less. With a pipe too small for its work, a linear velocity greater than the above would be obtained, and this greater velocity would produce a far greater proportional increase in friction, therefore would require more power to overcome that friction. It is, therefore, obvious that the larger the pipe up to certain limits, the less the loss of power required to overcome the friction produced. Also, though not indicated in the question as any given factor, the working pressure is an essential to be known—that is, the pressure which will be maintained at the end of the pipe and be available to supply the pressure lost in the pipe owing to the law of the conservation of energy. Now, this pressure lost in the pipe must be a decided factor, or the correct diameter cannot be calculated. Knowing all the above factors, a formula is required connecting them to the diameter. Various authorities from time to time have given different data as to results of their experiments and tests on the flow of water in pipes, and have produced formulæ likewise differing. Now, as these formulæ differ, and some greatly, it will be the best, in order to obtain a fair result, to take an average formula, one the average of them all. The mean of such formulæ may be taken as:

$$d = \sqrt[5]{\frac{W^2 \times L}{23{,}000^2 \times p}} = \sqrt[5]{\frac{W^2 \times L}{529{,}000{,}000 \times p}} = \frac{1}{55} \times \sqrt[5]{\frac{W^2 L}{p}}$$

where d = diameter of pipe (internal), in inches;
W = discharge of water, in pounds per hour;
L = length of pipe, in feet;
p = loss of pressure, in pounds per square inch.

This formula will give approximately the best size of pipe under the conditions represented in the question. The size will be such as not to produce a very high linear velocity. The loss of pressure might under ordinary conditions be equal to 1lb. per 100ft. of pipe. Assuming this in the above formula, for a discharge of, say, 400,000lb. per hour we shall get out a diameter of about 8in., which would be about the best size for the conditions prevailing.—G. W. B.

Answer to No. 596 (*awarded* 5*s.*).—The amount of water a given pipe can carry depends upon the pressure of the water at entering the pipe, and the quantity of water a pump can deliver is generally reckoned for practical purposes at two-thirds of the capacity of the cylinder or barrel multiplied by the number of strokes per minute, 277 cubic inches being reckoned as equal to one gallon. Of course, this is supposing the water to be pumped up from the well, and then to be allowed to run freely from the pump. Now, the question is, will it run to the place where it is wanted, or must it be forced there? If it will run there by the action of gravity only, we have a formula in Molesworth's book of engineering formulæ which exactly suits the case—viz., $G = \sqrt{\frac{(15\ D)^5\ H}{L}}$, where G = the number of gallons delivered per hour, H = the head of water in feet, D = the diameter of the pipe in inches, and L = the length of the pipe in yards. In words we may say: multiply the diameter of the pipe in inches by 15, then multiply this product together five times, and take the square root of the figures thus produced; then multiply this by the head of water—*i.e.*, the fall in feet—and divide the result by the number of yards the pipe is long This will give us the number of gallons which can be passed through a given pipe—*e.g.*, the size of the nozzle or delivery pipe of the pump, which would probably be a guide as to the fair amount to expect from the pump. The formula may be transposed to give the diameter of pipe required to deliver a certain number of gallons—thus:

$$D = \frac{1}{15} \sqrt[5]{\frac{G^2 L}{H}}.$$

A knowledge of logarithms will greatly facilitate the working of these formulæ, but the first can be worked with a little patience without logarithms. Valuable tables are also given by Molesworth. Of course, if the pump has to create the necessary pressure to raise the water to a higher level it has so much more work to do, and in this case probably the best thing to do would be to use a pipe the same size as the delivery pipe of the pump, but certainly not smaller, because a pipe which is too small causes so much friction that it puts too much work on the pump, and prevents it doing its proper amount of duty, and may often be the cause of a breakdown. Therefore, if the pipe is to be of great length, it would probably pay in the long run to have it a little too big rather than too small.—F. G. A.

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Answer to No. 596 (*awarded* 5*s.*).—The chief sources of loss in head or pressure of water when flowing through pipes are friction and losses at bends and sluice valves (when the latter are partially closed) due to friction and eddies, the amount of loss depending on the shape and radius of bend and the amount of opening of sluice valve. The amount of water that will flow through a pipe per second in cubic feet when the resistance is wholly or chiefly friction is given by equation

$$Q = 30 \sqrt{\frac{h}{l}} \times d^{\frac{5}{2}},$$

where Q = volume in cubic feet per second;
l = length of pipe, in feet;
d = diameter of pipe, in feet;
h = loss of head due to friction = difference of head at ends of pipe.

The loss of head due to friction is

$$h = 4 f \cdot \frac{l}{d} \cdot \frac{v^2}{2g},$$

where l = length of pipe, in feet;
d = diameter of pipe, in feet;
v = velocity of water, in feet per second;
g = 32·2;
f = ·0075 (approx.)

The common velocity of water through large mains is about 3ft. per second.

The loss of head due to bends = $c \frac{v^2}{2g}$, c being a constant with following values: for elbow, c = 1; right-angle bend of radius = diameter of pipe = ·3; right-angle bend radius = 3 diameter of pipe = ·14. This loss is multiplied by number of bends to give total loss due to bends, which obviously should be few as possible.

The loss of head due to partial opening of sluice valve = $c \frac{v^2}{2g}$, c being a constant as below.

Fraction of diameter of pipe that the valve has been lifted	1	⅞	¾	⅝	½	⅜	¼	⅛
c	0	·07	·26	·81	2·06	5·52	17	98

Now, summing the loss of head due to bends, sluice valves, and friction, and inserting in (1), we obtain the diameter of pipe, d, required for given discharge, Q. The above formulæ are from "Fowler's Pocket-Book."—ERG.

Answer to No. 596 (*awarded* 5*s.*).—Work done by the pump will be the weight of water removed from well to tank, friction in the piping, and other losses. The weight of water lifted is a simple calculation. The loss due to friction in pipes varies *directly* as the square of the velocity of flow and length of pipe, and *inversely* as the internal diameter of the pipe. There is some difference in the formulæ given by authorities on this matter. The following are generally considered reliable—

Eytelwein: $W = 26{,}788 \sqrt{\frac{d^5 p}{L}}$;

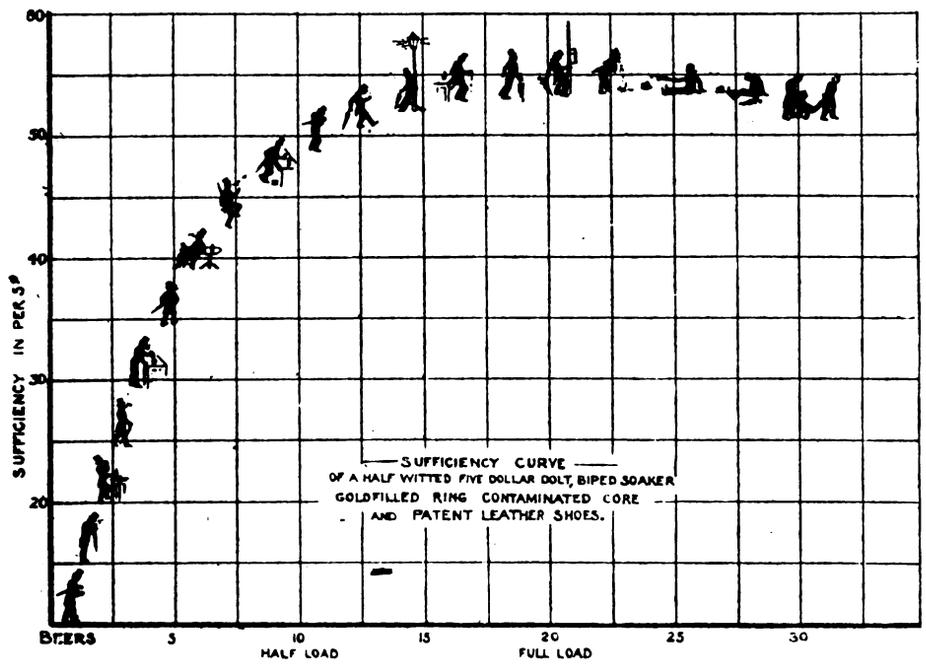
Hawksley: $W = 22{,}923 \sqrt{\frac{d^5 p}{L}}$;

where W = water, in pounds per hour;
p = loss of pressure (pounds per square inch;
d = internal diameter of pipe, in inches;
L = length of pipe, in feet.

It must be remembered that these formulæ represent the loss when pipes are smooth, straight, and free from incrustation. Where there is any danger to be apprehended from deposit, engineers allow an increase in the internal diameter of from 30 to 50 per cent. over the calculated sizes. Very elaborate formulæ have been given for losses due to curves and bends It is doubtful, however, if these formulæ are of much practical use, so much depending on the "sweetness" of the curves and general arrangement and workmanship A metropolitan report on water supply says: "The time necessary for the discharge of a given quantity of water through a straight pipe being 1, the time for an equal quantity through a curve of 90deg. would be 1·11; with a right angle 1·57, two right angles would increase the time to 2·464, and two curved junctions to only 1·23." We are all aware of the objections experienced workmen have to sharp "elbows." Roughness in the pipes, bad joints, rivet heads, etc., cause considerable increase in the frictional resistance, and must be allowed for. It is well to err on the side of having too large a pipe than one too small; cases are on record where the calculated losses due to friction in pipes have been considerably underestimated. A point to be noted is that the speed of plunger should not be greater than the rise of water below it; if it is, on the return stroke the plunger will meet water and cause knocking. The suction pipe should be of ample diameter, and the velocity of the rise of water in it not more than from 170ft. to 200ft. per minute.—M. M.

SATURATION CURVE.

We reproduce herewith from the columns of the *Canadian Engineer* an interesting skit on an efficiency curve of a ½-h.p. motor which was designed by Mr. Geo. Bickell, a young Canadian employed as chief draughtsman for a large electrical firm in the United States. The motor had a cast-steel ring, laminated cores, and cast-iron pole shoes. The figures on the curve clearly show when the field-magnet system approached saturation, and where.



The armature reaction overpowered any attempts to increase this saturation.

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OPEN DISCUSSION.

The eighth annual convention of the Incorporated Municipal Electrical Engineers' Association came to a successful end on Saturday last. In spite of the attempt of the weather to drown the members, or at least to damp their ardour, the convention was a great success. This success is, in our opinion, largely due to the open discussions which followed the seven papers read at the meetings in Sunderland, Newcastle, and Middlesbrough. It was remarkable that the most heated discussions took place on those papers which dealt with policy, while those on engineering subjects did not attract so many speakers. As was to be expected, the controversy over the relative merits of municipal and company management was exceptionally keen. On this, as was only right, the chairmen of committees had much to say, but in spite of the commercial knowledge which these gentleman brought to bear on the subject, it was, in our opinion, the engineers who took the most businesslike view of the matter. Thus Mr. Robert Quin's remarks on the comparative figures for company and municipal management were much to the point. He said that the provincial corporations are supplying all the largest towns, and in consequence should be ashamed of themselves if they could not do better than the provincial electric light companies, who had to confine their attention to smaller places. As far as electric light undertakers are concerned, the controversy serves no useful purpose, but it has a considerable bearing on the future policy in the country as regards power distribution schemes. Those responsible for the organisation of the meeting had invited representatives of several of the large power companies to attend, and these gentlemen, who represent the largest company organisation in this country, freely gave their views. That at times these views were expressed rather strongly was only to be expected under the circumstances, although it is difficult to know whether they could be classed as "Daniels in the lions' den" or as "wolves in the fold." In any case, they were in the minority, and they boldly supported their own views. The question was, of course, as to whether corporations or power supply companies should both have the right to supply the large power consumers within borough boundaries. One representative of the power companies said that the North Metropolitan Electric Power Company had contracts in hand for supplying fifteen millions of units per annum at rates varying from 1d. to 1·4d. per unit. Another remarked that the Newcastle-on-Tyne Supply Company, in which is merged the power supply on the north bank of the Tyne, only received on the average 1·85d. per unit, while the County of Durham Power Company obtained only 1·43d. per unit. These figures are exceedingly creditable in view of the transmission of the energy over a considerable distance. The fact remains that without such transmission the Newcastle-on-Tyne Corporation is able to supply their own tramways with electrical energy at 0·88d. per unit, which figure includes all capital charges. Again, the Bradford Corporation have for years supplied all-day users of power at 1d. per unit; thus a manufacturer requiring a five horse-power motor in Bradford is in a better position than the average consumer of the above power companies. We believe it would also be right to say that he is as favourably situated as the largest consumer of these companies. The difference in the above costs of supply is largely due to the cost of the transmission system laid out with underground mains. As one speaker said, the crux of successful power distribution in this country is the use of high-tension overhead cables for the purpose. There seems to be some indication in Government quarters that

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permission to use such cables may be granted by the Board of Trade in the near future. Unless some such means of reducing the annual capital charges for cables can be adopted, we are afraid in the future it will be found that the companies and corporations have been fighting as to who shall supply consumers who will not be content on either system. Large users of power having regular loads will find in many cases that it will pay them to put down their own generating plant. This fact was alluded to by an engineer in the discussion on Alderman Pearson's paper, and is one which cannot be disregarded by either side. To give an example, we need only quote from Mr. A. D. Williamson's able paper read before the Institution of Electrical Engineers in London last May. In this figures are given of four works with private plants in which the works cost vary from 0·469d. to 0·77d. per unit, and the total cost from 0·675d. up to 0·97d. per unit. The works which has the total cost of 0·675d. per unit use 2,610,620 units per annum, so that to take a supply from a company at 1d. would mean an annual increase in cost of £3,500. The order to supply these works, or others of a similar size, with electrical energy must therefore be difficult to obtain, and still more difficult to hold.

LOWESTOFT ELECTRIC TRAMWAYS.

FORMAL OPENING.

Under favourable conditions, the system of electric tramways constructed by the Lowestoft Corporation was formally inaugurated on Wednesday last. At 11.30 a.m. the guests of the Mayor (L. F. Orde, Esq.) and Corporation assembled at the car depôt, which adjoins the generating station, and were subsequently driven over the route. The Mayor, who, it may be mentioned, is also chairman of the Tramways Committee, himself drove the first of the gaily-decorated cars which formed the procession, attired in his robes and chain of office. As is usual upon such occasions, much enthusiasm was evinced by the crowds which lined the route. The line opened consists of a single track, with turn-outs, and the present length of route is approximately 5½ miles, the equivalent of some 6½ miles of single track being laid. Noteworthy in connection with the scheme is the fact that a commencement was not made with the construction of the line until March 11, 1903, the whole of the work, including overhead equipment, being practically complete by the end of June.

After a pleasant drive the party adjourned to the Grand Hotel, where they were entertained at lunch by the contractors and engineers. Speeches of the usual congratulatory and complimentary order followed, and the Corporation's consulting electrical engineer, Mr. W. C. C. Hawtayne, M.I.E.E., presented the Mayor, on behalf of the engineers and contractors, with a massive silver rose bowl as a memento of the occasion. Owing to the great pressure on our space we are unable to give Wednesday's proceedings in greater detail, but hope in a subsequent issue to fully describe the undertaking of which they were the immediate outcome. In doing this we shall be assisted by a very excellent descriptive souvenir, a copy of which was presented to each guest.

FORTHCOMING EVENTS.

Iron and Steel Institute.—Summer meeting, Barrow-in-Furness, September 1-4.

Municipal and County Engineers.—Meetings: Aberdeen, Aug. 20, 21, and 22; Hastings, September 11 and 12. Detailed programmes will be issued when definite arrangements are made.

London Electrical Contractors' Association.—Annual general meeting, July 27, 6 p.m., at Frascati's Restaurant, Oxford-street.

CHLORINE SMELTING, WITH ELECTROLYSIS.*

BY JAMES SWINBURNE, VICE-PRESIDENT.

(Concluded from page 116.)

CAPITAL COST.

As regards capital cost it is difficult to say how much the plant for any particular case will cost, as it depends on the ores to be smelted and local conditions. It is therefore wise to allow a large margin on all plant of a new description, and a large margin is left in the 30s. a ton for depreciation, repairs, etc. The electrical generating plant is a different matter, however. A large installation may be taken at an outside figure of £25 per kilowatt, including buildings and spares. In this case there is no accidental overloading, as in light and power distribution stations, so that £25 a kilowatt includes spares by overloading and separate plant. It will be evident that the cost of generating plant is a consideration in the capital expenditure. In the case of water power at 0·086 the capital expense is borne wholly by the owners of the power station. The power is there, and if it is not used for one purpose it is used for another, so that the water-power company really takes no special risks involved in a new process. The 0·086 thus covers the capital of the water station, and no water-power capital figures in the process accounts. A given amount of available capital thus gives much the best results on a water power. In the case of a gas plant the owners of the process may put up their own plant. The capital cost of gas generating plants may perhaps be safely taken as £25 a kilowatt, but it must be borne in mind that there is more uncertainty about it, and more chance of its becoming antiquated soon. Improvements in gas generators and engines are more rapid than in steam just now. In the case of steam generating plant the same considerations come in. If the owners of the process put down their own plant, they must allow for high profits on a share of it. Though 0·25 is given as the cost of steam-generated electrical energy, that is only if there is no risk. No business men would put down a generating plant specially to supply us with nothing but a guarantee of 0·25 per kilowatt-hour for a year or two. The nearest approach to such a case is a power station such as those being put up in various districts now. Even one of them would not contract for 0·25, as an output of some thousands of kilowatts day and night means adding special plant which, if thrown out suddenly by the financial failure of the process, would have to be idle till the demands of the station caught up with it, and even then the dynamos would have to be altered. In buying energy from a modern power station without contributing to the capital, the price would probably be about 0·3 per kilowatt-hour. If the process owns its own steam generating plant, it would be safe to allow for part of the cost being covered by 5 per cent. debentures.

The idea of risk-profits is this: Any new process such as this, however satisfactory the results so far, involves risks of failure. There are many chances of difficulties in working on a still larger scale, and chances of new and better processes coming out. The last chance is probably small, because the various problems of smelting copper, lead, zinc, antimony, tin, etc., have all been before the world for many years, and a new process that bids fair to solve all of them in a new way is not likely to be superseded, as regards many of them, by something else, though it might be as regards one of them. The only real risk is that of all new processes—unforeseen difficulties or expenses. The present process is too far advanced to leave many loopholes, but even then experience of other industries shows that it is not wise to embark in a new scheme unless, after the most searching criticism, the profits on paper are so large as to leave a very wide margin. But to get a fair idea, it is obvious that capital in steam generating plant, or in sites, must not all be counted in as expecting what are here called risk-profits. One kilowatt at four volts per cell deposits 2·61 tons of zinc a year at a current efficiency of 1. The departure from this current efficiency is minute, but the pressure will probably be reduced considerably with larger vats. Steam plant for a ton of zinc a year thus costs £9. 12s., or, roughly, £10 in capital. To reduce a ton of lead a year by replacement with zinc thus involves a capital of £3, and a ton of copper (cuprous) £5 approximately. In metallurgy it is usual, and some people find it convenient, to work in "units." For each ton of ore smelted per year the capital cost of steam plant thus comes out: zinc £0·1 per unit, copper £0·05, lead £0·03 approximately, so that if an ore has 33 units of lead, 20 of zinc, and 10 of copper, and plant is wanted to smelt 100,000 tons a year, the steam plant would cost £350,000.

As to smelting plant, including vats, transformers, agitators, pumps, boiling-down plant, and buildings for all the works other than the generating plant, it may be wise to allow as much as half the steam plant for cost of process, plant, etc., and another equal sum for working capital. To begin with, we may work out a rough estimate for treating bluestone ore in this

* Paper read before the Faraday Society.

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country with steam generating plant put up for the purpose. One hundred thousand tons of ore a year will be taken, the ore containing as delivered 22 per cent. zinc., 18 per cent. lead, iron 4 per cent., manganese 3 per cent., gangue 35 per cent., sulphur 18 per cent., silver 15oz. The process would require a capital of, roughly, £550,000, including the generating plant, with no debentures. This allows nothing for payment of patent rights. The costs of working would be :

By 100,000 tons of slimes delivered at £2. 10s.	£250,000
By 100,000 tons of ore carried through process, excluding cost of energy	150,000
By electrical energy	94,200
By allowance for loss of metals and chlorine, say	15,000
By cost of realising products	16,000
	£525,200
Profits	£341,200
To sales of zinc at £20, lead at £12, silver at 2s., two-thirds of the sulphur at £3, iron oxide at £2, manganese £5. 5s.	£866,400

This leaves over 60 per cent. profit on capital, a profit which would leave a margin even after paying the royalties wished for by the proprietors of the patents. Suppose, however, energy were bought at no less than 0·4d. per kilowatt-hour from a power supply station. The costs would be increased by £55,800 per annum. But the capital would be reduced to, say, £275,000, making a profit of £285,000 on £275,000, or over 100 per cent.

Another estimate may be taken for different conditions. In this case a water-power works on the waterway from the American lakes to the sea will be considered, dealing with ore from the district above. Take the ore as zinc 41, lead 15, and silver 2oz. This is a real ore, but I have no data as to iron contents. If there is any iron to speak of, there must be little gangue. Also I do not know the value of this ore, but will assume it to be refractory. It will then give a good miner's profit if the ore is taken at £2 a ton delivered on the works. To smelt 100,000 tons a year of such a rich ore as this would need about £500,000, of which half is process plant and half working capital. Electrical energy would be bought at, say, 0·1d. per kilowatt-hour. One hundred thousand tons Canadian ore smelted in America by water power :

By 100,000 tons ore	£200,000
By process expenses	150,000
By electrical energy	73,500
By losses, commission, etc.	30,000
	£453,500
Profits	£566,500
To sales of metals	£1,020,000

There is thus well over 100 per cent. profit on this scheme—of course before paying royalties. This ore has very little gangue, and in that case it might be worth while to dilute it with poor copper ore, especially if the copper ore contains some other valuable metals, such as zinc, antimony, nickel, or precious metal. Thus if the ore has only 10 per cent. of gangue, and a low-grade copper with 3 per cent. of copper, 5 per cent. of zinc, and 5 per cent. of iron, has some 80 per cent. of rock ; for every ton of the rich ore more than a ton of this poor ore could be run through too. The works would then deal with 100,000 tons of this poor ore with very little extra capital cost or expense, as it is nearly all rock, which is eliminated near the beginning of the process. A little more than £1. 10s. a ton for the process should have been allowed for the rich ore, and a poor ore takes a great deal less. Discussing the different metals in order :

Antimony.—This metal is very easily extracted from the sulphide, either as brown sulphide or as oxide, preferably as oxide. It can also be got out as regulus by reduction. It does not matter whether the antimony is mixed up with other metals or alone.

Arsenic.—This is almost on all fours with antimony. Like it, its sulphide is very easily converted into chloride. It can be equally easily treated when it is an arsenide of other metals. The chief difficulty of antimony and arsenic arises from the poisonousness of their volatile chlorides. We have done little with arsenic.

Bismuth.—This is a small question. Bismuth would be easy to deal with, as it falls out of solution as oxychloride.

Cobalt.—This comes out as oxide ; if nickel is also present, the nickel and cobalt and iron, and perhaps manganese have to be separated in the wet way. There is nothing special about the problem.

Copper.—This comes out of the transformer as cuprous chloride, which is soluble in the other chlorides. It is deposited as cement copper by zinc, not iron. The process will handle ordinary high-grade copper ores successfully, as any other metal, except iron or manganese, is extracted separately as metal too. The copper is, of course, free from sulphur, arsenic, iron, antimony, phosphorus, silver, etc. In fact, it is pure. Copper can be equally cheaply extracted from arsenical or antimonial ores ; in fact, the ores may have arsenic, antimony, zinc, lead, iron, nickel, gold, silver, cobalt, or anything else, and they are all separately extracted without appreciable extra cost. Poor copper ores will either be concentrated, or run in with other richer stuff.

Gold.—When present in copper, lead, or other such ores the gold comes out with the silver. Gold in conjunction with antimony, arsenic, tellurium, and small quantities (per ton) of common metals can be treated as a low grade ore, and run in with any rich mixed or other sulphide, such as lead, zinc, or even rich copper ore or matt. It is largely a question of carriage, and what ores are near each other and near the works.

Iron.—This metal occurs in zinc and copper ores, and comes out as oxide. This oxide is reckoned at £2 a ton, and is useful as a paint. The value depends on the tint, and this depends on the way it is worked up—a matter we have not yet studied. Good oxide fetches high prices, up to £15 or £20 a ton, but the sale is probably very limited. Assuming the lowest price, £2 is not too much to count upon for paint for preserving iron structures where colour is not an object. The extraction of iron itself is a different question. It would come down as a powder from the fused chloride, and would have to be fused together. It would probably cost something under £10 a ton. It may prove that chemically pure iron, with no trace of phosphorus, sulphur, silicon, or manganese, or other impurity, is well worth £10 a ton for making special steels or electrical iron stampings.

Manganese.—This metal, like iron, is a drawback in an ore, as it comes out of dioxide, which is not valuable, though the sale of the manganese from such an ore as Broken Hill slimes is worth considering.

Nickel.—This is much the same as cobalt as far as the process goes. It comes out of the transformer as nickel chloride.

Silver.—The silver comes out separately—that is to say, it is extracted from a lead ore as a rich lead-silver alloy. From copper ores it is precipitated by cement copper from the solution of the chloride. Or it may be thrown down by the Claudet method.

Tin.—Tin ores can be added to the charge of the transformer, or treated alone. There is nothing peculiar about it.

Zinc.—Has been fully discussed. Zinc need not exist in the ore worked.

As it is not possible to give a series of estimates for all the innumerable complex ores, it may be well to give an approximate rule which can be applied to any ore.

Rule for Capital.

For each ton of ore per annum to be treated allow :

Zinc	£0·1	per unit.
Copper	0·05	,,
Lead	0·03	,,

and for other metals which are extracted in the metallic state, in proportion, inversely as their equivalents. Metals like iron and manganese or antimony, which are extracted as oxides, do not count. This gives a very rough idea of capital necessary for process plant and working capital. If steam or gas generating plant is to be put down, double this capital.

Rule for Working Costs.

For each ton of ore treated at works allow cost of ore delivered, plus £1. 10s. per ton for treatment, including everything but cost of electrical energy, and allow 5 per cent. extra on cost of ore to cover all waste. The cost of energy depends on the metal content and on the cost of generation. Steam may be taken at 0·25d., gas at 0·125d., and water at 0·1d. per kilowatt-hour.

Cost per unit of	Steam power. £	Pence	Gas power. £	Pence	Water power. £	Pence
Antimony (if as metal).	0·042	10	0·021	5	0·016	4
Copper	0·0175	4·2	0·009	2·1	0·007	1·7
Iron (as oxide)	—		—		—	
Manganese (as oxide)	—		—		—	
Lead (desilverised)	0·0107	2·6	0·0054	1·3	0·0043	1
Nickel	0·038	9	0·019	4·5	0·015	3·6
Silver and gold	Inappreciable		—		—	
Tin	0·038	9	0·019	4·5	0·015	3·6
Zinc	0·0342	8·2	0·017	4·2	0·0136	3·3

The price in pence is added because it gives cents, too, by doubling. To find the value of the products, add up all the metals in full, the waste or loss being amply covered by the 5 per cent. The iron and manganese must be omitted, being oxides. Their market is uncertain, and much must not be allowed for them. Some of the sulphur is burnt ; it is safe to allow for two-thirds of the sulphur contents of the ore at market price.

The process is thus anything but expensive. To see how this is the case comparison must be made with other plants. Take a mixed zinc, lead, and copper ore for example. If we take the corresponding plant on the present system, we have first a concentration plant ; next a lead-smelting works with all

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its adjuncts, including a desilverisation plant; a zinc works and refinery; and a copper-smelting works with an electrolytic refinery. There can be no comparison as to capital cost. As to working cost, the new process begins by saving the concentration, except for very low-grade ores, or where carriage comes in, and thus saves waste. Though 5 per cent. waste has been allowed, there is practically no waste of metals; there is nothing to correspond with the waste of copper, zinc, and lead in smelting. In addition, iron and manganese oxides are got out, and most of the sulphur is obtained as brimstone. In this process a smelting works is independent of ore supply, in the sense that it can work any ores. If copper ores go up, it can devote its whole energy to zinc and lead, and so on, and the variety of ores is so great that the process cannot enhance the value of the ores to the miners. The supply of ores is thus practically unlimited.

This process is the joint invention of Mr. E. A. Ashcroft and myself. Mr. Ashcroft came on the scene when the process was in the baby or test-tube and patent stage. He took it up from that point, and has developed it, not without the necessary pecuniary food being provided for it, into a healthy, full-sized process which appears to have the backbone of a giant. Since he joined we have worked together as co-inventors, and he has designed and worked out all the plant and carried out all the works. Mr. Ashcroft has also read a paper on this process before the Institution of Mining and Metallurgy; but the process is so little known that it seemed advisable to offer a paper to the Faraday Society.

I hope no one will object to the introduction of questions of cost. This paper is largely financial. All engineering—electrical, chemical, or otherwise—is purely a question of cost. There may be people who think that science is not science unless it is merely useless information. Science really is not science unless it is or seems likely to be of use. Every step of the inception and development of a process like this involves science, and practically nothing but science. I have also dwelt rather on the broad questions of the scope of its application than on details, because Mr. Ashcroft's paper goes into details very fully, and should be read with this. I am anxious also that the discussion should not turn on detail difficulties that speakers think we ought to meet, or the impossibility of getting off sulphur by replacement with chlorine, or of electrolysing zinc chloride on the large scale; because we have transformed and electrolysed on the large scale with perfect success. I am much more anxious to know the society's opinions on the probable future of such a process as this, and its application to the various ores found in different localities.

My thanks are due to the Metallurgical Trust, Limited, the proprietors of this process, for leave to offer this paper to the Faraday Society.

TRADE NOTICES AND NOVELTIES.

Ships' Light Indicator.

We have received from Messrs. William McGeoch and Co., Limited, 108, Argyle-street, Glasgow, a circular describing their duplex ships' light indicator. The chief feature of this indicator is that it not only gives warning when a lamp is extinguished, but also indicates when one filament of a twin-filament lamp has burnt out. On the front of the containing case there is arranged a series of "windows" representing the various signal lamps of the ship, and, in addition, a small green window is fitted at the top of the case to show when the "pilot" lamp, which is used to illuminate the windows, is alight. When all the signal lamps are burning properly, the windows representing signal lamps are screened by shutters, and no light appears except from the small pilot window. Should one filament of a lamp burn out, the window representing that lamp half uncovers and shows a half-red light. Should a lamp go totally out, the corresponding window shows an all-red light, and a bell in connection with the indicator commences to ring, and continues doing so until switched off by the switch controlling the faulty lamp.

The Siemens "Liliput" Arc Lamp, etc.

From the Siemens Electric Appliances, Limited, 61 and 62, Watling-street, London, E.C., we have received a number of sheets on which various telephone instruments, etc., are illustrated and described. One of these sheets deals with the firm's "Liliput" arc lamp. This lamp is of the continuous-current type. Its mechanism is simple: for the regulating of the carbons it contains in place of a clockwork a movable clamping arrangement, which is not disturbed by vibration or even a hard knock. The lamp burns singly at 100-120 volts, or two in series at 200-300 volts, and gives without a globe a hemispherical light of 160 c.p., whereas with an alabaster globe it gives a light of 130 c.p. The energy expended is equivalent to 1 to 1·2 watts per candle-power. It is claimed that this lamp is most suitable for indoor use as a dining-room, drawing-room, or even as a table lamp. Its outer dimensions are very small. The cylindrical cover has a diameter of 2½in., and the globe of 3¼in. The length is 12¼in. For the indoor use of these lamps special fittings and shades have been designed. These are illustrated on another of the sheets sent to us.

Nernst Lamps.

We give below the results of a second series of life tests of Nernst lamps made by Mr. Hoadley, the borough electrical engineer of Maidstone. It will be noticed that the average life of the lamps tested was considerably over 1,000 hours, a far better result than obtained for previous tests. The illumination tests made in the streets with a Trotter illumination photometer are also interesting. We are indebted to the Electrical Company, Limited, 122 and 124, Charing Cross-road, who supplied the lamps, for the accompanying figures:

Lamp Tests.

Arc lamps. The unit is one candle-foot. Distance in feet.	Reading.
15	·29
20	·275
30	·135
40	·055
50	·043
60	·025

·5 Nernst lamp with clear globe.	
10	·125
15	·105
20	·052
30	·025
40	·013

Gas lamp (incandescent).	
10	·065
15	·04
20	·026
30	·012
40	·0055

·5 Nernst lamp with prism globe. Distance in feet.	Reading.
10	·052
15	·05
20	·034
30	·02
40	·0085

·25 Nernst lamp with clear globe.	
10	·095
15	·04
20	·028
30	·018
40	·006

·25 Nernst lamp with clear globe.	
10	·12
15	·06
20	·04
30	·019
40	·008
50	·0055

Second Life Test of ½-Ampere Nernst Lamps.

Six lamps.....	210 volts	20 volt resistances	= 230 volts.
,, ...	215 ,, ...	20 ,, ,,	= 235 ,,
,, ...	220 ,, ...	20 ,, ,,	= 240 ,,

Switched on 12 noon, April 8, 1903. Switched off 3 p.m., June 22, 1903.

230-volt lamps.	H.	M.
1.	555	45
2.	1,494	0
3.	1,802	0*
4.	1,802	0*
5.	1,802	0*
6.	1,802	0*

Average hours burning =1,543 hours.

235-volt lamps.	H.	M.
1.	1,675	30
2.	598	0
3.	1,802	0*
4.	1,802	0*
5.	1,802	0*
6.	1,802	0*

Average hours burning =1,580 hours.

240-volt lamps.	H.	M.
1.	1,502	0*
2.	707	0
3.	824	30
4.	1,802	0*
5.	476	0
6.	411	0

Av. life (hours burning) =1,004 hours.

* Still burning.

The lamps still burning have been taken as burnt out at 1,802 hours.

Catalogues and Pamphlets Received.

W. F. Dixon and Co., 60 and 63, Percival-street, Chorlton-on-Medlock, Manchester: Messrs. Dixon and Co. make a speciality of the manufacture of metal-bushed, screw-bound, and steel-shrouded buffalo raw-hide silent gears. We are informed that in several instances their pinions have been running 140 hours per week at 800 and 900 revolutions, developing 40 b.h.p. and upwards, for more than four years, and are still running well. Others have been running upwards of five years on reversing motors in the most trying situations with no sign of requiring renewals.

PERSONAL.

Mr. J. Baillie Hamilton, general manager of the Leeds tramways, who had been offered £1,500 a year by the Tramways Committee of the Birmingham Corporation for the performance of duties similar to those he now fulfils for £900 a year, has decided to remain in Leeds on the understanding that his salary be advanced to £1,200 with an annual increase of £100 until £1,500 be reached.

The Portsmouth Corporation have decided to advance the salaries of Mr. C. M. Gardner, manager, and Mr. T. Holme, assistant manager of the telephone department, to £250 and £135 per annum respectively.

Mr. J. F. Shoolbred, chief assistant at the Corporation electricity works at Stockport, has been appointed clerk of works for the Newcastle Corporation electricity department at a salary of £150 a year. There were over 100 applications.

Mr. J. Gray Scott, the borough electrical engineer of Croydon, has been presented with a handsome marble time-piece by the Lighting and Electricity Committee on the occasion of his approaching marriage.

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LONDON TRAFFIC COMMISSION.

The Royal Commission which is enquiring into the question of the traffic of London had another sitting on Friday at the Westminster Palace Hotel, Sir David Barbour presiding.

Mr. Maurice Fitzmaurice, chief engineer of the London County Council, was the witness. In reply to questions, he said that the Council, when making new streets, constructed subways for water and gas mains, electric light, and other cables. There were 14 subways, with an aggregate length of 5¼ miles, which contained gas-pipes, water-mains, telephone cables, electric lighting cables, District Messenger wires, and Hydraulic Power Company's mains. A subway 12ft. by 8ft. would cost about £18 per yard run for construction, but this price might easily be trebled. The Council under the Subways Act, 1893, had made by-laws by which it could compel all companies laying new pipes in a street where there was a subway to lay them in that subway. In reply to further questions, the witness said that before 1889, with the exception of the East London Railway and the row-boat ferries, there was no crossing of the river to the east of London Bridge. The Rotherhithe Tunnel was to cross the river from Wapping to Rotherhithe. The cost would probably be about £2,000,000. Vauxhall Bridge was being reconstructed, and would be finished in about two years. It was to be built so as to be suitable for a tramway. A new bridge between Waterloo and Blackfriars Bridges was urgent.

The **Chairman:** You have certain proposals before you with reference to north and south connections?

The **Witness:** Yes. Among them there is one from the Crystal Palace district to Waterloo-road, near Waterloo Station, and then continued across the river by a new high-level bridge between Waterloo and Blackfriars Bridges. One branch of the new street might then fall to meet the eastern crescent of the new Holborn to Strand street, and another branch might continue north by a bridge over Fleet-street between Chancery-lane and Fetter-lane, from which point it might be continued to the county boundary. Three types of streets have been taken for the new road from the Strand to the county boundary near the Crystal Palace. Type A is a street 150ft. wide, footpaths 20ft.; the central portion of the street, 30ft. wide, is reserved for motor and other quick traffic, and on each side of the central part is a width of street of 40ft. for surface tramways and slow traffic. Underneath is a subway for single-deck tramcars, and there are the usual pipe subways and sewers. Type B shows a street 100ft. wide, with two footpaths each 14ft. wide, and a roadway of 72ft. Underneath is a double subway. Type C is the same as type A with regard to surface, but the tramcars are carried in two tubes at a deep level. The cost of the above roads, including 150ft. of land on each side, is estimated at: Type A.—Works, £4,000,000; property, £12,000,000—total, £16,000,000; cost per mile, £2,560,000. Type B. — Works, £4,550,000; property, £10,500,000 — total, £15,050,000; cost per mile, £2,400,800. Type C. — Works, £5,125,000; property, £12,000,000—total, £17,125,000; cost per mile, £2,740,000. The figures given are the gross estimates, making no allowance for recoupment. Continuing, the witness said there was no engineering difficulty in constructing a shallow subway under the Strand, or even under Piccadilly. The principal reason why deep-level tubes had been adopted in London was the presence of London clay over the greater portion of the area. The want of consent of various borough councils had made it impossible for the County Council to obtain powers to construct all the tramways which they thought necessary. The remarkable system of shallow subways for railways now being constructed in New York would, when completed, give facilities for traffic which would be ahead of anything contemplated for London. In many cases four lines were proposed in the subways—two for express trains and two for slow trains—and that was no doubt the ideal system. The largest system of shallow subways in the world was that of the Metropolitan and District Railways of London. When electrified they should compare favourably with any others.

The Commission adjourned.

SWANSEA ELECTRICITY ACCOUNTS.

The accounts of the Swansea electricity undertaking for the year ended March last show that the gross profit amounted to £4,578. 14s. 3d. Allowing £2,418. 17s. 6d. for interest the net profit on the year's work comes out at £2,159. 16s. 9d., less debit balance 1902 £349. 9s. 10d., leaving £1,810. 6s. 11d. to be carried forward to next year. The following are the principal items in the accounts, the first set of figures in every case being for the year 1901-2 and the second the year 1902-3; amount sanctioned, £52,046—£205,231; amount borrowed, £52,046—£89,595. 19s.; capital expenditure, £60,230. 15s. 9d.—£89,595. 19s.; revenue from supply, £4,571. 12s. 3d.—£8,249. 8s. 11d.; motor rents, nil—£50. 19s. 4d.; total revenue, £4,571. 12s. 3d.—£8,300. 8s. 3d.; total costs, £2,308. 8s. 2d.—£3,721. 14s.; gross profit, £2,263. 4s. 1d.—£4,578. 14s. 3d.; percentage of gross profit to capital, 3·75 per cent.—5·11 per cent.; interest on loans, £2,612. 13s. 11d.—£2,768. 7s. 4d.; percentage of interest and sinking fund to capital, 4·33 per cent.—3·09 per cent.; financial result—after payment of all charges (including interest) on year's working, and including the £349. 9s. 10d. deficiency last year, but excluding sinking fund—profit, £292. 14s. 11d.—£1,810. 6s. 11d.; capacity of dynamos at end of year, 525 kw.—1,725 kw.; maximum load reached, 423 kw.—547 kw.; load factor, 8·61—12·06; number of equivalent 8-c.p. lamps connected at end of year, 23,166—42,112; total units sold, 319,215—578,182; units sold per 8-c.p. lamp, 13·77—13·73; price charged—private lighting, 6d. and 2d.—6d. and 2d.; power, 2d. and 1½d.—2d. and 1½d.; average price obtained—private, 3·54d.—3·41d.; ditto, public lighting, 3·14d.—2·71d. The following are the principal items of generation and distribution costs: year 1901-2—coal, £697. 3s.—1902-3, £1,224. 4s. 7d.; water, oil, and engine-room stores, £135. 11s.—£231. 8s. 1d.; wages on generation, £481. 7s. 10d.—£865. 12s. 5d.; wages, etc., on repairs and maintenance of buildings, plant, etc., £18. 0s. 6d.—£125. 10s. 6d.; wages, etc., on public lamps, £40. 14s. 2d.—£224. 18s. 11d.; works costs, £1,372. 16s. 6d.—£2,671. 14s. 6d.; rents, rates, and taxes, £307. 11s. 10d.—£322. 14s. 5d.; management expenses, etc., £627. 19s. 10d.—£655. 3s. 4d.; total costs, £2,308. 8s. 2d., or 1·72d. per unit sold—£3,649. 12s. 3d., or 1·48d.

STAFFORD ELECTRICITY ACCOUNTS.

Appended is an abstract of the accounts of the Stafford electricity undertaking for the year ended March 31 last, the capital expenditure on which date amounted to £30,000.

REVENUE ACCOUNT.

Dr. Expenditure.	£	s.	d.
Coal or other fuel	367	3	6
Oil, engine-room stores, etc.	42	11	10
Salaries and wages at generating station	597	19	7
Repairs and maintenance of machinery, etc.	117	0	8
Repairs and maintenance of mains, etc.	122	17	3
Repairs and maintenance of meters, etc.	8	8	2
Public lamps—lighting and repairing	17	7	9
Rents, rates, and taxes	221	16	2
Management expenses	29	16	4
Bad debts and allowances	15	18	2
Insurance	16	1	8
Law and parliamentary charges	50	0	0
Total expenditure	1,607	1	1
Amount carried to net revenue account	1,489	10	11
	£3,096	12	0

Cr. Income.	£	s.	d.
Sale of current per meter	2,850	4	10
Public lighting	180	0	0
Electric fittings	59	9	9
Rental of meters	3	4	0
Rents	3	13	5
	£3,096	12	0

BALANCE-SHEET.

Liabilities.	£	s.	d.
Capital account	25,339	3	3
Sundry creditors	337	14	10
Loans repayment account	4,660	16	9
Depreciation fund account	500	0	0
Amount due to bankers	5,400	3	1
	£36,037	17	11

Assets.	£	s.	d.
Capital account	29,887	16	7
Suspense account—repairs, etc., of mains	3,000	0	0
Stock of electric fittings, etc.	368	17	11
Sundry persons for rental and fittings	1,127	9	0
Cash in hand	6	13	5
Profit and loss account—balance to debit of this account	1,647	1	0
	£36,037	17	11

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated, in B.T. units			290 915
Output of station			283,835
Quantity sold	Public lamps	7,878	
	By contract	96,346	232,694
	Private consumers by meters	128,470	
Quantity used on works			19,460
Total quantity accounted for			252,154
Quantity not accounted for			38,761
Number of public lamps			8
Total maximum supply demanded (kilowatts)			184
Equivalent in 8-c.p. lamps connected			13,293

HACKNEY ELECTRICITY AND REFUSE DESTRUCTOR UNDERTAKINGS.

The joint report of the borough accountant and borough electrical engineer of Hackney for the year ended March 31 last, together with the accounts for that period, which have been jointly prepared in the electricity and finance departments, has reached us. These accounts form the records of the first complete year of working of the electricity and destructor undertakings. With regard to the electricity department, the report states that the progress made during the period under review is remarkable and entirely satisfactory. At the close of the accounts there were the equivalent of 68,897 lamps of 8 c.p. connected to the mains, including 98 motors with an aggregate of

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380½ h.p. 1,943,983 units were generated. Of this total, 539,006 units were sold to the Works and General Purposes Committee for public lighting, realising 2·70d. per unit, out of which 0·40d. per unit was spent in carbons, trimming, maintenance, and attendance on the lamps and columns. 1,075,962 units were sold to private consumers for lighting and power, realising 3·36d. per unit. 132,558 units were used on the works for lighting and driving the auxiliary machinery; 51,736 units represent the energy used by the battery, and 144,721 units the distribution losses. The cost of working—viz., 1·03d. per unit sold—is extremely low, especially when it is remembered that at present the day load is small and the load factor only reaches 15·88 per cent. The analysis of costs is set forth below:

	Total costs.	Cost per unit sold.
Coal and other fuel	£3,199 9 4	0·48d.
Oil, waste, water, and stores	217 3 8	0·03d.
Wages of workmen	1,303 16 8	0·19d.
Repairs and maintenance	607 16 2	0·09d.
Works costs	5,328 5 10	0·79d.
Rents, rates and taxes, and management expenses	1,604 2 4	0·24d.
Total costs of generation and distribution	£6,932 8 2	1·03d.

The cost of carbons, trimming, attendance, and lighting the public lamps amounted to £902. 9s. 1d., or 0·40d. per unit sold for public lighting. The report claims that these costs hold the record for the Metropolis. The total revenue was £21,367. 14s. 7d., while the total working expenses amounted to £7,834. 17s. 3d., leaving a gross profit of £13,532. 17s. 4d. The interest on borrowed money accrued to March 31 was £9,090. 16s. 5d. The instalments repaid on borrowed money to the same date was £2,609. 7s. 3d., while £421. 4s. 4d. interest was received on money on deposit, so that a net surplus of £2,253. 18s. remains. The writers of the report have not thought it necessary to depreciate the cost of the works and plant, inasmuch as the full cost of maintenance and renewals has been charged to revenue account. In accordance with the recommendation of the Finance Committee adopted by the Borough Council on March 5, 1903—viz., "That whatever profits accrue during the present financial year and also the next, that they be placed to the credit of a reserve fund and invested as required by the electric lighting order"—it will be observed that the net surplus of £2,253. 18s. has been so transferred. All the plant that has been taken over from the contractors has been efficiently maintained, and the works generally are in a satisfactory condition.

Reporting on the destructor department, the writers state that the destructor was put into operation on April 21, and during the 11 months it has been in use it has cremated 34,006 tons of refuse. The largest quantity cremated in any one day was 186 tons, and the smallest quantity 41 tons, the average daily quantity burnt being 120 tons. The average quantity of water evaporated per pound of refuse was ·54lb. As the demand for electricity throughout the daytime does not require the full amount of heat generated by the destructor, the surplus heat has to be by-passed direct to the chimney during the light-load period, but with the increasing day demand for electricity the destructor heat is gradually being utilised to greater advantage. From the 34,006 tons of refuse 120 tons of tins and scrap iron were removed, and 11,578 tons of clinker, fine ash, and flue dust were carted away. The following is an analysis of the destructor costs:

		Cost per ton of refuse.
Oil, waste, water, and stores	£60 11 5	·43d.
Electricity	660 9 11	4·66d.
Wages of workmen	2,708 0 2	19·11d.
Repairs and maintenance	47 17 5	·34d.
Clinker disposal	746 16 4	5·27d.
Works costs	4,223 15 3	29·81d.
Management expenses	304 4 1	2·15d.
Total costs	£4,527 19 4	31·96d.

In addition to the foregoing amounts, the interest and repayment charges amounted to £2,771. 13s. 1d. The net cost of the destruction of the borough refuse, after crediting the destructor with the heat utilised by the electricity department to the value of £2,272. 4s. 8d., and with £7. 16s. 1d. of sundry receipts, was £5,019. 11s. 8d., or practically 2s. 11½d. per ton. The accounts show that the capital expenditure on March 31 last was £233,100.

REVENUE ACCOUNT.

Dr. Expenditure.	£ s. d.
Coal and other fuel	927 4 8
Value of steam supplied by destructor	2,272 4 8
Oil, engine-room stores, etc.	217 3 8
Wages at generating stations	1,303 16 8
Repairs and maintenance of machinery, etc.	369 9 4
Wages of distributing staff	123 19 8
Repairs of mains and services	86 8 6
Repairs and maintenance of meters, etc.	27 18 8
Cost of carbons, trimming, etc., public lamps	774 12 2
Repairs and maintenance ditto	127 16 11
Rents payable	23 8 9
Salaries, etc.	1,580 13 7
Total expenditure	7,834 17 3
Amount carried to net revenue account	13,532 17 4
Total	£21,367 14 7

Cr. Income.	£ s. d.
Sale of electricity per meter, less discounts	15,061 0 6
Public lighting, less discounts	6,075 5 9
Rentals of meters, etc., less discounts	227 5 0
Rentals of "free-wired" installations, less discounts, £523. 0s. 3d.; less amount payable to National Wiring Company, Limited, £523. 0s. 3d.	—
Receipts from sale of lamps, less expenditure	2 11 4
Miscellaneous receipts	1 12 0
	£21,367 14 7

GENERAL BALANCE-SHEET.

Dr. Liabilities.	£ s. d.
Capital account	233,100 0 0
Sundry creditors	5,969 5 1
Consumers' deposit account	10 10 0
Reserve fund account	2,253 18 0
Redemption of debt	2,616 15 11
	£243,950 9 0

Cr. Assets.	£ s. d.
Capital account	227,065 14 10
Stores on hand	452 11 11
Sundry debtors	7,204 3 3
Cash with treasurer and engineer	9,227 19 0
	£243,950 9 0

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T. units		1,943,983
Quantity sold: Public lamps	539,006	1,614,968
Quantity sold: Private consumers	1,075,962	
Quantity used on works		329.015
Number of 8-c.p. lamps connected		68,897
Total maximum supply demanded (kilowatts)		1,161

LANCASTER ELECTRICITY ACCOUNTS.

From the accounts of the Lancaster electricity department for the year ended March 25, 1903, it appears that the total expenditure on capital account to that date amounts to £55,195. Abstracts of the revenue account, balance-sheet, and statement of electricity generated, sold, etc., are given herewith.

REVENUE ACCOUNT.

Dr. Generation of Electricity.		£ s. d.
Coal or other fuel	£970 12 2	
Steam generated at refuse destructor	500 0 0*	
Oil, waste, water, and stores	238 18 6	
Wages at generating stations	619 18 3	
Repairs and maintenance	99 10 0	
		2,428 18 11
Distribution of Electricity.		
Maintenance of mains	176 6 6	
Maintenance of meters	130 16 10	
Labour, fittings, and lamps sold	244 16 6	
		551 19 10
Rent, rates, and taxes		351 11 3
Management Expenses.		
Salaries—engineers' department	279 10 8	
Salaries—clerk and surveyor's department	135 12 6	
Printing, stationery, etc.	33 12 4	
Stamp duties, postages, etc.	78 19 6	
Auditors' fees	6 6 0	
		534 1 0
Special charges—insurances		17 14 5
Allowances and bad debts		20 2 11
Balance to net revenue account		3,116 14 5
		£7,150 1 2

Cr.	£ s. d.
Sales of current and meter rents	6,324 3 7
Public lighting	584 0 0
Sales of lamps and other apparatus	241 9 10
Cost of summonses (repaid)	7 9
	£7,150 1 2

* As estimated between committees before actual output was known.—ED. *E. E.*

BALANCE-SHEET.

Dr. Liabilities.	£ s. d.
Mortgages	18,950 0 0
Corporation 3 per cent. stock	24,680 2 4
Reserve fund account	3,484 9 7
Amount set aside for redemption of stock	2,464 11 10
Floating liabilities	9,882 16 1
Balance	1,147 9 7
	£60,609 9 5

Cr. Assets.	£ s. d.
Capital expenditure on works	54,875 13 4
Changing-over account	166 9 8
Debt redemption account	2,464 11 10

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Floating assets	2,860	7	0
Stores, etc., on hand	121	10	11
Cash in hand	120	16	8
	£60,609	9	5

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T.U.			431,650
Quantity sold — Private consumers by meter	318,736		
Quantity sold — Tramways Committee	12,616		
Quantity sold — Public lamps	52,674		398,960
Quantity used on works			12,616
Total quantity accounted for			411,576
Quantity not accounted for			20,074
Maximum supply demanded (kilowatts)			660

Number of public lamps, 30.

APPOINTMENTS VACANT.

Engineer-in-Charge, Electricity Department, Borough of Bermondsey, £104 per annum, July 31. Advertisement in last issue.

Assistant Superintendent, Indian Telegraph Department, Rs.4,200 a year. Apply, Secretary, Judicial and Public Department, India Office, Whitehall, London, S.W., Aug. 1. Advertisement in last issue.

Two Skilled Cable Jointers, Durban Municipality, 15s. a day. Applications, by letter, to be sent to Z.X.Y.Z., care of Deacon's Advertising Offices, Leadenhall-street, London, E.C., by July 27.

Chief Assistant Electrical Engineer, Hoylake and West Kirby Urban District Council, £126 per annum, July 28. See advertisement.

Electric Wiring Clerk of Works, Parish of St. Pancras, £3 per week. See advertisement.

Estimating Engineer for large electrical works in the Midlands. See advertisement.

Electrician (working) for collieries near Durham. See advertisement.

Representative.—Firm of manufacturers require energetic representative for developing sale of new type of transformers. See advertisement.

Switchboard Attendant, Corporation of Swindon, 27s. 6d. per week, Aug. 3. See advertisement.

LEGAL INTELLIGENCE.

THE READING OF METERS.

At the Brompton County Court, on Monday, the Brompton and Kensington Electric Supply Company applied for an injunction to enable them, by their inspectors, to enter the premises of Mrs. Shadforth, 143, Gloucester-road, Kensington, W., for the purpose of reading the company's meter.

Plaintiff's solicitor explained that the Electric Lighting Acts provided that any officer appointed by the undertakers might, at all reasonable times, enter any premises to which electricity was, or had been, supplied by the undertakers, in order to inspect the meter, etc. There was a contract dated Nov. 4, 1901, between the plaintiff company and Mrs. Shadforth for the supply of electricity to her house—she being the lessee—but on various occasions when the inspectors called to read the meters, they were refused admission because they had not made an appointment.

One of the company's inspectors bore out solicitor's statement regarding the refusal on various occasions to allow witness to read the meter at defendant's house.

Counsel for the defendant explained that Mrs. Shadforth was away from London, and had absolutely nothing to do with the matter.

His Honour said that before he could grant the injunction he would have to be satisfied that the lady had acted, under the circumstances, unreasonably. He came to the conclusion that she had done nothing to justify the granting of the injunction. There would be judgment for the defendants, with costs.

WEST RIDING TRAMWAYS.

The Court of Appeal, consisting of the Master of the Rolls and Lord Justice Cozens Hardy, on Saturday heard the case of Dixon *v.* the Ito Syndicate, Limited, on the defendants' appeal from an order of Mr. Justice Walton in Chambers.

Mr. Rufus Isaacs, K.C., for the appellants, said the plaintiff, Mr. Dixon, claimed £7,401 under an engineer's certificate for work done under a contract, and damages for wrongful determination of an agreement by the defendants, who had purchased from the West Riding Tramways and Electricity Company certain rights to construct tramways, etc. The Master, as a condition to defend the claim, ordered the defendants to bring the £7,401 into court. The Judge in Chambers varied that order by directing that £6,660 should be brought in, and gave leave to defend the action as to the balance and as to the claim for damages. The present appeal was for unconditional leave to defend.

At the close of the arguments, the **Master of the Rolls** gave judgment. He said the case must go for trial in the ordinary way, the defendant having unconditional leave to defend.

RECORDING TELEGRAPH.

On Monday, in the Chancery Division, Mr. Justice Buckley heard the case of Prankerd *v.* Lee, which was an action brought by Mr. Archibald Arthur Prankerd, a retired barrister, against Mr. Sydney Lee for the return of £500 which plaintiff invested in the Recording Telegraph Corporation, Limited, on the ground, as plaintiff alleged, that it was obtained from him by fraud and misrepresentation of the defendant, the promoter. After a consultation between counsel, Mr. Terrell announced that his lordship would be saved any further trouble. They had agreed that the action should be dismissed, the defendant to pay back the £500 and take back from the plaintiff the securities he had given him. The action was dismissed by consent with costs.

"TUBE" CONSTRUCTION.

On Wednesday, in the Chancery Division, Mr. Justice Kekewich gave judgment in the action of Ash *v.* the Great Northern, Piccadilly, and Brompton Railway Company, brought by Mr. William Ash and Colonel Du Vernet for an injunction and damages, they complaining that the defendants, by their contractors, workmen, servants, and agents, in the course of the construction of their tunnel at the Sloane-street Station site conducted their operations with excessive noise so as to cause a nuisance and interfere with the comfort of the tenancy of the plaintiffs' residences. The defendants pleaded their statutory powers, and asserted that the work was done with caution and judgment, and without negligence.

Mr. Justice Kekewich held that the defendants had acted reasonably and in the exercise of their statutory powers from Nov. 18, 1902, when their Act received the Royal assent, and he gave judgment in their favour, without costs. He awarded Mr. Ash £20 in respect of damage prior to 1902.

COMPANIES' MEETINGS AND REPORTS.

EASTERN TELEGRAPH.

The directors, in their report for the six months ending March 31 last, state that the revenue for the period amounted to £626,750, from which are deducted £162,847 for the ordinary expenses and £27,472 for expenditure relating to repairs and renewals of cables, etc., during the half-year. After providing £7,206 for depreciation of spare cable, £110 for sundry differences in exchange, and £11,365 for income tax, there remains a balance of £417,748, to which is added £22,383 brought from the preceding half-year, making a total available balance of £440,131. From this balance there has been paid interest on mortgage debenture stock, dividends on preference stock, and an interim dividend of 1½ per cent. on the ordinary stock, leaving a balance of £320,031, out of which the directors have placed £5,000 to the reserve fund for maintenance ships and £180 to the general reserve fund. The directors now recommend the declaration of a final dividend on the ordinary stock for the year ended March 31, 1903, of 1½ per cent. and a bonus of 2 per cent., amounting together to £130,000, both payable on the 30th inst., free of income tax, and making, with the three previous payments on account, a total distribution of 7 per cent. for the year. The balance of £5,031 is proposed to be carried forward.

DIRECT UNITED STATES CABLE.

The report of the directors for the six months ended June 30 last states that the half-year's revenue, after deducting payments, amounted to £48,886, as compared with £46,610 for the corresponding period of 1902, showing an increase of £2,276. Working and other expenses for the same period, including income tax, amounted to £21,724, leaving a net profit of £27,162, making, with £4,779 brought forward from the previous half-year, a total of £31,942. For the corresponding period of 1902 the working expenses and other payments amounted to £21,515. Three quarterly interim dividends of 3s. each per share, amounting to £27,319, have been declared and paid during the year, and a final dividend of 3s. per share is now proposed, together with a bonus of 1s. per share, making, with the three interim dividends, 3¼ per cent. for the year, being a total distribution of £39,461. After transferring £8,000 to reserve fund, there remains a balance of £2 693 to be carried forward. The reserve fund account has been debited with £22,931 for cost of cable repairs, and after being credited with interest on investments, profit on sale of securities, and amount transferred from revenue, the balance now amounts to £474,664, taking the investments at cost price.

EDMUNDSONS' ELECTRICITY.

The report of the directors for the year ended March 31 last states that, including the sum of £6,179 brought forward from last year, the net profit, after payment of debenture interest, amounts to £53,048. After deducting dividends on preference shares paid and accrued, amounting to £9,540, and an interim dividend at the rate of 5 per cent. per annum on the ordinary shares, there remains a balance of £37,257. The directors recommend a final dividend on the ordinary shares at the rate of 9 per cent. per annum, making 7 per cent. for the year, to be written off goodwill account £5,000, and added to reserve fund £9,274, leaving to be carried forward £11,733. During the year 20,000 preference shares and £40,000 debenture stock have been issued. The premiums received in respect of these issues, less expenses, amount to £16,725, and have been added to the reserve fund, which, with the contribution proposed to be made from revenue account, will be increased to £40,000. The 4,500 deferred shares have

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been converted into ordinary shares, in accordance with the articles of association.

DUBLIN UNITED TRAMWAYS.

The report of the directors for the half-year ended June 30 last states that the amount available for division is £36,882. 16s. 8d., out of which dividends for the half-year are recommended at the rate of 6 per cent. per annum on the preference shares and at the rate of 5 per cent. per annum (free of income tax) on the ordinary shares, and a sum of £2,000 has been set aside to reserve fund. These dividends, with the sum set aside, will absorb £34,025, leaving £2,857. 16s. 8d. to be carried forward. The amount charged against revenue of the half-year for rates and taxes again shows an increase of £2,125 as compared with the corresponding period of 1902.

AUCKLAND ELECTRIC TRAMWAYS.

At the ordinary general meeting of this Company **Mr. C. Shirreff Hilton** (the chairman) intimated that work on the electric lines, which was commenced in August 1901, was now almost finished. There remained still unfinished the overhead work for about two miles in the Onehunga district. Since May 23 about 14¾ route miles had been in operation, and from the latest figures there was every reason to congratulate the shareholders on the result of electric traction to date. Since the opening of the lines the traffic receipts had certainly been up to expectations, and every mail that came in gave reason to have confidence in the future.

The report was adopted.

CHILI TELEPHONE.

The general meeting of the shareholders in this Company was held on the 16th inst. at Winchester House, E.C., Mr. George Keith presiding.

The **Chairman**, in moving the adoption of the report (which appeared in our issue of the 10th inst.), said that the Company had made steady progress. The gross revenue had increased, and the higher rate of exchange had also contributed to the profits. The business was very satisfactory, and the payment of a 6 per cent. dividend realised the expectations of the Company at its start. The financial position of Chili had improved and business prospects generally were better. The Chilian people appreciated telephone communication, and business had extended. The service had been well maintained, and he looked forward to continued prosperity for the Company.

The report was adopted.

NEW COMPANIES REGISTERED.

Reliance Electric Company, Limited. — Capital, £1,000. Objects: to carry on the business of electrical and mechanical engineers, electricians, suppliers of electricity for light, heat, power, or otherwise, manufacturers of and dealers in electric, magnetic, telegraphic, telephonic, and other appliances and apparatus, etc.

British Tramways and General Construction Company, Limited.—Capital, £300,000. Objects: to carry on the business of financiers, concessionaires, contractors for public or private works, tramways, electric light, traction and power works, gas and water works, and means of transport, constructors of electric tramways or light railways, wires, cables, dynamos, motors, engines, rolling-stock, and the like, electricians, suppliers of electricity, etc.

Ulster Electric Power Distribution Company, Limited.—Capital, £10,000. Objects: to produce and supply electrical energy and power for public and private lighting.

CONTRACTS FOR ELECTRICAL SUPPLIES.

Lisbon.—The Public Works Department require tenders for the public electric lighting of Macao. Tenders by Oct. 21.

Bath.—The Corporation invite tenders for the supply and erection of a main switchboard. Tenders by 12 noon on 27th inst.

Birkenhead.—The Corporation require tenders for one 350-kw. direct-current high-speed steam dynamo. Tenders by July 28.

Edinburgh.—The Corporation are prepared to receive tenders for the supply of arc-lamp posts. Tenders by Aug. 3. See advertisement.

Brighton.—The Town Council invited tenders for the supply of meters for a period of one year from Sept. 1, 1903. Tenders by Aug. 10. See advertisement.

Besszterczebanya, Neusohl (Austria).—The Municipality require tenders for the construction of an electricity station and plant of about 600 h.p. Tenders by Aug. 1.

London, S.W.—The London County Council invite tenders for switchboards. Particulars may be obtained at the County Hall, Spring-gardens, S.W. Tenders by Aug. 11.

Atherton.—The Urban District Council are prepared to receive tenders for the supply and delivery of electricity meters for an alternating-current supply. Tenders by 28th inst.

Pietermaritzburg.—The Corporation invite tenders for the supply of electric tramcars. Particulars may be obtained from Messrs. Mordey and Dawbarn, 82, Victoria-street, London, S.W. Tenders by July 29.

Colchester.—The Tramways Committee invite tenders for the erection of a tramcar shed, consisting chiefly of iron and steel. Particulars may be obtained upon application at the Surveyor's Office. Tenders by July 28.

Pointe-a-Pitre (Guadeloupe).—The Municipality invite offers for a concession for public and private electric lighting for 15 years. Tenders by Aug. 29. Particulars may be obtained from the Colonial Office, Paris.

Aldershot.—The Urban District Council invite tenders for the supply and erection at the sewage works of two 4in. motor-driven centrifugal pumps, also generator, battery, and automatic starting switches. Tenders by Aug. 4.

Hapton.—Tenders are invited for lighting the township with electricity. Particulars may be obtained from Mr. Edward O'Shaughnessy, clerk to the Hapton Parish Council, 16, Hamilton-terrace, Padiham. Tenders by July 31.

Lisbon.—The Public Works Department require tenders for the construction of 1m. gauge light railways as follows: (1) Limatal, Vianna-Ponte de Barca; (2) Oberer Minho, Braga-Monçao; (3) Braga-Guimaraes. Tenders by Aug. 1.

Atherton.—The Urban District Council invite tenders for the supply and delivery of electricity meters. Particulars may be obtained from Mr. D. Schofield, clerk to the Council, Town Hall. Tenders by July 28. See advertisement.

Rochdale.—The Corporation invite tenders for the supply and delivery of copper tramway rail bonds. Particulars may be obtained from Messrs. Lacey and Sillar, 2, Queen Anne's-gate, Westminster. Tenders by 28th inst. See advertisement.

Blackburn.—The Town Council invite tenders for one complete main switchboard and accessories. Particulars may be obtained from Messrs. Lacey and Sillar, 2, Queen Anne's-gate, Westminster. Tenders by July 27. See advertisement in last issue.

Shanghai.—The French Colony propose to instal motor-propelled tramways. Tenders may be sent by Oct. 31, 1903, to Secrétariat de la Municipalité Française de Shanghai. Particulars may be obtained from l'Office National du Commerce Extérieur, Rue Feydeau, 3, Paris.

Launceston (Tasmania).—The Mayor and Aldermen invite tenders for the supply of 500 or more electric meters. Particulars may be obtained on application to Mr. William Corin, city electrical engineer, Launceston, Tasmania, or to Messrs. John Terry and Co., 7, Great Winchester-street, London, E.C. Tenders by Sept. 28.

Aldershot.—The Urban District Council invite tenders for the supply and erection at the sewage works of two 4in. motor-driven centrifugal pumps; also generator, battery, and automatic starting switches. Particulars may be obtained at the office of the Engineer and Surveyor to the Council. Tenders by Aug. 4. See advertisement.

London, S.W.—The London County Council invite tenders for the supply and delivery of two low-tension feeder switchboards, and for the erection of one of them in each of the Council's sub-stations at Camberwell and New Cross respectively. Particulars may be obtained at the County Hall, Spring gardens, S.W. Tenders by 10 a.m. on Aug. 11.

Wednesbury.—The Corporation invite offers from firms willing to undertake free and hire-purchase electric wiring and motors within the borough. Full particulars may be obtained from Mr. F. J. Warden-Stevens, the consulting engineer to the Corporation, 34, Victoria-street, Westminster. Tenders by July 30. See advertisement.

Bath.—The Corporation invite tenders for the supply and erection of a main switchboard at the new generating station. Particulars may be obtained from Messrs. Kincaid, Waller, Manville, and Dawson, 29, Great George-street, Westminster, or at the City Electrical Engineer's Office, 7, Dorchester-street, Bath. Tenders by 27th inst. See advertisement.

Rochdale.—The Corporation invite tenders for the supply and delivery of 16 double-deck, double-truck cars, 20 double-deck, single-truck cars, and five single-deck combination cars, with all trucks, motors, and accessories. Particulars from Messrs. Lacey and Sillar, 2, Queen Anne's-gate, Westminster, and 78, King-street, Manchester. Tenders by Aug. 10. See advertisement.

Cheadle (Cheshire).—The Urban District Council invite tenders for the supply and delivery of about 350 tons of grooved steel girder tramway rails, eight tons of tie-bars, 13¼ tons of fishplates, and three tons of bolts and nuts; also for 17 sets of points and crossings. Particulars may be obtained from Mr. Charles R. Brady, A.M.I.C.E., 13, Warren-street, Stockport. Tenders by July 27.

Madrid.—The Posts and Telegraphs Department require tenders for the supply of 25 telegraph apparatus of the Hughes system and 25 motors with weight elevators for the same, for the service of the telegraph stations of the State, at the upset price of 2,530 pesetas, or about £73, for each apparatus with its accessories as detailed, and 408 pesetas, or about £12, for each motor with its corresponding elevator.

Cheadle.—The Urban District Council are prepared to receive tenders for the supply of materials and execution of works in the laying of concrete foundations, fixing rails, points and crossings for the tramway permanent way complete, including taking up present macadam and paving setts, but except fixing bonding. Particulars may be obtained on application to Mr. Chas. R. Brady, A.M.I.C.E., 13, Warren-street, Stockport. Tenders by 12 noon on Aug. 17.

Northampton.—The Corporation are prepared to receive tenders for the supply, delivery, and erection of the following in connection with the Corporation electric tramways: (Section No. 1) boilers, steam, exhaust, and water piping, condenser, cooler, water-softening

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plant, mechanical draught, etc.; (2) steam generators, dynamos, battery, and booster, switchboard, travelling crane, station lighting, etc.; (3) overhead trolley equipment; (4) underground feeders, pilot, and telephone wires; (5) cars; (6) permanent way; (7) power station buildings; (8) car-sheds, workshops, offices, etc. Particulars on application to the borough engineer, Mr. Alfred Fidler, A.M.I.C.E., Guildhall, Northampton. Tenders by 12 noon on Aug. 15.

RESULTS OF TENDERS.

Govan.—The Corporation have accepted various tenders for the extension of the electric lighting station building.

Rochdale.—The Town Council have accepted the tender of W. A. Peters and Sons, Townhead, Rochdale, at £18,000, for erecting a permanent tramway shed.

Middlesbrough.—The Corporation have accepted the tender of Callender and Co., London, at £2,733, for carrying out the Grove Hall and Linthorpe electric lighting extensions.

Paisley.—The tenders of the British Schuckert Electric Company, Limited, have been accepted by the Corporation for extension of main switchboard, amounting to £633. 19s., and for 12-kw. negative booster, amounting to £220.

London, N.W.—The St. Pancras Guardians have accepted the tender of Barlow Bros. and Co., 237, Shaftesbury-avenue, W.C., at £1,093. 12s. 8d., for the wiring and fitting of the St. Pancras Infirmary, Dartmouth-park-hill, N., for electric light.

Islington.—The Lighting Committee recommend the acceptance of the following tenders: Brush Electrical Engineering Company, Limited, at £91. 10s., for the supply of 36 meters; Electrical Company, Limited, at £559. 4s., for the supply of 159 meters.

Birkenhead.—The Corporation have accepted the tender of Dobell and Co., Limited, Birkenhead, for the supply of washed slack, delivered at the Corporation electricity stations in Bentinck-street, Craven-street, and New Chester-road respectively, for 12 months.

Hampstead.—The Borough Council have accepted the tender of the St. Helens Cable Company for the supply of high-tension, house service, and rubber cable for 12 months, and that of Henley's Telegraph Works Company for the supply of three-core cable, also for 12 months.

Coventry.—The Electric Light Committee have accepted the following tenders: Aiton and Co., London, pipework, £1,138; Green and Co., Wakefield, economiser, £286; Bennis and Co., Bolton, coal-conveying plant, £1,032; Danks and Co., Oldbury, flue doors and damper doors, £90.

Rochdale.—The Corporation have accepted the following tenders: for the supply and erection of the overhead line equipment of the remainder of the tramway system, J. G. White and Co., Limited, £21,619. 13s. 10d.; points and crossings for special work and for entrance to car-shed, Lorain Steel Company, £2,587; points and crossings for the general track, Hadfield's Steelfoundry, Limited, Sheffield, £5,322.

Bradford.—The Corporation have accepted the following tenders for works required in the erection of a new electricity station at the Sunbridge-road destructor works: J. Moulson and Son, Limited, masons' work £980, joiners' work £175; Plasterers' Works Department, concretor and plasterers' work, £193 13s. 7d.; G. Jackson, plumbers' work, £79; Roberts and Co., Limited, ironfounders' work, £273; T. Nelson and Son, slaters' work, £37. 19s.; J. Lynn, painters' work, £20. 17s. 6d.

Walsall.—The following tenders have been accepted by the Corporation: Messrs. Wm. Griffiths and Co., Limited, for relaying the existing tramway track in Lichfield-street and Lower Bridge-street, and the construction of new loops on The Bridge, and a double track in Park-street, at £5,899. 15s.; Messrs. Robert W. Blackwell and Co., Limited, for supplying a first-class collapsible repair tower wagon, at £75; Messrs Percy U. Fellows and Co., for lighting the car sheds, offices, and yard at the tramway depot, Birchills, at £98. 12s.

Sleaford.—The Urban District Council have received the following tenders for supply and erection of water-tube boiler with piping, and 90-kw. steam generator and switchboard panel:

Boiler and piping.

Stirling Boiler Company, Manchester	£630
B. R. Rowland and Co., Reddish, near Stockport	599
Hornsby and Sons, Limited, Grantham	763
Stirling Boiler Company, Edinburgh	554
Babcock and Wilcox, Limited, London (accepted)	595
Babcock and Wilcox (alternative)	555

Engine and dynamo and switchboard.

Thomas Parker, Limited, Wolverhampton (accepted)	741

Bath.—Colonel Boughey, C.S.I., and Mr. H. Allan Steward, Light Railway Commissioners, have heard an application for an order authorising certain alterations and extensions of the Bath Electric Tramway Company's system. The Chairman said the Commissioners would be prepared to recommend an order, but they were anxious not to do anything to injure the hospital on the line of route. They would require the company to use wooden sleepers, the speed would be limited, and undue ringing of the bell would be guarded against. At Tuesday's meeting of the Town Council it was resolved that the question of the rebuilding of the Midland bridge be referred to a joint committee of the Electric Traction and Street Improvement Committees for further consideration, with instructions to report on the probable cost of improving the bridge and its approaches, and also to report to the Council further information as to the cost of the other improvements on the tramway routes.

BUSINESS NOTES.

TRACTION.

Salford.—The Corporation tramways will shortly be extended in the Ordsal-lane and Monton-green districts.

Rotherham.—The Board of Trade inspector in spected the Tinsley section of the Corporation electric tramways on Tuesday.

Gloucester.—Mr. Geo. Law, of Kidderminster, informs us that his tender has been accepted for the city of Gloucester tramways.

Blackpool.—The electric line on the new promenade from Alexandra-road to the south end of the promenade is now ready for service.

Rochdale.—There is every reason to believe that the electric cars will be running on several important central routes before the end of October.

Birkenhead.—The local bench have imposed a fine of 40s. on the driver of a cart for having obstructed a New Ferry electric car in New Chester-road.

Burton.—Arrangements are being made for the inauguration of the new electric tramways, and the first two of the 20 cars on order have arrived in the town.

Nottinghamshire and Derbyshire Tramways.—In the House of Commons the Nottinghamshire and Derbyshire Tramways Bill has been ordered for third reading.

West London.—It is announced that the London United Tramways Company intend to apply for a further extension of time for the construction of new lines in Uxbridge.

Chester.—The Town Council have received a memorial signed by 722 ratepayers asking the Council to at once proceed with the extension of the trams to Boughton and Tarvin Bridge.

Dewsbury.—On the 28th inst. the Government inspection of the electrical lines within the borough will take place. All the cables have now been laid, and the tramways are ready for working.

Rawtenstall.—It was stated at the last meeting of the Town Council that the construction of the electric tramways will be commenced soon. The scheme is expected to be completed within two years.

Hastings.—The first of the motor omnibuses ordered by the Corporation has been delivered, and will start running on the Fish-market to Grosvenor-gardens route in place of one of the horse-drawn vehicles.

Rowley.—The Birmingham and Midland Tramway Company have deposited plans of the proposed new tramway to be constructed from Old Hill to Blackheath. The matter has been referred to a committee.

Hull.—The work of preparing Hedon-road for the electric tramcar service is being rapidly pushed forward by the Corporation. Before the summer is past the electric cars are expected to be running along the route.

Central London Railway.—The directors have declared a dividend for the past half-year at the rate of 4 per cent. per annum, carrying forward £45,400. A year ago the distribution was at the same rate, with £25,000 carried forward.

Batley.—A communication has been received from the Board of Trade intimating that the inspection of the electric tramways within the borough will take place on Monday, July 27. A successful trial trip was made on Wednesday.

Railway and Tramway Competition.—Owing to the competition of the electric tramways in and around Leeds and Bradford, the Great Northern Railway Company are granting special and revised third-class fares in the districts affected.

Bilston.—The General Purposes Committee have decided not to relieve the British Electric Traction Company from their obligation to construct a tramline to Ettingshall, but if they prefer to construct the line *via* Ward-street they will consent.

Colne.—Good progress continues to be made with the construction of the tramways. A commencement has now been made with the laying of the conduits for the cables, while a number of poles have been received in readiness for the erection of the overhead equipment.

Glasgow.—Colonel Yorke on Tuesday inspected the Yoker-to-Clydebank extension of the tramways and that to the monument at Langside, both of which are already open, also the new line through the Green and along Govan-street connecting Alexandra Park with Paisley-road.

West Ham.—The Borough Council have arranged for the completion of the purchase of the tramway lines in the borough. Arrangements have also been made for the working of the same by the North Metropolitan Tramways Company pending the electrification of the lines by the Corporation.

Litherland.—The District Council have decided to call the attention of the manager of the Liverpool tramways to the delay in the commencement of the construction of the proposed tramway to Linacre. It had been promised that the trams would be running in June, but nothing has been done so far.

Blackburn.—The traffic returns of the Corporation tramways for the week ending July 10 show that the total number of passengers carried was 156,781, and that the receipts amounted to £878. 7s. 10d., as against 152,214 and £860. 11s. 1d. for the corresponding time last year, being an increase of 4,567 passengers and £17. 16s. 9d. receipts.

Paisley.—At a meeting of the Town Council on Tuesday a letter was read from Mr. W. Murphy, in which he stated with regard to the new tramways that he would be placing the orders for rails and

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setts in the course of a few days. As soon as these were delivered, and which would be in as short a time as possible, the works would be commenced.

Leith.—The directors of the Street Tramways Company have negotiated with the Corporation of Leith for the sale of the tramways within the borough of Leith, subject to the approval of the shareholders. A special meeting of the company will be called to approve acceptance of the offer of purchase. The price offered by the Corporation of Leith is £60,000.

Birmingham.—The committee of the House of Commons presided over by Mr. Ashton on Friday concluded the consideration of the Bill by which the City of Birmingham Tramways Company seek power to extend their Yardley tramways to Shirley and Olton. At the conclusion of counsels' speeches the chairman stated that the committee found the preamble proved.

Ravensthorpe.—The removal of the telephone wires and posts from Hudderafield-road has been accomplished, and there appears to be nothing further to impede the traction company from opening their line through the village to Shepley Bridge, except that the sanction of the Board of Trade has not yet been received. Trial cars have been run with satisfactory results.

Poole.—The Poole and District Electric Traction Bill was on Friday before the Select Committee of the House of Commons on Unopposed Bills. Mr. Frere, parliamentary agent, explained that the object of the Bill was to obtain sanction to an extension of time for the purchase of lands in respect of which they already had powers. The Bill passed the committee.

Paris.—A Paris message dated Monday states that a tramway accident occurred at about six o'clock the previous evening in the Bois de Vincennes, near the Porte Jaune. A car coming from Nogent having had to stop, and its light having gone out, it was run into by another car going at full speed, and smashed up. Thirty passengers were more or less seriously injured.

Reading.—On Wednesday afternoon the Mayoress, in the presence of a very large company, opened the new electric tramways system, which has been laid down at a cost of £223,000, and which traverses a distance of 13 miles. Experts consider the service one of the finest in the country. Prior to the opening a large company was entertained to luncheon by the Mayor and Alderman Monck.

Shipley.—The Board of Trade inspection of the electric tramways from Nab Wood End, Shipley, to the Thackley boundary of that township took place on Thursday, and immediately thereafter the line was opened for traffic. The system of ½d. fares will be put into operation on this line, as also on the Baildon Bridge section which is expected to be ready for traffic a fortnight hence.

Electrical Plant.—The British Vice-Consul at Hanover calls attention to the change which is contemplated in the system of electric tramways there. The accumulator storage battery system which has been employed for the last 10 years in most of the streets in the town itself is to be superseded by the overhead wires. Enterprising electric companies may feel inclined to compete for this work.

Yorkshire Schemes.—The Tramways Order Confirmation (No. 2) Bill, which relates to tramways schemes promoted by the Horsforth Urban District Council, the Keighley Corporation, and the Ramsbottom Urban District Council, will shortly come before a committee of the House of Commons. The West Riding County Council have presented a petition in opposition to the Horsforth order.

Hove and Worthing.—The Corporation of Hove and the Urban District Council of Portslade having withdrawn their opposition to the Hove, Worthing, and District Tramways Bill, it is no longer a contested measure. It has consequently been withdrawn from the consideration of the Private Bill Committee and referred to Mr. J. W. Lowther, chairman of the Committee of Ways and Means.

Wakefield.—At the last meeting of the Town Council Alderman Atkinson called attention to the fact that he, along with the deputy-chairman of the General Works Committee and the assistant surveyor, had had interviews with the Corporation officials of Leeds, Bradford, and Dewsbury, with the view of ascertaining the best policy to follow respecting the laying down of single or double lines in narrow streets.

Metropolitan Railway.—A dividend is announced on the ordinary stock of the Metropolitan Railway Company for the past half-year at the rate of 2½ per cent. per annum, carrying forward about £26,000. The dividend on the surplus lands stock is at the rate of 2¾ per cent. per annum. Last year the dividend on the lands stock was the same, while the railway stock received 2¼ per cent., with £20,277 carried forward.

South Lancs.—The South Lancashire Electric Tramways Company are about to lay tramways from Four Lane Ends, near Bolton, where their system at present terminates, through Little Hulton, Walkden, and Swinton, joining the Manchester-Salford system. When this section, about six miles in length, is complete it will be possible to travel from Manchester to Liverpool by electric car, a distance of over 40 miles.

Dundee.—An abstract of the annual accounts of the tramways undertaking shows that the gross receipts for the year amounted to £42,605. 5s. and the working expenses to £28,166. 6s. 5d., leaving a balance of £13,838. 18s. 7d. This, however, is absorbed in interest, sinking fund, depreciation, and the annual payment to the old company, causing a deficit of £486. 13s. 9d. to be carried to debit of suspense account.

Berlin.—The Berlin Overhead and Underground Electric Railway Company have complied with the proposal of the municipal authorities that they should construct an underground extension of the system from the Potsdamer Platz right through the town, from the eastern to the western centre, where it will, for the present, terminate. The only point still to be decided is in regard to a municipal subsidy to the company.

Kirkcaldy.—Following on their decision to lay a double line of rails over their new tramway extension, the Town Council has lost no time in proceeding with the work. Part of the single line and loops laid in Victoria-road have been removed, and notices are being served on proprietors and tenants over the route with a view to obtaining their sanction to the double line, which is most favourably viewed by the general community.

Nottingham.—The Board of Trade have made an inspection of the latest completed section of the Corporation's electric tramways. This most recent extension of the tramways comprises a double line from the Derby-road end of Upper Parliament-street to the top of Market-street, with a single track down Market-street itself. A line has also been completed along Hartley-road, connecting Alfreton-road with the Radford-boulevard.

Newport (Mon.).—Major Druitt on Tuesday went over the Malpas-road section of the Corporation electric tramways and sanctioned it for public traffic. A new thoroughfare, Oakfield-road, is in process of construction, which would give good gradients for descending if, as is expected, Stow-hill is used only for the ascent of trams, thus following the practice found to be safe and useful in other towns where steep gradients have to be negotiated.

St Pancras.—As the County Council are anxious to proceed with the construction of a tramway extension on the electrical conduit system along Tottenham Court-road, they have again asked the consent of the St. Pancras Borough Council as the road authority concerned. The latter have decided to adhere to their resolution only to sanction the scheme as part of the general plan of linking up the tramways of north and south of the Thames *via* Charing Cross and Northumberland-avenue.

Bolton.—The South Lancashire Tramways Company have refused to accept the terms offered for the through running of their cars into Bolton, and the borough engineer has been requested to further negotiate with the company. The Tramways Committee have ordered a motor 'bus from the Stirling Motor Company. A letter has been received from the Secretary of the Board of Trade asking for drawings and descriptions of the type of lifeguards proposed to be fixed on the tramcars.

Light Railways.—The Board of Trade have recently confirmed the following light railway orders: (1) West Manchester Light Railways (Extensions and Amendment) Order, 1903, amending the Manchester Light Railways Order, 1899, and authorising the construction of additional light railways in the parish and urban district of Stretford and county of Lancaster; (2) Callington Light Railway (Extension of Time) Order, 1903, amending the Callington Light Railway Order, 1900.

Manchester.—According to a newspaper report, shortly after noon on Friday an accident occurred to one of the Corporation electric tramcars proceeding in the direction of Ashton, at Beswick. A flash of lightning struck the electric wire, and suddenly dislodged the trolley and smashed all the lamps in the car. The impetus sent the car along for a short distance. No one was injured, and the passengers continued the journey in another car, the trolley of the damaged car not being fit for further use.

Bexley.—At the last meeting of the District Council the engineers reported they had received notification from the town clerk of Woolwich that the formal consent of the London County Council to the widening of Wickham-lane in the borough of Woolwich had been received, and, the sanction of the Board of Trade having been obtained, the committee recommended the Council formally to resolve that the tramway track be constructed in the middle of the road as proposed to be widened.

Drighlington.—The tramway service between Drighlington and Bradford is reported to be a great success. There is a very convenient service of trams, which run about every 20 minutes, and the fares are very reasonable—it is only 3d. the full journey to Bradford, whilst the railway fare is 5d. single and 9d. return. A considerable advantage which working people find who have to work Bradford way is that they can make the full tram journey from Drighlington to Bradford for 1d. if they travel before 8 a.m.

Bournemouth.—On Friday the Bournemouth Corporation Tramways Bill came before the Select Committee on Unopposed Bills, Mr. Jeffreys, deputy chairman of committees, presiding. Sir E. Chandos Leigh, the Speaker's counsel, said there were two Bills before the committee relating to this district—the Bournemouth Corporation Tramways and the Poole and District Electric Traction—but they were virtually one and the same. The Bill passed the committee, and was ordered to be reported to the House.

Newcastle.—A collision occurred one night last week between two electric tramcars at the corner of the North-road and Jesmond-road. While an Osborne-road car was turning into Jesmond-road shortly before eight o'clock, the trolley slipped from the wire and the car stopped at once half way round the turn. A Gosforth car was coming up behind, and before the driver could pull up the car dashed into the rear of the Osborne-road car with considerable violence. Both cars were slightly damaged, but no one was hurt.

Mid-Yorkshire.—The Mid-Yorkshire Tramways Bill, which has already passed through the House of Lords, has come before the Unopposed Committee of the House of Commons, Mr. J. W. Lowther presiding. The object of the Bill is to incorporate the Mid-Yorkshire Tramways Company, and to empower that company to make and maintain tramways and other works, and for other purposes. The preamble having been formally proved, the Bill was passed through the committee stage, and ordered to be reported for third reading.

District Railway.—It is stated on the authority of Mr. J. R^{d} Chapman, chief engineer of the Underground Electric Railways Company, that London will not be able to enjoy the electrified underground line until the end of next year. The work which is taking up

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the time is the building and equipping of the generating station at Lot's-road, Chelsea. The power-house at Neasden, which the Metropolitan Railway Company are building, is likely to be completed by the end of 1903, and will supply sufficient power to run 40 trains on the Inner Circle.

Huddersfield. — The Tramways Committee have accepted a recommendation of the Traffic Sub-Committee to adopt a merit system of graduated awards in the form of increased wages to the employés for good conduct and length of service. The borough treasurer reports that the receipts for the three months ended June 30 amounted to £16,749. 16s. 5d., or 9·81d. per car mile run. The expenditure amounted to £18,485. 13s. 3d., or 10·82d. per mile, thus showing a deficiency of £1,735. 16s. 10d., or 1·01d. per mile. The figures include £2,921. 16s. 3d. allowed for depreciation and £6,665 interest and sinking fund.

South Staffordshire.—The Bill to confirm agreements for leases to the South Staffordshire Tramways Company of certain portions of the Wednesbury and Handsworth tramways, and to confer further powers on the company for the working of tramways by electrical power, came before one of the examiners of private Bills for proof of compliance with the Standing Orders of the House of Commons. There was no opposition at this stage, and on the requisite proof the examiner certified compliance, and reported the Bill in the form in which it has already passed the House of Lords for second reading.

Additional Traffic Returns.—Anglo-Argentine, £1,061 increase; Barcelona Ensanche y Gracia, £219 increase; Barcelona, £323 decrease; Brisbane, £295 decrease (month of June, £9,575, decrease £612); British Columbia Electric (month of March), gross earnings £10,352, net income £2,658; Buenos Ayres and Belgrano Electric, £154 increase (month of April, £12,995, increase £1,123); Calcutta, £436 increase; Cape Town (month of April), receipts £16,003, expenditure £8,313; Isle of Thanet Electric, £27 increase; Mexico Electric (month of June), recepts £46,270; Perth Electric, £62 increase; Port Elizabeth (month of April), receipts £4,292, expenditure £2,281.

Dewsbury and Batley —The Dewsbury, Batley, and Birstall Tramways Bill, which has already passed through the House of Lords, came on Friday before the Unopposed Committee of the House of Commons, Mr. J. W. Lowther presiding. The object of the Bill is to authorise the construction of a new tramway in the urban district of Ravensthorpe, and the electrical equipment and reconstruction of tramways in the boroughs of Dewsbury and Batley, and urban districts of Gomersal, Birkenshaw, Soothill Upper, and Birstall, and for other purposes. Formal proof of the preamble having been given, the Bill was passed through the committee stage, and ordered to be reported for third reading.

North Somerset Light Railway.—On Tuesday Colonel Boughey, C.S.I., and Mr. Henry Allan Steward, Light Railway Commissioners, sat to hear the application for an order authorising the construction of a light railway in North Somerset some seven miles in length, commencing at Midford and continuing to Preston. It is proposed that the line shall be a single one of standard gauge. Mr. Sidney William Yockney, C.E., stated that the estimated cost of the line is £57,000, and a short spur line £3,000. Ultimately decision was reserved to give an opportunity to the Great Western Railway to consider whether they should not endeavour to make some satisfactory arrangement with the promoters.

Lowestoft.—On Thursday afternoon last week Mr. A. B. Trotter inspected the overhead electric equipment of the tramways. Some public interest was manifested as the car approached the swingbridge, which, however, it negotiated capitally. Here aluminium rods are used instead of the customary copper wire, and these are so fixed that when the bridge is turned "off" they disconnect themselves from the runner on each side and again interlock with a spring when the bridge is closed again. The inspector expressed himself satisfied with the way the work has been carried out. Colonel Von Donop visited Lowestoft on Tuesday to inspect the cars and permanent way. The system was formally opened on Wednesday, when the cars commenced running for public traffic on about five and a half miles of line.

Blackwall Tunnel.—At their fortnightly meeting the Poplar Borough Council had under consideration the question of the proposal of the London County Council to run tramways through the Blackwall Tunnel. The General Purposes Committee of the Borough Council reported against the proposal, and recommended that the consent of the Council be withheld. On behalf of the committee it was urged that the tunnel was too narrow to allow of a double line of tramways, and that a single line would result in the traffic being blocked. Mr. Barge, the chairman of the committee, said that a suggestion had been made to abolish the footpaths through the tunnel, lay down a double line of tramways, and convey passengers in the cars free of cost. Eventually the report was referred back for further consideration.

Private Bills.—The following Bills which have already passed the House of Lords came before a House of Commons Committee as unopposed measures, and were ordered to proceed: Mid-Yorkshire Tramways Bill; Dewsbury, Batley, and Birstall Tramways; and Burton-upon-Trent, Leeds, and Huddersfield Tramways. The Lords' amendments to the Metropolitan District Railway (Various Powers) Bill have been agreed to by the Lower House. The Dudley, Stourbridge, and District Tramways Bill and the Poole and District Electric Traction Bill were considered in the House of Commons on Friday, and ordered for third reading. The South Stafford Tramways Bill has been read a second time in the Commons, and the City and South London Railway Bill and the Romford and District Tramways Bill a third time.

Bromley (Kent).—On Friday the Light Railway Commissioners held an enquiry at the Royal Bell Hotel, Bromley, into the application of the British Electric Traction Company for an order empowering them to construct and work light railways in the parish of Bromley going from the Lewisham boundary of the district at Bromley-hill, right through the town, and continuing to Farnborough and Green-street-Green. The total cost of the scheme was estimated at £73,335. Colonel Boughey gave the decision of the Commissioners. He said that no evidence had been called for the important part of the scheme north of Bromley South Station, and under all the circumstances, and having regard to the opposition indicated by the Urban Council and by the residents and others, they would not be prepared to consider the application any further.

Camberwell.—The Borough Council have received a letter from the London County Council intimating that that Council have resolved to exercise the powers conferred by the London County Council (Tramways and Improvements) Act, 1902, in respect of the widening of Denmark-hill, Champion-park, Grove-lane, Dog Kennel-hill, Grove-vale, and Lordship-lane, the Camberwell Council having agreed to make the necessary contribution towards the cost of the Camberwell portion of the scheme. The Borough Council have also received a letter from the secretary to the London General Omnibus Company, Limited, calling attention to the fact that the London County Council or other tramway owners have no power to lay a rail for tramway work unless the uppermost surface of the rail is on a level with the surface of the road (Tramways Act, 1870, Section 25), and suggesting that the Council should take legal opinion as to the liability of the County Council for damages should accidents occur through improper rails.

Southport.—Another discussion of the question of running Sunday trams has taken place in the Town Council. Recently a poll of the ratepayers resulted in a majority of nearly two to one against the running of the cars, but Councillor Travis, chairman of the Tramway Committee, at the last meeting remarked that one-third of the ratepayers voted against Sunday running, one-sixth in favour of it, while the remaining half seemed indifferent as to the result. A resolution stood on the minutes to the effect that on receipt of a demand in writing from the Southport Tramway Company the electrical engineer be instructed to supply current on Sundays for purposes other than running of trams; this proposition found three supporters only. A resolution was carried instructing the electrical engineer to supply current for purposes other than plying carriages for hire upon the tramways in Southport on Sundays. There was a desire evinced by some members of the Council to lay bare the whole of the facts, but to a great extent discussion was stifled with the object, as one councillor said, "of not disclosing their hand." Interesting developments are expected in the law courts.

South London.—The work of reconstructing the short section of the London County Council tramways between Kennington-gate and the beginning of the cable in Brixton-road is practically complete with the exception of the paving, and several experimental trips have been made with the new cars. An interesting arrangement has been made for the transformation at the junction of the two systems. The electric plough has to be raised, and the cable "gripper" is then run under the car and fixed in the manner which is familiar to all who use the present service. On the return journey the reverse operation takes place, the "gripper" being released and the plough replaced in position. The Council's engineer has devised an ingenious system by which at the point of transformation the electric and the cable slots are for a little distance side by side, the former being diverted towards a hatchway in the road through which the plough can be reached. It is expected that the delay in fixing will be very slight. A soon as the line has been inspected by the Board of Trade, the new trams will be run from Westminster at first, and afterwards from the other termini. At the same time the line from Kennington Church past the Oval to Vauxhall is complete, except that there is some paving still to be done, owing to the widenings which have been carried out.

Light Railways in Kent.—A committee of the House of Commons presided over by Mr. Gair Ashton gave its decision on Wednesday last week on the Bills promoted by the Corporation of Rochester and the Chatham and District Light Railways Company for the construction of several lines of electrically-worked tramways. The Bills were originally competing measures, but during their consideration by a Select Committee of the House of Lords an arrangement was come to between the Corporation and the company, and the Bills were allowed to proceed concurrently. The tramways to be constructed by the Corporation are wholly within the boundaries of Rochester. A number of street widenings and improvements are also contemplated, the total cost of the scheme being estimated at £140,557, of which £66,109 is for the construction of the tramways inclusive of the overhead electrical equipment and the distributing cables. The main proposals of the company are the construction of a new tramroad, 3½ miles long, from Chatham to Rainham, and one from Chatham to Maidstone, a distance of about seven miles. The line from Chatham to Maidstone, the estimated cost of which is £63,585, is to be laid chiefly on private land and not on the public highway. By this means it is hoped to secure a faster service than would be possible on the public roads. It is also intended to utilise the line for the purposes of a goods service as well as for the conveyance of passengers. The committee, having heard evidence in favour of, and in opposition to, the two schemes, found the preambles of both Bills proved.

Wellington (N.Z.).—The electric tramway contracts with the Electric Construction Company and Messrs. Marcartney, M'Elroy, and Co. have been duly executed, and Mr. J. H. Woodward (assistant to Messrs. Preece and Cardew) is to act as representative for Mr. Wright, electrical engineer of Wellington, who is now on his way to the colony, whilst Mr. Howard Smith is to inspect the material for the permanent way. We have received from New Zealand the annual report of the city engineer and surveyor of the city of Wellington, Mr. R. S. Rounthwaite, showing the work carried out or in preparation by his department during the year ended March 31 last. In it interesting reference is made to the tramway scheme which is being

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promoted by the municipality. Although this work had not been commenced on the date named, specifications and conditions of contract for the supply of timber for wood paving, stone setts for tramway borders, Portland cement, etc., had been prepared. In connection with the scheme, it will be necessary to carry out some street widenings, especially at curves, and arrangements are being made to this end. With regard to water power for the generation of electricity, the engineer has submitted a report advising that the dry-weather flow of the Hutt and Alratarana rivers is not sufficient to give the necessary volume and head for producing the energy required without the construction of expensive impounding works. At a later date the engineer, together with Messrs. Allo and Barton, visited the higher reaches of the Hutt river. Mr. Allo, who was specially brought out by the Government to give expert opinion upon the possibility of utilising the various rivers of the Colony for generating electrical energy, has already submitted his report upon this scheme, and confirmed in the most emphatic manner the conclusions previously reported by Mr. Wright, the electrical engineer of Wellington, and Mr. Rounthwaite.

Cardiff.—During a discussion at a meeting of the Finance Committee on Monday a question was asked as to whether £9,500 odd profit had been made by the tramways, as one of the officials had stated at the previous Monday's Council meeting that the sum of £8,800 borrowed by the Tramways Committee had been paid back by the Finance Committee, while another official said directly opposite. Mr. Courtis, chairman of the Tramways Committee, explained that the £8,800 was borrowed for the purpose of covering the loan charges and interest on money borrowed for the purpose of constructing certain lines before they took over the old tramway company's service. In 1903 they made an estimate for £9,000 to meet the sinking fund, and when they made up their accounts for 1903 they found that they had sufficient money to repay. Mr. F. J. Beavan said the £9,500 was not really a surplus, and it was an unfortunate thing that the balance-sheet should have been issued until it had been before the Finance Committee. The sinking fund ought to have been allowed to go on to the same date on the traffic receipts. Mr. Courtis provisionally agreed to this, and added that the balance-sheet had only been before a sub-committee, and would yet have to go before the Finance Committee. Mr. Lewis (deputy borough treasurer) said the proportion of loan charges in respect of the three months would be £4,459, to which must be added £2,903. 17s. 3d. interest and £2,310 for management. Mr. Beavan observed that if the sums just mentioned were deducted from the surplus, the profit would be reduced to £2,475. 4s. 10d., which, he held, was the legitimate result of the year's working. Mr. Blow said the balance-sheet issued was only an informal document, whereupon Mr. Courtis said it was an official balance-sheet, but it was yet to go to the financial department. The decision arrived at by the Corporation to construct for electric traction the tramlines from St. Mary-street through Penarth-road to the junction of Clare-road and Corporation-road is to be made the subject of an appeal to the ratepayers.

Walsall.—The Board of Trade have consented to the relaying of the existing tramway track in Lichfield-street and Lower Bridge-street, and the construction of the new loops on the bridge, and a double line in Park-street, and have also approved of the proposed mode of construction. The consideration of the question of altering the track at the Brown Lion Inn has been deferred until the borough surveyor has had an interview with managing director of the South Staffordshire Tramways Company. The Tramways Committee of the Town Council have been considering what arrangements it is necessary should be made for efficiently managing the tramway undertaking by the Corporation as from Jan. 1 next, and the town clerk has obtained from a number of corporations owning and working their tramways on the overhead system information which has been of material assistance to the committee. The total mileage to be worked by the Corporation is 12 miles 3 furlongs 2·07 chains. The committee recommend that the tramway manager receive a salary of £200 a year, rising to £250 by annual increases of £25, and make several other recommendations with regard to the staff. The committee recommend that the upkeep of the generating plant for tramway purposes, both at Woverhampton-street and the transformer sub-stations, and the interest and instalment on the capital expenditure, estimated at £20,000, for providing the tramway electrical plant and sub-stations, and also any further expenditure for supplying current to the tramways, be charged to the Electric Lighting Committee, such committee to undertake at their own cost the charge, control, and upkeep of all such plant; that there be charged to the Tramways Committee the cost of the street equipment—namely, feeders and overhead wires—and that the expenditure be allocated accordingly. In considering the price to be paid for current, the committee estimate that about 500,000 car miles will be run per annum, and that the annual consumption of current, based upon such mileage, will be about 560,000 units. The committee recommend that the Electric Lighting Committee be asked to fix the minimum price of current for tramway purposes at not exceeding 2d. per unit, and informed that, if practicable, it is hoped they will be able to adopt a sliding scale of charges, so that as the consumption increases the price will be reduced.

London County Council.—At the usual weekly meeting of the London County Council on Tuesday there came up for discussion the report of the Highways Committee (given in our last issue) recommending the construction of new tramways of a total length of just on 30 miles, and the doubling and reconstruction of existing tramways of a total length of 3¾ miles, at an estimated cost of £1,580,325, the estimated cost of the necessary street widenings being £722,230—a total of £2,302,555. Mr. Sears, chairman of the Bridges Committee, moved an amendment to drop out of the scheme the proposed tramway through Blackwall Tunnel. On the other hand, Mr. Benn urged the public convenience of the proposed tramways, and the amendment was rejected by a majority of 9 to 5. The whole scheme was then adopted, and it was decided to seek parliamentary powers to carry it out. The recommendations of the Improvements Committee for seeking parliamentary powers for certain street widenings to accommodate the tramway scheme just sanctioned were after discussion adopted. The gross cost of the street improvements is £722,230, towards which the tramways account is to contribute one-third. The local authorities are to be asked to contribute another one-third, so that only one-third will form a charge on the county rate. In reply to questions, Mr. Benn said that, as a result of negotiations with the City Corporation, he hoped the Council would be enabled to carry a tramway over Southwark Bridge. The Improvements Committee brought up a report recommending: (*a*) that tenders be invited by advertisement for the construction of a tramway subway and of a subway for pipes and wires, and for the paving, etc., works between Great Queen-street and Holborn and between Eagle-street and Vernon-place; (*b*) that the operation of the standing order which requires that all tenders in respect of works estimated to cost £500 shall be opened in the Council by the chairman be suspended so far as may be necessary to enable the chairmen of the Highways and Improvements Committees to open during the ensuing recess the tenders referred to in the foregoing recommendation, and to accept on behalf of the Council the lowest satisfactory tender, subject to any action taken in the matter being fully reported to the Council at the first meeting after the recess; (*c*) that the employment of a resident engineer and of a clerk of works be sanctioned in connection with the above-mentioned works at a total cost not exceeding £550.

Bradford.—Mr. C. J. Spencer, the general manager, has issued his annual report on the work of the city tramways for the year ended March last. The principal figures have already been published, but the point has not yet been finally disposed of—viz., what is to be done with the balance. Its exact amount is £19,849. 17s. 4d., equal to 1·187d. per car mile run. Seeing that the total receipts per mile are 10·377d., this would seem at first sight a small margin to have left. But, to begin with, ordinary expenditure absorbs a little over 7d., and interest on loans and sinking fund charges account for more than 2d. Mr. Spencer enters largely into the peculiar local circumstances which have to be encountered in working the tramways in Bradford, and mentions that the proportion of fixed charges to gross receipts is as high as 20 per cent. This, he says, is accounted for by the fact that the Bradford system is about equal in size to systems in cities with double and treble the population. He then goes on to make a comparison with "a neighbouring city," a thinly-disguised reference to Leeds, where with a capital of only 17 per cent. more than Bradford the cars earn 51·4 per cent. more money. The amount of current consumed alone is 23 per cent. higher per mile in Bradford than in Leeds. "The working expenses are necessarily much higher in Bradford than in the average town, owing to its steep gradients and consequent heavy current consumption, and also to the heavy wear and tear of rolling-stock and permanent way." One much-discussed item does not appear in the balance-sheet, and that is depreciation. The department, however, has a reserve fund of £23,000. Items under the head of "maintenance" sufficiently illustrate the extent of the repairs to the system during the past year: cars, tools, etc., £24,956. 7s. 9d.; permanent way, £5,758. 14s. 2d.; and overhead equipment, £1,804. 6s. 1d. The total receipts of the year amounted to £173,534. 5s. 6d., or 10·377d. per mile. The expenditure amounted to £117,495. 16s. 4d., equal to 7·026d. per mile, which leaves a gross trading profit of £55,038. 9s. 2d. From this is deducted £36,188. 11s. 10d., representing interest on loans and sinking fund, leaving the before-mentioned disposal balance of £19,849. 17s. 4d. In some interesting statistics, Mr. Spencer mentions that the passengers carried during the year were 41,000,000, and the car miles run 4,013,191. The average length of the 1d. stage in Bradford is 1 mile 1,156 yards, and the number of miles in the system is 39. A committee of the House of Commons has found the preamble proved of the Corporation Bill, which, amongst other things, authorises further extensions of the tramways system at an estimated cost of £29,397.

New Issues.—This week subscriptions have been invited by the Manchester and Liverpool Electric Express Railway Company for its capital of £2,100,000 in £10 shares. The company was incorporated by an Act of Parliament in August, 1901, empowering the company to construct and work an electrical railway between Manchester and Liverpool on Behr's monorail system. The prospectus states that the Manchester terminus of the railway will be on the west side of Deansgate, within a distance of about 600 yards from the exchange and about 400 yards from the town hall, while the Liverpool terminus will be closely adjoining Church-street, and within a distance of about 700 yards from the exchange and town hall. The length of the railway will be about 34½ miles, and the time occupied in the transit will be 20 minutes, instead of 40 to 45 minutes, the time at present taken by the fastest express train running between Manchester and Liverpool. It is proposed to work this new line at a speed of 110 miles an hour, the trains running every 10 minutes, or, if necessary, more frequently. Mr. S. B. Cottrell, the engineer and general manager of the Liverpool Overhead Electric Railway, estimates that the total annual expenditure for traction, maintenance, and working expenses would amount to £65,554 per annum, equal to a cost per train mile of about 7½d. It is computed that on this basis an average of 7½ third-class passengers carried per train would, therefore, cover all working expenses. An average of 20 passengers per train, or 2,000 per day in each direction would, it is estimated, be sufficient to pay 5 per cent. per annum upon the capital, and every additional 2½ passengers per train will be sufficient to pay about an additional 1 per cent. interest. The company is authorised to pay interest at the rate of 3 per cent. per annum on the amount for the time being paid up on its shares during construction, but the aggregate amount is not to exceed £150,000. Subscriptions were also invited by the Auckland Electric Tramways Company, Limited, for an issue at par of £200,000 5 per

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cent. first mortgage debenture stock, part of a total of £285,100 which the company is authorised to issue. The stock is redeemable at £105 per cent., after 1912, on six months' notice, and a 1 per cent. sinking fund is to be maintained for purposes of redemption. The prospectus states that the company, which has a share capital of £300,000 (£285,100 paid up) was formed in 1899 by the British Electric Traction Company to acquire a tramway undertaking in Auckland City, New Zealand, and to construct certain extensions; 14½ miles are now under electrical operation, and a further two miles will shortly be completed. The capital expenditure is estimated to amount to £535,000, and it is principally to repay the money borrowed that the present issue is made.

LIGHTING AND GENERAL.

Lowestoft.—The minimum charge for power purposes has been fixed at 10s. per quarter.

Gainsborough.—The Urban District Council have decided to take steps to apply for an order to supply the district with electricity.

Hebden Bridge.—The Urban District Council have received sanction to borrow £10,260 for their proposed electricity scheme.

Power Bills.—The Carmarthenshire Electric Power Bill and the Fife Electric Power Bill have been read a third time in the House of Commons.

Kingsteignton.—Edmundsons' Electricity Corporation intimate their intention of applying for a provisional order to supply electricity to this place.

Huddersfield.—The borough electrical engineer reports that the total length of mains laid on July 1 was primary 80,679 yards, secondary 58,031 yards.

Maximum Demand Indicator.—We have pleasure in stating that the Atkinson-Schattner maximum demand indicator has been approved by the Board of Trade.

Newry.—The Guardians have decided to introduce a system of electric bells in the infirmary, and to connect the fever hospital with the house by telephone.

Grimsby.—On Tuesday Mr. W. O. E. Meade-King held an enquiry into the application of the Town Council to borrow £7,000 for the purpose of electric lighting.

Fleetwood.—The School Board are negotiating with the local electric lighting syndicate as to connecting the new Board school with their electric lighting system.

Ham.—Edmundsons' Electricity Corporation have given notice that they intend to apply for an order empowering them to supply electric light and power in the district.

Stourbridge.—After long consideration the Council have determined not to sell their electric lighting provisional order to a company, and will keep it in their own hands.

Ramsgate.—The Town Council have given the light railway company one week in which to come to a decision as to their taking over the Council's electric lighting order.

Hanwell.—This district is proposed to be supplied with electricity by the Southall Electric Supply Company, who have given notice of an application for a provisional order.

An Electric Lighthouse.—It is stated that on the first night of the trial of the new electric arc lighthouse on Heligoland the light was visible at Busum, a distance of 40 km.

Aberaychan.—The South Wales Electrical Power Company have given notice of their intention to lay further cables in the Council's district, from Havodyrnys to Pontypool.

Loughborough.—The Town Council are seeking the sanction of the Local Government Board to appropriate certain land for the purposes of their electrical undertaking.

Wimborne.—The Southern District Electrical Supply Corporation intend to apply for a provisional order authorising them to supply electricity within the area of the urban district.

Rhyl.—Application to the Local Government Board has been authorised for leave to borrow £2,000 as working capital for the electric lighting undertaking of the Urban District Council.

Stratford-on-Avon.—Notices have been received from two companies of their intention to apply to the Board of Trade for provisional orders for supplying electricity within the area of the Council.

Rawmarsh.—The Empire Electric Light and Power Company, Limited, have given notice that they intend to make application for a provisional order to supply electricity within the Council's area.

Wilts.—On account of the high cost of providing an efficient service, the Standing Joint Committee of the County Council have decided not to connect up the county police station by telephone.

Taunton.—It was stated at the last Town Council meeting that the gas company have refused to put gas in certain houses unless the electric light is taken out. The town clerk is looking into the matter.

Blackpool.—Returns from the electricity works for the month ending June, as presented at the last meeting of the Tramways and Electricity Committee, show an increase in the works output of 33,306 units.

Whitehaven.—The terms on which the Corporation will supply electric lighting to the workhouse are that the rate of charge shall be 6d. per unit, the Guardians to pay rent of £100 per annum to merge in the unit charge.

Ashton.—It has been decided to supply electric current to the town hall, police station, and other municipal buildings direct from the electricity works, the old gas-engine plant previously used for this purpose being dispensed with.

Rawtenstall.—A draft agreement has been prepared for the supply of electrical energy to the Corporation by the Lancashire Electrical Power Company. The company have commenced the erection of a generating station at Radcliffe.

Chichester.—The draft agreements, as finally settled, relating to the transfer of the Corporation's provisional order to the Chichester and District Electric Supply Company, Limited, have been approved and adopted by the City Council.

Brandon.—An application from the Empire Electric Light and Power Company, of Romford, for leave to make an installation of the light in the district has been received by the Rural District Council and deferred for further consideration.

Limerick.—An enquiry has been held at the town hall relative to the application of the Corporation for a further loan of £7,000 from the Board of Works to extend the electric installation in the city, for which a sum of £22,000 has been already sanctioned.

Hampstead.—Having regard to the suggestion made by the factory inspector as to the necessity of enlarging some of the street transformer stations, 21 further sub-stations are to be altered (one sub-station having been so treated) at an estimated cost of £1,080.

Kingswinsford.—The Rural District Council are in negotiation with a company for the electric lighting of the district. Mr. Fiddian has been asked to report to the Council with regard to gas and electricity for the pumping stations at Ashwood and Wordsley.

Anglo-American Telegraph Co.—The directors have resolved, after placing the sum of £6,000 to credit of the renewal fund, to declare an interim dividend for the quarter ended June 30 of 15s. per cent. on the ordinary stock, carrying forward a balance of about £1,468.

Port Arthur.—A wireless telegraphy station has been established at Port Arthur at a place known by the name of the Golden Mountain, with the object of organising a regular telegraphic communication between Port Arthur and the Russian warships in the Gulf of Pechili.

Whittlesey.—A letter was read at the last Rural District Council meeting from the Phodyne Electrical Company, Limited, giving notice that it is their intention to apply to the Board of Trade for a provisional order authorising them to supply electricity in the district.

Hammersmith.—Numerous tenders, varying considerably in prices, have been received by the Borough Council for the supply of arc lamps and accessories required in connection with the electric lighting on the new tramway routes and in Glenthorne-road, and have been referred to committee.

Friern Barnet.—The matter of the lighting of the district has been discussed by the Lighting Committee, and the surveyor has been directed to ascertain upon what terms the North Metropolitan Electric Power Supply Company will undertake to supply electric light in the district.

Alloa.—At the last meeting of the Town Council a letter was read from Parliamentary agents of the British Electric Plant Company giving notice that the company propose to apply to Parliament for a provisional order for enabling them to supply electrical energy to Devon Valley district.

Portsmouth Telephones.—There are now some 1,240 lines completed and in working order in connection with the municipal telephone exchange, and Mr. C. M. Gardner, the manager, is to be congratulated on having brought the undertaking to so progressive a stage in so short a time.

Liverpool.—One of the electric mains running under the pathway just outside St. John's fish market fused on Wednesday last week and became ignited. The fire brigade rendered assistance, and in the course of a few minutes the cable was reached and severed, resulting in the fire being speedily extinguished.

Electric Launch.—An electric launch has been put upon Derwentwater, principally for use by visitors. The craft is about 35ft. long, and will accommodate 20 passengers. The engines are of 6½ h.p., driven from storage cells, which are charged by the dynamo used for electric lighting at Lodore Hotel.

Radstock.—The clerk to the District Council has been instructed to obtain the terms proposed to be charged by the Western Distributing Electrical Corporation to consumers, and if such terms should prove satisfactory the Council will support the company in their application for a provisional order for Radstock

Colwyn Bay.—At the last meeting of the Urban District Council it was decided to reduce the price of electricity to consumers of over 10,000 units per annum to 4½d. per unit. Current for motive power on the new promenade works has been offered at 2½d. a unit, with a maximum consumption of 80,000 per annum.

Greenock.—During June 33,265 units were generated for private and public supply, and 61,313 units for traction supply. This is a total increase of 16,478 units when compared with the previous June. The number of consumers was 341—an increase of 69—and the lamps for private supply were equal to 41,155 8-c.p. lamps.

Milngavie.—The Clyde Valley Electrical Power Company are going to apply to the Board of Trade for power to lay mains throughout this district. The sanction of the Town Council has been sought to the company supplying electricity and power within the burgh, and a committee has been appointed to deal with the question.

Kingswear.—The necessary permission having been obtained for lighting this place by electricity, the Urban Electric Supply Company, Limited, Dartmouth, are now pushing on with the mains with all possible dispatch to meet with the wishes of the Parish Council, who are anxious to see the streets electrically lighted as soon as possible.

August Holiday.—Messrs. Willans and Robinson ask us to state that their works and offices will be closed from Saturday, Aug. 1, to

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Monday, Aug. 10, for the usual annual holiday. The British Prometheus Company have arranged their summer holiday at the same time, closing their works from Friday, 31st inst., till Tuesday, Aug. 11.

Newton Abbot.—Notice has been received by the District Council from the Urban Electric Supply Company stating that they intend to apply to Parliament for a provisional order for permission to lay electric cables in Kingsteignton, and asking whether the Council would give their consent. The Council have determined to withhold their consent.

Eastern Telegraph Co.—The accounts of the Eastern Telegraph Company show that, after payment of the interim dividend of £1. 5s. per cent. on the ordinary stock to Dec. 31, a balance sufficient to pay a final dividend of £1. 5s. per cent. and a bonus of £2 per cent. on the ordinary stock, making a total distribution of 7 per cent. for the year.

Tewkesbury.—Notices have been received from the National Provincial Electricity Corporation, Limited, and the Empire Electric Light and Power Company, Limited, of their intention of applying to the Board of Trade for provisional orders for supplying electricity within the Council's area. The matter has been referred to the Electric Light Committee.

Chesterton.—The Potteries Electric Traction Company have been asked on what terms they could supply electric lighting to the village. A committee of the Parish Council has been appointed to procure all the necessary information on the subject of lighting the streets, the probable cost, and the amount of rate necessary for repayment of any loan that may be contracted.

Hampton (Surrey).—The Empire Electric Light and Power Company have informed the District Council of their intention to apply for a provisional order to supply electricity within the Council's area. The Council have already obtained a provisional order authorising them to supply electricity within their district, and are taking active steps to carry the same into effect.

Change of Address.—We are notified that Mr. Frank Broadbent, consulting and inspecting electrical engineer, has removed to 4, Queen-street-place, E.C. Mr. H. D. Wilkinson has removed to the same address. Mr. Arnold G. Hansard, consulting electrical engineer, also has removed to 53, Victoria-street, Westminster, S.W. His telephone number will in future be P.O. Victoria 60.

Barnstaple.—The Town Council have received the sanction of the Local Government Board to borrow £5,400 to extend the electric light outside the central area. This sum, added to the £21,600 for which borrowing powers had previously been obtained, makes the £27,000 which the Council originally applied for to complete the installation of the electric light throughout the borough.

Littleborough.—The Council have sealed an agreement with Littleborough School Board for the supply of electricity. The price to be charged is 8d. per unit for all units consumed, and the agreement provides that six months' notice to terminate may be given on either side. If after a time the Council find they can supply electricity to the School Board at a cheaper rate, they agree to do so.

Hand-Book.—We have received an advance copy of the Great Eastern Railway Company's hand-book, "Holiday in Eastern Counties," issued in convenient pocket size. Prominence has been given to some less-known districts in East Anglia, and the illustrations have been made a special feature. A list of East Anglian golf links, which is given for the first time, lends additional interest to the issue.

Bilston.—A letter was read from the Midland Electric Corporation at the last meeting of the District Council offering to supply energy to the public buildings at a reduced rate of 2d. per unit for seven years, subject to the right of the Council to call upon the company to carry out the public lighting of the streets being waived for five years. The Council decided to waive their right in consideration of the reduction in price.

Shrewsbury.—The Lighting Committee reported that the satisfactory progress of the electric light undertaking is such as to warrant a reduction being made to the consumers in the price charged for the electric light, and they have decided that the initial charge shall henceforward be 6d. per unit instead of 7d. In addition to this, the usual rebate under the maximum demand system will continue to be made as heretofore.

Portsmouth.—In connection with the drainage scheme which the Corporation have just taken up for dealing with the drainage of the low-lying parts of Southsea, it is proposed to utilise electricity for the purposes of pumping. The scheme has been reported upon by Sir Frederick Bramwell, who suggests that continuous current should be taken from a battery of accumulators which are available at the electric lighting station.

Clydebank.—The Town Council last week considered whether they should themselves supply electric light in the burgh, or whether they should hand over their rights to the Clyde Valley Electrical Supply Company, who are erecting works at Yoker. It was ultimately resolved to go in for a combined electricity generating station and dust destructor, and so carry out the terms of the order, at an estimated cost of £35,000.

Farnham.—Reporting with regard to the installation of electric calls at firemen's residences at the last meeting of the Joint Fire Brigade Committee, Superintendent Elliott recommended that calls should be fixed at certain residences. The Inland Waterways Company, Limited, have informed the Rural District Council of their intention to apply to the Board of Trade for a provisional order to supply the district with electricity.

Goole.—The Urban District Council have received notification from the electric lighting company of their intention to make application for a provisional order to supply electricity within the Council's area, but the Council have decided that a small deputation shall wait upon the Board of Trade at an early date to put the Council's case before them, and to urge upon the Board the necessity of a definite extension of time being granted to the Council.

Abercarn.—At the District Council meeting last week a letter was read from the Empire Electric Light Company giving notice of their intention to apply for a provisional order to supply the district with electricity, and the matter was relegated to a special meeting of the Council to be held a fortnight hence. A letter from the South Wales Electric Company, giving notice of their intention to lay cables throughout the district, was likewise referred.

Exeter.—The Electric Lighting Committee report that inasmuch as the electric main will have to be carried into the parish of Heavitree at more than one point for the purpose of supplying power to the tramways, it is desirable that negotiations should be opened with the Heavitree Urban District Council with a view to its being ascertained whether arrangements can be made by which Heavitree may be supplied with current for lighting power purposes from the Exeter works.

Dalkeith.—The Council have received from the Board of Trade a description of the system of supply of electrical energy which has been approved by them for the purposes of the Council's order, subject to the regulations for securing the safety of the public and for ensuring a proper and sufficient supply of energy imposed by that department, together with the Board's formal approval of the connection by the undertakers of certain parts of their electrical circuits with earth.

Watford.—The proposed loan for electric lighting purposes has been increased to £1,550. On the 30th inst. the Town Council will discuss a report by the electrical engineer on the proposed extension of the electrical lighting station. The engineer reports that he proposes to put down transformer chambers at the corner of Hatfield and St. Albans roads, and at the corner of Durban and Whippendell roads. These are of the type described and allowed for in his original report.

London County Council.—At the meeting of the London County Council on Tuesday it was agreed to lend the Fulham Borough Council £37,138 for electric lighting purposes. Notices were received of the intention of the following companies to lay mains in their respective areas, subject to the consent of the Council—namely: Blackheath and Greenwich, Brompton and Kensington, County of London and Brush Provincial Electric Lighting, and Metropolitan Electric Supply Company.

Wellington.—In a report of Mr. R. S. Rounthwaite, city engineer and surveyor of the city of Wellington, in New Zealand, for the year ended March 31 last, some interesting information is given with regard to the street-lighting of the city. It seems that incandescent electric lighting of the streets was considerably extended during that period, and that arc lighting is being adopted, though only to a limited extent. These lamps are of 2,000 nominal candle-power, and appear to have given every satisfaction.

St. James's and Pall Mall Electric Light Co.—The directors have declared the following interim dividend for the half-year ended June 30, 1903: at the rate of 7 per cent. per annum on the preference shares, and at the rate of 10 per cent. per annum on the ordinary shares. The amount of electricity sold by the company for the quarter ended midsummer is returned at 1,460,572 units, estimated to produce £23,734, as against 1,420,683 units, which produced £23,678 for the corresponding period of last year.

Wakefield.—The accounts of the Corporation for the year ended March 31 last show that while the total debt on the city at the year end aggregated £1,119,925, the only revenue-producing undertaking was the electricity works. The total receipts were £6,669. 8s. 11d., and the expenditure was £5,721. 3s. 2d., leaving a balance of £948. 5s. 9d. The output during the past year has exceeded that of any previous year, the sale of current, at prices varying from 1d. to 4½d. per unit, having reached 393,315 units.

Burton.—The electrical engineer has reported to his committee that the second attempt of the Patent Regenerative Furnace Company to cure the smoke from the chimney at the electricity works has proved unsuccessful. This time they improved the smoke very much, but at the same time blocked the draught to the flues, and under these circumstances was, of course, useless. He has further reported that he has connected 2,623 8-c.p. lamps to the mains since March 31, making a total of 17,528 8-c.p. lamps connected.

Pudsey.—The Town Council was recommended by the Destructor and Electricity Committee at their last meeting to adopt a joint scheme for a destructor and electric lighting station at an estimated cost of £11,000, of which amount £7,000 had already been passed for an electric lighting station. It was generally felt that a destructor was needed, but some members complained of the lack of details regarding the extra £4,000 for the destructor. It was decided to apply for the extra loan, and to combine the two schemes.

Hackney.—It is proposed to spend £320 on the installation of 40 small arc lamps in Downham-road, Victoria Park-road, and Cazenove-road. A cable is to be laid to the factory of Messrs. A. T. Muratori and Co. for supply to a 2-h.p. motor. The company have agreed to take a minimum supply of energy of a value not less than £25 per annum for two years, and will probably add another 5-h.p. motor if the one at present installed should prove satisfactory. Mains are proposed to be laid in Northfield-road at a cost of £235 for electric lighting.

Chester.—In connection with the proposal to use electricity for pumping purposes at the sewage extension works, the Town Council have resolved that the Sewering Committee be offered the supply of energy required at the rate of ⅝d. per unit for the first 100,000 units per annum, and of ¼d. per unit for all over the first 100,000 units per annum. The Lighting Committee have been authorised to have the distributing main extended along Hough Green-road for supplying

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energy for public and private lighting at Saltney at an estimated cost of £294.

Dust Destructors.—The Horsfall Destructor Company, Limited, have received from the Sanitary Institute in connection with their health exhibition at Bradford the institute's silver medal (being the highest and only award given for destructors) for one of their patent patent portable refuse destructors exhibited in operation at the exhibition. The firm have recently been successful in obtaining destructor contracts for the Corporations of Leigh (Lancashire), Folkestone, Swansea, Stourbridge, Bridport, Gosport, Bloemfontein, and Durban.

Thornbury.—At the last meeting of the Rural District Council the clerk stated that he had been making preliminary enquiries with regard to the raising of opposition to the proposed application by an electric power company for a provisional order to supply and distribute electricity in the Council's district. He had been strongly advised to recommend the Council to apply to the Board of Trade for a provisional order to supply their own district. The recommendation was agreed to, and it was decided to forward an application to the proper quarter.

Wisbech.—It was decided at the last meeting of the Town Council to apply to the Board of Trade asking them not to revoke the Wisbech electric lighting provisional order obtained in 1901, until Dec. 31, 1904. Communications on the subject of electric lighting within the borough were read from Edmundsons' Electricity Corporation, Limited, Sir Hiram Maxim's Electrical Company Limited, Empire Electric Light and Power Company, Limited, Wisbech and District Electrical Supply Company, all of whom made offers to carry out a scheme for the town.

Highgate Archway.—It has been considered advisable to light Highgate Archway by electricity, in consequence of the danger to the men in lighting and cleaning the present gas lamps. So far as the Islington side is concerned, the question is in abeyance, as at present there is no electric supply as far as the Archway. The Hornsey District Council have decided to light their side of the Archway by electricity. Each of the three lanterns is to be fitted with three incandescent electric lamps, at an annual cost of £18. 13s., or just 13s. more than the cost of the present system of gas lighting.

Mansfield.—Application is to be made to the Local Government Board to borrow £15,000 additional capital for the electric lighting undertaking. The Electric Lighting Committee are prepared to light the public footpath through the Nottingham-road pleasure ground with four 80-c.p. Nernst lamps, including special standards, for the sum of £6 per lamp per annum. The borough electrical engineer and the town clerk have been instructed to report to the next meeting as to the hire-purchase system of motors. It was resolved at the last meeting of the committee that an electrical exhibition be held in the autumn, and a committee was appointed to make the necessary arrangements.

Emsworth.—A long debate took place at the monthly meeting of the District Council in reference to the proposal of the Portsmouth Corporation Telephone Committee to extend their cables to Emsworth. At a previous meeting the Council refused to comply with the request unless furnished with details of the names of subscribers already given in. Now the General Purposes Committee stated that they were satisfied with the particulars supplied, and recommended that the Corporation be permitted to carry out their scheme as far as Emsworth was concerned. This at length was adopted, the poles to be erected to the approval of the surveyor, and the wayleave of 1s. per pole per annum be charged.

Stepney.—The annual report of the electrical department of the Borough Council shows that up to March 31, 1903, £153,291 had been expended on the undertaking, and it is proposed to write off £2,833 of that sum out of the year's profits. There is a gross balance of income over expenditure during the year of £9,400, as compared with £5,210 in the previous year. The total revenue derived from private consumers was £15,126, while the revenue from public lighting was only £2,923, figures which show how popular the system has become with individual consumers, who took over one million units during the 12 months. As to the distribution of the balance, it is proposed to allot £4,438 to the appropriation account for the wiping off of the remainder of the "dead capital" and the formation of a reserve fund.

Penrith.—On a motion favouring certain alterations and improvements at the gasworks coming up for discussion at the last meeting of the Urban District Council, Mr. Seatree said that some time ago, when work was required to be done at the gasworks, it was put off purposely because the work might be modified if electric lighting was decided upon. The latter question had been in abeyance, but could not remain so, as the date for the closing of the order would soon be reached. It had been represented that an electric lighting company might come and take the business if the Council failed to do so, and they should know more as to their position. If they parted with their provisional order it would probably go into the hands of a company of capitalists, who would be prepared to put down money for the purposes of making a profit The matter was deferred.

Beverley.—Apparently the Corporation have no inclination to embark on a scheme for introducing electricity into the borough. Some months ago they obtained an order from the Board of Trade giving them the necessary powers, and initial steps were taken in the way of engaging an expert to prepare plans and estimates. The scheme, however, was practically abandoned. The latest phase of the question is an offer on the part of a private firm to erect the works and run the same for a few years, under certain guaranteed conditions, whereby a responsibility would be thrown upon the Corporation. This did not find favour with the majority of the Council, who have declined to accept the proposals made. As the time allowed by the order obtained from the Board of Trade has nearly lapsed, it remains to be seen if any private company will apply for powers to erect and run the works.

Oban.—The resident engineer has been authorised to convert the gas lamps on Benvoulin-road and on Corriebeg-road as far as Delshangie washing-house into 16-c.p. incandescent electric lamps, and instructed to bring up a report on the cost of converting all the other gas lamps on the line of the mains into incandescent electric lamps or alternatively for the supply of new pillars for incandescent electric lamps, and also to bring up an estimate of the cost of laying a suitable cable for running the lamps in circuits in Breadalbane-street, and to report on the comparative cost of lighting that street by arc and incandescent lamps. The annual rate to be charged against the lighting department for incandescent electric lamps has been fixed at £5. 10s. each for "all night." The resident engineer has submitted a report on the electricity works for the month of June, from which it appears that up to the 30th ult. the equivalent of 3,932 8-c.p. lamps have been applied for, of which 3,178 have been connected.

Derby.—A long report was submitted to the Lighting and Power Committee of the Corporation on Tuesday by Alderman Maxwell, the chairman, and the engineer on the subject of the recent convention of the Incorporated Municipal Electrical Association. In this report these gentlemen speak of the wisdom of the Corporation in becoming members of the association, and sending them as representatives to the convention; and draw attention to the increasing importance of electricity as exemplified at the recent annual meeting. "One thing," the report continues, "above all others for a Corporation to do in managing such an undertaking as ours—which is a new line in our Corporation business—is to place it in charge of the most competent standing committee, the members of which should use all means to keep themselves well informed and up-to-date by studying the principal current electrical papers and otherwise, and we suggest that you should at once become subscribers for the following publications: *Lightning*, *Electrical Engineer*, and *Electrician*."

Bo'ness.—It has been decided to advertise for a consulting engineer to the electric lighting scheme. At their last meeting the Town Council signed the agreement with the National Wiring Company for supplying and fitting up all the necessary plant for electric light and power within the burgh, the provisional order having now been obtained. By the agreement the Town Council finds the capital to equip the works, lay down wires, etc., and pay to the company a premium of 7 per cent. on the cost, while the company pay interest and sinking fund on the Council's loan at 6 per cent. The lease is for 20 years, with breaks at 10, 14, and 17 years. At the end of any of these periods the Council may bring the agreement to a termination, and if the company have made a greater average profit than 3 per cent. per annum during these years the excess has to be paid to the Council, who take over the works without further payment. The maximum prices are to be 5½d. per unit for lighting, 3d. and 2d. for power and heating, and 2½d. for streets and public buildings.

Cardiff.—At a meeting of the Electric Lighting Committee on Tuesday Mr. A. Ellis, borough electrical engineer, presented his report for the month of June last. It set forth that there were now 853 consumers whose premises were connected to the mains, with a total equivalent of 86,390 8-c.p. lamps, against 54,307 in the corresponding period of last year, the total increase being 59 per cent. The total number of units generated at the lighting station during the month was 75,303, and the total supplied from the Roath power station to the Hayes sub-station was 54,640, the combined alternating and direct current units making a total of 129,943. At the same period last year the units equalled 72,484, being an increase of 79 per cent. There was an increased daily output of 77 per cent. The estimated revenue for June was £1,404. 15s. 9d., as compared with £802 7s. 1d. in June, 1902, being an increase of 75 per cent The new electric lamps between Llandaff-road and Clive-road would be in use before the next meeting. The members generally expressed themselves well satisfied with the report.

Hastings.—The borough electrical engineer having called the attention of his committee to the desirability of procuring two additional 20-kw. transformers to be interchangeable with those now in use, and submitted a quotation from the Electric Construction Company, Limited, at £45 each, the quotation has been accepted, and application will be made to the Local Government Board for sanction to the borrowing of the cost (£90). The Electricity Committee have received a report from the borough electrical engineer calling attention to the desirability of providing a spare water feed pump for supplying the boilers at the electric light works, the two existing Worthington pumps which had been installed for a number of years being practically worn out, and submitting an estimate from G. and J. Weir, Limited, of Cathcart, Glasgow, for the supply of one of their standard direct-acting feed pumps, capable of delivering 2,541 gallons per hour at 12 double strokes per minute against a boiler pressure of 185lb. per square inch, for the sum of £88. He estimates the total cost of the pump, including erection and duplicate feed pipe with valves, at £160. Application will be made to the Local Government Board for sanction to the borrowing of this amount.

Walton.—With regard to the clause which the Walton Gas Company desired to get inserted in the Council's electric lighting order, with a view to preventing any deficiency on the working of the undertaking being made good from the rates, the clerk reported at the last meeting of the Council that he had attended before the House of Commons Committee, but had not absolutely obtained the terms which the Council wanted. They did not get the clause postponed for five years, but only for three years. He thought if the committee had taken the Walton application alone on its merits, they would have got a clean Bill, but the Walmesley Council had already agreed to accept the term of three years, which considerably handicapped Walton by being included with them. The Bristol Gas Company also proposed the insertion of the clause at the end of three years, and under these

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circumstances he did not think that Council's position was altogether unsatisfactory. Communications were received from three companies desirous of supplying Walton with electrical energy, and proposing to apply for provisional orders. The clerk said the application in question could not be successfully made without the consent of the Council, and it was resolved to withhold such consent.

North-Western Electricity and Power Gas Bill.—A Select Committee of the House of Commons, Sir F. Godson in the chair, had this Bill under consideration this week. Mr. Balfour Browne, K.C., described the Bill as promoted with the object of incorporating a company with power to supply electricity and Mond gas within an area of about 2,000 square miles, including Cheshire and portions of Derbyshire, Staffordshire, and Flintshire. Within the area, he said, were works of a very varied character, including collieries, steel and iron works, and salt works and factories of various kinds. Generating stations were proposed at convenient points, and the promoters proposed to supply the power to authorised distributors in the first instance, but not to supply electricity for lighting purposes. The object was to supply power at the cheapest possible rate, and by the use of Mond gas they estimated they could do this four times as cheaply as through production by steam power. Petitions in opposition to the Bill had been presented by local authorities, gas companies, and others within the proposed area. Among these are the Corporations of Hanley, Stockport, Birkenhead, Crewe, Manchester, Stalybridge, Dukinfield, and the Fenton District Council. Mr. Humphreys, engineer, gave evidence in favour of the Bill, and explained the advantages of Mond gas in manufactures.

Cable Rate Reductions.—The full list of changes in the cable rates referred to elsewhere in this issue is as follows: Europe—Bosnia-Herzegovina, from 4d. to 3½d.; Crete, 6½d. to 6d.; Gibraltar, 3½d. to 3d.; Greece, 6½d. to 6d.; Malta, 6d. to 4½d.; Montenegro, 4d. to 3½d.; Portugal, 3½d. to 3d.; Russia, 5½d. to 4½d.; Spain, 3½d. to 3d. Africa—Tangier, from 5d. to 4½d.; Tripoli, 8½d. to 7d. West Coast—Gold Coast—Accra and Sekondi, from 5s. 7d. to 4s. 8d.; other places, 5s. to 4s. 10d. Nigeria—Brass, Bonny, and Lagos, 6s. 3d. to 5s.; other places, 6s. 5d. to 6s. 2d. Sierra Leone—4s. 6d. to 3s. 6d. Asia—British Borneo—Labuan, from 5s. to 3s. 6d.; other places, 5s. 3d. to 3s. 9d.; China and Hong Kong, 5s. 6d. to 4s. 5d.; Corea—Chemulpo, Fusan, and Séoul, *via* Great Northern Company, 6s. 2d. to 4s. 10d.; *via* Eastern Company and Indo-European Company, 7s. 9d. to 5s. 8d.; other places, *via* Great Northern Company, 6s. 6d. to 4s. 10d.; *via* Eastern Company and Indo-European Company, 8s. 1d. to 5s. 11d.; Formosa, 6s. 2d. to 4s. 10d.; Japan, *via* Great Northern Company, 6s. 2d. to 4s. 10d.; *via* Eastern Company and Indo-European Company, 7s. 9d. to 5s. 8d. Philippine Islands—Luzon, 5s. 9d. to 4s. 5d.; other islands, 6s. 2d. to 4s. 10d. The reductions to China, Corea, Formosa, Japan, and the Philippine Islands have already come into force; the others will take effect not later than July 1, 1904.

St. Marylebone.—With a view to obviating any further litigation or arbitration with regard to the purchase of the Metropolitan Electric Supply Company's undertaking by the Borough Council, the price of which has been fixed at £1,212,000, the parties have agreed on a compromise. After the recent action in the High Courts, reported in our issue of the 10th inst., the legal advisers on either side met and suggested an agreement on the following terms: (1) The undertaking to be taken over and money paid on Dec. 31, 1903 (subject to power to apply to court). (2) The capital expended by the company between Jan. 1, 1902, and June 30, 1903, agreed at £67,250, to be paid on Dec. 31, 1903 (subject as above). (3) The amount of £5,000 to which the company are committed to be repaid, if expended, on that date without interest. (4) Profits to be set off against interest on amount awarded until payment of purchase money. (5) Expenditure to be made for future developments as Council approve and to be repaid with interest at 4 per cent. on Dec. 31, 1903 (subject as above). (6) Company to take back motor-generators on July 1, 1906, at £15,000, Borough Council keeping them in good order in the meantime. (7) The Council to repay to the company the cost of severing the St. Marylebone portion of the Norfolk-crescent and St. John's Wood districts, when the Council cease to take their supply for those districts from them. Having considered the above terms, the committee of the Borough Council unanimously recommended the acceptance of the proposed compromise, stipulating that for the requirements of the Council's auditors the Metropolitan Company must be ready to prove that their expenditure down to June 30 has been as stated, and that the company be asked to agree to proceed with the change over from the high-tension to the low-tension system as quickly as the Council's advisers think necessary. This recommendation was fully discussed at the last meeting of the Borough Council, and in the end it was unanimously agreed to accept the compromise.

Scottish Central Electric Power Bill.—An official copy of the agreed clauses and amendments to the Scottish Central Electric Power Bill has been issued. This Bill was opposed by the burghs of Stirling, Falkirk, Alloa, Bo'ness, Grangemouth, Alva, Kilsyth, Denny, and Dunipace, and Stirling Waterworks Commissioners, and the Falkirk and Larbert Water Trustees. The burghs and the water commissioners and trustees have now adjusted clauses, and have received the promoters' undertaking that these clauses will be inserted in the Bill in the first House. Among the protective clauses agreed upon are the following: Should any of the burghs decide at any time to take a supply of electric energy from the company, the company is bound to supply the same to the burgh, taking the supply at the price mentioned in their Bill, and such prices are to include the cost of transforming the energy to such a pressure as the burgh taking the supply may wish. The principal clause for the protection of the burghs is an entirely new clause, and provides that the promoters are not to exercise any of the powers of their Act within the burghs of Stirling, Falkirk, Bo'ness, and Alloa, in order to supply energy which may be used within these burghs without the consent of the local authorities. It is also provided that any extension of the boundaries of these burghs is to be deemed part of the burgh as so extended. It is, moreover, provided that for the purpose of this clause tramways between Bridge of Allan, Stirling, and Bannockburn are to be deemed part of the burgh of Stirling. The company is to have powers to lay their electric mains through the burghs mentioned for the purpose of supplying districts outside those burghs, but subject to certain provisions, as to the Town Councils being empowered to fix the time, the manner, and the position of laying the mains, and also several other provisions as to the protection of property, streets, pipes, etc. It is also provided that should any of of the burghs mentioned apply for an extension of their boundaries, the company is not to have power to oppose the application for extension.

York.—Mr. C. A. Midgley has submitted to the Electric Light Committee his report on the electric light undertaking during the year ended March 31 last—the third year of working. The engineer remarks that the growth of the department has been very remarkable, as the increase in the sales shows. The bulk of the increase, however, is attributable to the increased consumption for power purposes, and the proportionate increase in the revenue, therefore, is not so marked. The demand for power is one which should be fostered, and the great improvement in the cost sheets is chiefly owing to this increased demand in the day time. The total amount of current sold during the year was 652,000 units, being an increase of 229,000 on last year, or 55 per cent. As mentioned above, the most marked feature in the year's working is the sale of current for power purposes. On March 31, 1902, there were 22 motors connected, representing 85 h.p.; the units sold in that year were 63,000 for this purpose. On March 31, 1903, there were 63 motors connected, representing 210 h.p., and the number of units sold in that year was 130,000, being an increase of 106 per cent. In consequence of there being no increase in the public lamps, a feature which is to be deplored, there has been only a small increase in the units sold on the arcs, and in consequence of the reduction in the charges to the Corporation for arc lighting, the revenue from this section has increased very little, being only £219. Some 15 months ago the Streets and Buildings Committee ordered that Fishergate and Fulford were to be lit by some 18 arc lamps, and whilst the cables were being laid the order for arc lighting was countermanded. The cost of this main was approximately £2,000, including new feeder from Walmgate Bar to Fishergate, and the committee are therefore paying in interest and sinking fund for this main some £150 per annum without receiving any income. This fact forms one of the principal reasons for advising that the Fulford pumping station and the new asylum, for which the mains are ample, should be worked from the Corporation supply. The number of consumers has increased from 270 to 386, being an increase of 43 per cent. The maximum load on the station has increased from 410 kw. to 550 kw., being an increase of 35 per cent., the capacity of the plant being 720 kw. To meet the demand the boilers were all working at the same time, and the plant was doing nearly full work. This is a state of affairs which Mr. Midgley trusts the committee will endeavour to alter for the next winter by insisting upon the building contractors completing their contract within the specified time. The capacity of the plant is only 20,000 8-c.p. lamps, and there are some 44,500 8-c.p. lamps connected, and some 2,500 8-c.p. lamps still waiting. The plant in the station has done good work during the past season, and the heavy work has been satisfactorily dealt with by the engineers. The behaviour of the mains has been splendid, as but for one slight stoppage the supply has been continuous. The accounts show that the total capital expenditure on March 31 last amounted to £69,428 The principal items in the balance-sheet are as follows: liabilities—loans, £40,000; sundry creditors (revenue), £613. 4s.; treasurer—owing on capital, £29,428. 1s. 8d.; owing on revenue, £2,386. 13s. 1d.; sinking fund accumulations, £2,401. 12s. 11d.—total, £75,829. 11s. 8d.; assets—expenditure on capital, £69,428. 1s. 8d.; sundry debtors (revenue), £2,477. 18s. 9d.; stores on hand (revenue), £170. 12s. 4d.; sinking fund accumulations, £2,401. 12s. 11d.; deficit balance on reserve fund account, £351. 6s.—total, £74,829. 11s. 8d.

Somerset Electric Power Bill.—This Bill has already received the sanction of the House of Lords. Last week it came before a committee of the House of Commons presided over by Sir F. Godson, K.C., who, after two days' enquiry, found the preamble proved. The area of supply, comprising 381,632 acres, or nearly 600 square miles, includes the whole of Somersetshire, a small portion of Wilts, and a small portion of Gloucestershire, embracing a population of 584,891. The County Councils of Gloucestershire and Wilts, the Corporations of Bath and Well, and the local authorities in the district covered by the scheme did not oppose, and the main issue which the committee had to try was whether or not the city of Bristol ought to be excluded from the operation of the scheme. Counsel stated that the population of Bristol was 339,000, its area was 11,657 acres, and its rateable value was £1,583,000. The principal part of the city was lighted by gas, which was in the hands of a private company; while the electricity, on which a little over half a million had been expended, mainly for the purpose of lighting, was in the hands of the Corporation, who had also begun to supply power. It was believed that an enormous amount of power would be required at the new docks at Avonmouth when completed, and the Somerset District Electric Power Company are anxious to be able to supply power there in the event only of the Corporation being unable to do so. So long as the Corporation were able to do the work themselves, of course the company would not have any power to compete with them. As regarded the industries of Bristol, and, in fact, throughout the whole area of supply, they were extremely numerous and varied, most of them being of a character capable of using power in some form or other. Similar conditions prevailed at Bath, where, as in the case of Bristol, the gas supply was in the hands of a private company and the electricity was in the hands of the Corporation. The

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share capital of the company was £1,000,000, and it was proposed to construct two generating stations—one a little to the south of Bristol, in a most advantageous position, just on the borders of the coalfield; and the other at Radstock, surrounded by collieries. Counsel then proceeded to quote the Cleveland and Durham case, in which Middlesbrough, Darlington, and Stockton were included against their will, and other cases as precedents for including Bristol within the area of supply subject to certain limitations. Dealing with the case of the Bristol Water Company and the question of the supply of water by them to the promoters for condensing purposes, counsel contended that ample protection was given under the general law. In support of the Bill expert evidence was given by Prof. Frederick Capper, electrical engineer, of the firm of Kirkland and Capper, joint engineers for the scheme along with Messrs. Pressland and Fippard; Mr. A. A. Campbell Swinton, and Mr. Jas. Swinburn. On behalf of the Bristol Corporation expert evidence was given by Sir William Preece, consulting engineer, and Mr. Proctor, electrical engineer, to the Corporation. After consultation, the committee found the preamble of the Bill proved. The chairman announced that the committee were of opinion that the Bristol Corporation should be protected against undue interference, undercutting of prices, and anything like undue preference to one customer over another with regard to rates. The company must not come in and charge absurd prices. The committee thought that some official of the Board of Trade should come before them and help them to carry out these views on the clauses.

Wolverhampton.—The annual report of the Lighting Committee to the Council, for the year ended March 31 last, states that on the year's working a working profit was made of £11,697. 11s. 4d. =9·07 per cent. on the capital expenditure. Out of this amount the following charges have to be met: interest, £3,659. 4s. 7d. =2·84 per cent. on capital; sinking fund, £3,956. 4s. 5d. = 3·07 per cent. expenditure; cost of change-over of system, £637. 8s. 4d. = ·49 per cent. averaged during year; loss on sale of old engines, £965. 9s. 10d. = ·75 per cent.—a total of £9,218. 7s. 2d. =7·15 per cent.; balance being net profit for the year, £2,479. 4s. 2d. =1·92 per cent. The committee are of the opinion that this result of the past year's working is satisfactory in all respects, and indicates that the undertaking is in a sound financial condition. Special attention is directed to the manner in which the committee have dealt with the question of the sale of the old engines, and a table is given showing the dates of purchase of the engines, the original cost, the amount written off for sinking fund, the sale price, and the balance to be met out of revenue. It is seen from this that the debt of £2,929 in respect of these engines is absolutely extinguished, and consequently the department will in future be relieved from the payment of £168 annually in respect of interest and sinking fund on this amount of capital. The change-over of the system of supply is now completed, and consequently the revenue of the undertaking will not in future be burdened by further charges in this respect. The change-over of the system of supply and the rewiring of consumers' premises was commenced in October, 1899, and has been gradually proceeding until its completion in March, 1903. The total cost of this work has been £2,500. 8s. 3d., the whole of which has been paid out of the revenue of the undertaking. During the year the output of electrical energy to private consumers for motive power has increased by 160 per cent., and the committee have every reason to believe that this rate of increase will be proportionately maintained. Owing to the fact that during the first four months of the financial year only a portion of the tramway routes were in operation and comparatively few cars running, the total output of electricity for tramway purposes has not been quite so large as was anticipated, but, nevertheless, the additional day load which it has occasioned has proved of considerable benefit to the undertaking. It is confidently anticipated that the output will be considerably larger during the present year, and that proportionately better results will be obtained. A table is given illustrating the continued growth of the undertaking, and although a considerable percentage of the total increase in units sold is in respect of electrical energy supplied to the Tramways Committee, yet it is seen that the percentage increase in units sold to private consumers is also of a satisfactory character. The figures for the past two years are respectively as follows: Number of consumers, 545, 655; percentage increase, 18·2 per cent., 20·2 per cent. Number of lamps connected, 40,953, 54,578; percentage increase, 23·1 per cent., 30·5 per cent. Number of units sold, 746,318, 1,624,639; percentage increase, 17 8 per cent., 117 per cent. The greater proportion of the capital expenditure during the financial year has been in respect of mains, the committee having adopted the policy of extending the distributing mains in all directions where there was any prospect of adequate revenue being obtained, and they are confident that, although the capital expenditure so incurred will not be remunerative for the next two or three years, it will ultimately lead to the securing of considerable additional revenue from a profitable class of consumers.

PROVISIONAL PATENTS, 1903.

JULY 13.

15469. **The self-acting adjusting fork for the trolleys of electric tramcars, or other vehicles or engines to which it may be applicable.** Charles Gandy, 24, Lynnwood-avenue, Newcastle-on-Tyne.

15479. **Improvements in regulating systems of electric distribution.** Philip Middleton Justice, 55, Chancery-lane, London. (The National Battery Company, United States.) (Complete specification.)

15481. **Improvements in electric arc lamps.** Egidio R. Viale, 55, Chancery-lane, London. (Complete specification.)

15489. **Improvements in regulating systems of electric distribution.** Philip Middleton Justice, 55, Chancery-lane, London. (The National Battery Company, United States. (Complete specification.)

15494. **Improvements relating to electric insulating material.** Isaac Shimwell McDougall, 18, Southampton-buildings, Chancery-lane, London.

15495. **Improvements relating to electric insulating fabrics.** Isaac Shimwell McDougall, 18, Southampton-buildings, Chancery-lane, London.

15500. **Improvements in alternating-current contact apparatus.** The Aktiengesellschaft Brown, Boveri, und Co., 46, Lincoln's-inn-fields, London. (Date applied for under Patents Act, 1901, November 13, 1902, being date of application in Switzerland.) (Complete specification.)

15509. **Improvements in armatures for electric induction motors.** William Phillips Thompson, 322, High Holborn, London. (Electricitäts-Gesellschaft Alioth, Switzerland.) (Complete specification.)

JULY 14.

15532. **Improvements in dynamo suspension gear for use in connection with electric lighting systems for railway carriages and the like.** The Electric and Ordnance Accessories Company, Limited, and Robert Frederick Hall, 24, Temple-row, Birmingham. (Complete specification.)

15552. **Improvements in apparatus or devices for transmitting and receiving messages by wireless telegraphy.** Charles Goodwin Burke, 51, Deansgate-arcade, Manchester. (Complete specification.)

15562. **Improvements in telephone exchange systems.** William Aitken, Edge-lane, Liverpool.

15581. **Improvements in means for preventing arcing between commutator brushes.** Edgar Alfred Carolan, 83, Cannon-street, London. (The General Electric Company, United States.)

15592. **Improvements in synchronising alternators.** Edgar Alfred Carolan, 83, Cannon-street, London. (The General Electric Company, United States.)

15595. **Improvements in an electric arc lamp-hanger and cut-out.** Edgar Alfred Carolan, 83, Cannon-street, London. (The General Electric Company, United States.)

15599. **Improvements relating to the production of alternating currents.** Valdemar Poulsen, 45, Southampton-buildings, Chancery-lane, London.

15600. **Improvements relating to voltaic batteries.** James William Gladstone, 45, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents Act, 1901, Dec. 17, 1902, being date of application in United States.) (Complete specification.)

15605. **Improvement in and connected with the wiring of overhead conductors for electric traction systems at terminal stations and the like.** William Herbert Turner and William Herbert Isherwood, 322, High Holborn, London.

15623. **Improvements in means for protecting the exposed or live parts of electric switches, cut-outs, or the like.** William McDevitt, 18, Southampton-buildings, Chancery-lane, London. (Complete specification.)

JULY 15.

15636. **New electric contact breakers for sounding alarms when doors and windows are opened.** David Smith Semple, Calside-avenue, Paisley.

15647. **Improvement in insulated frogs or crossings or the like for overhead trolley wires as used on electric railways.** Henry Brecknell, Edward May Munro, and Hugh Innes Rogers, Thrissell-street, Bristol.

15662. **Improvements in and connected with wireless signalling.** Louis Heathcote Walter, 7, Victoria-street, Southport.

15682. **Improvements relating to electricity meters.** Emil Blumenthal and Siegfried Schlesinger, 45, Southampton-buildings, Chancery-lane, London.

15684. **An improvement in portable electric meters.** Francis Arthur Darton, 142, St. John's-street, Clerkenwell, London.

15700. **Improved process for reducing organic substances in an electrolytic bath.** Oliver Imray, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Farbwerke vormals Meister, Lucius, und Brüning, Germany.)

15687A/02. **A new or improved electric post, being a method of and means for the collection, transmission, and distribution of letters, parcels, and the like.** Roberto Taeggi Piscicelli, 24, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents Rule 9, Aug. 25, 1902.) (Complete specification.)

JULY 16.

15746. **Improvements in electrical arc lamps.** Guest, Keen, and Nettlefolds, Limited, and William Edward Symons, 7, Staple-inn, London.

15772. **Improvements in and relating to the magnetic separation of ore.** William Kennedy-Laurie Dickson, 18, Southampton-buildings, Chancery-lane, London.

JULY 17.

15787. **Improvements in detectors of electrical oscillations.** Louis Heathcote Walter, 7, Victoria-street, Southport.

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15793. A new or improved device for the quick repair of broken trolley wires of electric tramways. Thomas Henry Webb, 96, Buchanan-street, Glasgow.

15796. An improved clockwork or rotary register to be used with or adjusted to any style of electric or gas meters for timing, registering, measuring, etc., electric or gas energy or current. Charles Davis and Charles George Lawless, 165, Barton-road, Stretford, Manchester.

15810. Improvements in electrical fusible cut-outs. Charles Mark Dorman, Reginald Arthur Smith, and Herbert George Baggs, Ordsal Electric Works, Salford. (Complete specification.)

15811. Improvements in dynamo-electric machines for regulating the charge and discharge of storage batteries used in conjunction with train generators. The Lancashire Dynamo and Motor Company, Limited, and Robert Stafford McLeod, 34, Castle-street, Liverpool.

15817. Improvements in and relating to electrically-actuated musical instruments. William Kennedy-Laurie Dickson, 18, Southampton-buildings, Chancery-lane, London.

15821. A magnetic balance or magnetometer and galvanometer. Walter Hibbert, 101, Goldhurst-terrace, South Hampstead, London.

15831. Improvements in apparatus for use in welding railway rail joints by electricity. Henry Frederick Anton Kleinschmidt, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

15838. Improvements in fusible electric cut-outs. Killingworth William Hedges, 8, Quality-court, Chancery-lane, London.

15869. Improvements in elastic fluid turbines. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Charles Gordon Curtis, United States.)

15870. Improvements in and relating to elastic fluid turbines. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Charles Gordon Curtis, United States.)

15871. Improvements in and relating to elastic fluid turbines. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. Charles Gordon Curtis, United States.)

15872. Improvements in elastic fluid turbines. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Charles Gordon Curtis, United States.)

15873. Improvements in rotary compressors, blowers, and pumps. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Charles Gordon Curtis, United States.)

15874. Improvements in elastic fluid turbines. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Charles Gordon Curtis, United States.)

15876. Improvements in elastic fluid turbines. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Charles Gordon Curtis, United States.)

JULY 18.

15911. An improved method of interlocking electric lamps to their couplings. Charles A. Shanks, 12, Lorn-road, Brixton, London.

15940. Improvements in and relating to electric lamps for testing purposes. Frederick Joseph Gordon, 1, Queen Victoria-street, London.

15944. Improvements in elastic fluid turbines. The British-Thomson-Houston Company, Limited, 83, Cannon-street, London. (Charles Gordon Curtis, United States).

COMPLETE SPECIFICATIONS ACCEPTED.

To be published August 6, 1903.

1902.

15811. Arc lighting lamps. Andersson.

15827. Wireless telephony. Blondel.

15777. Telephone instruments. Golby. (Brander.)

16121. Method and apparatus for telegraphing and telephoning on non-insulated submarine lines. Tychonski and Dollinger.

16874. Trolley heads for electric tramways and the like. Small and Kerr. (Thomas.)

16924. Electromagnetic switches for electric railways and the like. Lake. (General Electric Company.)

17952. Electricity meters. North.

18225. Method of winding coils for electrical apparatus. British Thomson-Houston Company, Limited. (Lundskog.)

18229. Operating dynamo-electric machines. British Thomson-Houston Company, Limited. (Jeannin.)

18451. Electric switches, plug sockets, and the like. Baily.

19097. Apparatus for breaking electric arcs. Callender's Cable and Construction Company, Limited, and Hastings.

19227. Surface-contact electric traction systems. Dolter Electric Traction, Limited. (Dolter.)

19924. Trolley-wire holders for electric tramways and railways. Redford.

20074. Electric arc lamps. Wirtz and Hamilton-Adams.

20199. Construction of electric arc lamps. Brockie.

20230. Electric railway signals. Bass and West.

20700. Electrical fire-alarm. Timms.

23358. Thermo-electric batteries. Johnson. (A. Wolf., jun., and Co.)

24122. Arc lamp. Spies and Tutt.

26746. Electric motors. Lamme. (Date applied for under International Convention, Dec. 26, 1901.)

1903.

2067. Electric controllers. Brown.

5183. Electric transmitters for use in telegraphy. Kotyra.

7107. Electric drilling machines. Brebach.

8833. Electrolytic preparation of permanganate of alkaline earth metals and other heavy metals and the obtainment of by-products in the process. Johnson. (Chemische Fabrik Griesheim Electron.)

10546. Contact-boxes for surface-contact electric railway systems. Brown and Wetmore.

11761. Regulating apparatus for electrical circuits. Moy and Bastie.

12093. Electric traction systems. Lake. (Gibbs.)

12458. Electrical rail bonds. Wherry.

12466. Trolley supports or bases for electrically-propelled cars. Milloy.

12563. Coin-actuated electrical apparatus. Rose and Rose, Coop and Rissone, Limited.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.		Last price
Commercial and Industrial.—	£		£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1	..	¼-⅜
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1	..	¼-⅜
British Insulated and Helsby Cables, Ord., 1-100,000	5	..	6¾-7¼
—— 6 per cent. Cum. Pref., 1-100,000	5	..	5¼-5
—— 4½ per cent. Mortgage Debentures	100	..	102-106
British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red.	100	..	104-106
British Westinghouse Elec. and Manuf., 6 per cent. Pref., 275,001-375,000	5	..	5¾-6
—— 4 per cent. Mortgage Debenture Stock	100	..	100-102
Brush Electrical Engineering, Ordinary, Nos. 1-105,731	2	..	¾-1¼
—— Non. Cum., 6 per cent. Pref.	2	..	1¼-1¾
—— 4½ per cent. 1st Debenture Stock	100	..	99-102
—— 4½ per cent. 2nd Debenture Stock	100	..	87-92 xd
Callender's Cable, Debentures	100	..	106-110
—— Ordinary	5	..	11¼-12¼
—— 5 per cent. Pref.	5	..	5¼-5¾
Crompton and Co.	3	..	2-2¼
—— 5 per cent. Debentures	100	..	101-105
Edison and Swan United, "A" Shares, 1-99,261	3	..	¼
—— "A" Shares, 01-017,139	5	..	1¼-2¼
—— 5 per cent. Debentures	100	..	75-80
—— 4 per cent. Deb. Stock, Red.	100	..	71-76
Electric Construction, Limited, Nos. 1 to 112,100	2	..	1⅝-1¾ xd
—— 7 per cent. Cumulative Pref.	2	..	2¼-3
—— 4 per cent. Perp. 1st Mort. Deb.	100	..	99-102
Ferranti Limited, 5 per cent. 1st Mort. Deb. Stock, Red.	100	..	90-95 xd
General Electric Company (1900), 5 per cent. Cum. Pref.	10	..	9½-10
—— 4 per cent. 1st Mort. Deb. Stock	100	..	99-102
W. T. Henley's Telegraph Works, Ordinary	5	..	14-15
—— 4½ per cent. Preference	5	..	5-5¼
—— 4½ per cent. Debentures	100	..	108-112
India Rubber, Gutta Percha, and Telegraph Works	10	..	18¼-19¼
—— 4 per cent. Debentures	100	..	100-103
Parker, Thos., Limited, Ordinary	10	..	14¼-15¼
Telegraph Construction and Maintenance	12	..	32-35 xd
—— 5 per cent. Bonds	100	..	100-103
Electric Lighting and Supply.—			
Blackheath & Greenwich District Ordinary 1,201-101,200	1	..	⅜-½
—— 4½ per cent. Deb. Stk. Certs., Red. and Conv.	100	..	118-121
Bournemouth and Poole, Ordinary	10	..	12¼-13¼
—— 4½ per cent. Cum. Pref., 7,501-15,000	10	..	10-11
—— 6 per cent. Cum. Second Pref., 15,001-22,500	10	..	10¼-11¼
—— 4½ per cent. Debenture Stock, Red.	100	..	102-105
Bromley (Kent) Electric Light and Power Co., 4½ per cent. 1st Debenture Stock, Red.	100	..	102-105
Brompton and Kensington, Ordinary	5	..	10¼-11
—— 7 per cent. Preference	5	..	10¼-10⅜
Calcutta Electric Supply Corp., Ordinary, Nos. 1-40,000	5	..	6¼-7⅛
—— Nos. 20,001-30,000	5	..	7-8
Cambridge Electric Supply Company, Ltd., £10 Ord.	8	..	14⅜
,, ,, ,, £10 Ord.	6	..	10⅜
Central Electric Supply, Ld., 4 per cent. Guar Deb. Stock	100	..	106-109
Charing Cross and Strand, Nos. 1-70,000	5	..	9-9¼
—— 4½ per cent. Cum. Pref.	5	..	5¼-5⅝
—— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000	5	..	4⅝-5
—— 4 per cent. Debenture Stock, Red. (Prov. Certs.)	100	..	104-106
Chelsea Electricity Supply	5	..	6-6¼
—— 4½ per cent. Debentures	100	..	107-110
City of London, Ordinary	10	..	11-11¼
—— 6 per cent. Cumulative Pref.	10	..	13-14
—— 5 per cent. Debenture Stock	100	..	121-126
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100	..	102-105
County of London and Brush Provincial, Ordinary	10	..	8-9
—— 6 per cent. Cum. Pref.	10	..	11¼-12¼
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	100	..	109-112
Edmundsons' Electricity Corporation, Ordinary, 1-50,000	5	..	6¼-7
—— 6 per cent. Cum. Pref.	5	..	6-6¼
—— 4½ per cent. First Mort. Deb.	100	..	106-109
Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-30,000	5	..	4¼-4⅝
—— 5 per cent. Debenture Stock, Red.	100	..	95-98
Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000	5	..	6-6¼
—— 4½ per cent. First Deb. Stock, Red.	100	..	102-105
Hove Electric Lighting, Limited, Ord., 1-13,000	5	..	8-9
Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000	5	..	11-12
—— 4 per cent. Debenture Stock Red	100	..	103-106

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Name.	Amount paid.	Last price.
	£	£
Kensington and Knightsbridge and Notting Hill	100	103-106
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	9⅝-10¼
London Electric, Ordinary	5	2-2½
—— 6 per cent. Pref.	5	5¼-6
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	100-102
Metropolitan, Ordinary	10	17½-18½
—— ½ per cent. First Mortgage Debenture Stock	100	108-112
—— ½ per cent. Mortgage Debenture, Red.	100	97-100
Newcastle-upon-Tyne Electric Supply, Ordinary	5	100-103
—— Preference	4	102-105
Notting Hill Electric Lighting	10	13-14
—— 4 per cent. First Mort. Debs., Nos. 1-500 (Reg.)	100	99-102
Oxford Electric, Ordinary, 1-96 and 407-14,310	5	5-6
—— 4 per cent. Debenture Stock	100	98-101
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100	100-102
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5	3-3½
—— 4 per cent. Debenture Stock	100	88-93
South London, Ordinary	5	3¼-4
St. James's and Pall Mall, Ordinary, 101-20,080	5	15½-16½
—— 7 per cent. Pref.	5	8-9
—— 3½ per cent. Deb.	100	98-101
Urban Electric Supply Co., Ordinary, 8-30,007	5	5-5¼
—— 5 per cent. Cumulative Preference, 50,001-80,000	5	5-5¼
Westminster, Ordinary	5	12-13
—— 5 per cent. Cum. Pref., 110,101-138,251	5	6¼-6½

Electric Railways.—

Central London, Ordinary	100	104-107
—— 4 per cent. Pref.	100	101-104
—— ,, ,, deferred	100	107-110
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100	115-118
City and South London, Consolidated Ordinary	100	65-67
—— 4 per cent. Debenture Stock	100	116-119
—— 5 per cent. Pref. Stock '91	100	130-133
—— ,, ,, ,, '96	100	129-132
—— ,, ,, ,, '01	100	128-131
Liverpool Overhead, 5 per cent. Pref.	—	13-13½
—— Ordinary, 1-50,000	—	7⅛-8
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	—	103-104
Waterloo and City, Ordinary	100	97-100

Electric Tramways.—

Anglo-Argentine, 1-260,007	5	4⅛-4⅝
—— Permanent 6 per cent. Debenture Stock, 1888	100	125-130
Blackpool and Fleetwood Tramroad	10	13½-14½
Brisbane Tramway Invest., Lim., Ord., 1-75,000	5	2⅜-3½
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5	4½-4⅝
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100	100-103
British Columbia Electric Railway Co., Ord., Nos. 1-20,000	100	69-72
—— Non-Cum. 5 per cent. Pref., Nos. 25,001-38,600	100	92-96
—— 4½ per cent. 1st Mt. Debs., Nos. 1-6,250, of £40 each	40	104-106 p.c

Name.	Amount paid.	Last price
	£	£
British Electric Traction, Ord., 1-300,000 & 60,001-90,000	10	11¾-12¼
—— 6 per cent. Cm. Pf., 30,001-60,000	10	11¾-12¼
—— 5 per cent. Perpetual Debenture Stock	100	124-126
Buenos Ayres and Belgrano Tram., Ord., 1-100,000	5	2¼-2⅜
—— "A" 6 per cent. Cm. Pf., 1-40,000	5	5¼-5⅝
—— "B" 6 per cent. Cm. Pf., 1-27,500	5	4¾-5¼
—— 5 per cent. Deb. Stock, Red.	100	105-108
—— Prov. Certs., all paid	100	97-100
Cape Electric Tramways, Nos. 1-480,000	1	2¼-2⅜ xd
City of Birmingham Tramways, 5 per cent. Cum. Pref.	10	5-5¼
—— 4 per cent. 1st Mortgage Deb., 1-3,000 (1917)	100	99-102
Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red.	100	103-105
Cork Electric Tramways and Lighting Co., Ordinary	10	13-14
—— 5 per cent. Cum. Pref.	10	11-12
—— Debentures	100	98-99
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10	13-14
—— 6 per cent. Pref., Nos. within 1-60,000	10	15-16
—— 3½ per cent. Mort. Debs., 1-3,000, Red.	100	94-97
Imperial Tramways, Ordinary	all	23-23½
—— 6 per cent. Cum. Pref.	all	14½-15½
—— 4½ per cent. Deb. Stock	100	112-114
Isle of Thanet Electric Tramways and Lighting, 5 per cent. Cum. Pref., Nos. 30,001-60,000	5	4-4½
—— 4 per cent. Debenture Stock	100	92-95
Kidderminster and District Lighting and Traction, Pref.	5	3¼-4
London United Trys. (1901), 5 per cent. Cum. Pref.	10	11¾-12¼
—— 4 per cent. 1st Mt. Db. Stock, Red.	100	105-107
Metropolitan Electric Trams., Deferred, 1,000,001-1,314,016	1	3/16-5/16
—— 5 per cent. Cum. Pref., 500,001-814,016	1	⅞-1⅛
New General Traction, Ordinary	5	⅞-1⅛
—— 6 per cent. Cum. Pref.	5	2-3
—— 5 per cent. Mortgage Debentures, 1-1,713 (Regd.)	100	88-93
Oldham, Aston, and Hyde Tramway, Ordinary	10	10¼-10¾
—— 5 per cent. Cum. Pref.	10	11¾-12¼
Perth Elec. Tramways (W.A.) 5 per cent. 1 Mort. Deb. Stk.	100	99-102
Potteries Electric Traction, Ordinary, 20,001-40,000	10	9¼-10½
—— 5 per cent. Cum. Pref., 1-20,000	10	9¼-10½
—— 4½ per cent. Debenture Stock	100	102-105
South Lancashire Electric Traction and Power Company—		
—— £250,000 Ordinary	1	1
—— £101,132 6 per cent. Preference	1	1
—— £528,093 4½ per cent. Debenture Stock	100 p.c.	100 p.c.

Telephones.—

National Telephone, Preferred	100	102-104
—— Deferred Stock	100	82-84
—— 6 per cent. Cum. First Pref.	10	13-14
—— 6 per cent. Cum. Second Pref.	10	12¾-13½
—— 5 per cent. Non-Cum. Third Pref.	5	5¼-5⅝
—— 3½ per cent. Deb. Stock, Red.	100	96-98
—— 4 per cent. Deb. Stock, Red.	100	101-103
Oriental Telephone and Electric Company	1	13/16-15/16

TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line	Traffic Returns for week			Increase or decrease.		Miles of single track open.		Accounts for past year.				Receipts per			Cost per car mile.
	Ending	1903.	1902.	Week.	Current year.	1903.	1902.	Ending	Total receipts	Passengers carried.	Car miles run.	Pas-s'nger	Car mile.	Mile of track.	
		£	£	£	£				£			d.	d.	£	d.
Aberdeen Corporation	June 27	1,247	1,295	− 48	+ 4,863	19¼	17¼	May 31	37,931	9,099,715	794,641	0·98	13·02	1,970	6·14
Ayr Corporation	—	—	—	—	—	8	6	Sept. 25	12,503	2,979,276	290,099	1·00	10·34	1,560	4·7
Birmingham Tramways	July 18	5,183	5,010	+ 173	+ 6,633	6¼	6¼	—	—	—	—	—	—	—	—
Blackburn Corporation	June 26	909	1,195	− 286	+ 674	24	24	March 25*g*	40,964	7,234,106	826,558	1·36	11·87	1,705	7·44
Blackpool Corporation	July 9	1,078	996	+ 102	+ 1,254	17½	16½	,, 31	211,168	6,169,121	784,443	1·52	10·8	—	—
Blackpool-Fleetwood Tramways	,, 18	1,125	1,179	− 54	+ 95	16½	16½	Dec. 31	30,923	2,049,677	584,989	3·62	12·68	1,932	6·99
Bolton Corporation	,, 19	1,931	1,615	+ 316	+ 4,142	25	25	March 31	85,704	17,761,605	1,896,247	1·15	10·75	3,430	5·87
Bournemouth Corporation	,, 15	1,105	—	—	—	10½	—	—	—	—	—	—	—	—	—
Bradford Corporation	,, 19	3,954	4,310	− 356	+ 6,293	39	—	—	—	—	—	—	—	—	—
Brighton Corporation	,, 20	982	909	+ 73	+ 5,291	6½	—	,, 31	—	10,432,508	1,031,928	1·00	10·10	—	—
Bristol Tramways Company	,, 17	5,376	5,265	+ 111	—	51½	51½	Dec. 31	223,480	41,192,899	5,724,114	1·30	9·38	4,348	—
Burnley Corporation	,, 18	935	791	+ 144	—	—	—	—	—	—	—	—	—	—	—
Cardiff Corporation	,, 18	2,061	1,623	+ 438	+11,154	—	—	—	—	—	—	—	—	—	—
Carlisle Tramways Company	—	—	—	—	—	—	—	,, 31	—	2,216,583	320,129*h*	—	—	—	—
Central London Railway	,, 18	6,548	6,330	+ 218	− 113*h*	6	—	,, 31	367,225	45,305,110	1,276,971*a*	1·87	66·6*a*	59,076	35·6*a*
City and South London Railway	,, 19	2,490	2,569	− 79	− 758	6⅜	—	,, 31	165,003*a*	19,069,319*a*	—	—	—	—	—
Cork E. T. and L. Company	,, 16	680	801	− 120	− 136	—	—	—	—	—	—	—	—	—	—
Darwen Corporation	,, 10	220	243	− 23	− 113	7·23	—	March 31*g*	12,341	2,360,735	254,279	1·25	11·65	1,707	9·36
Dover Corporation	—	—	—	—	—	3	—	—	—	—	—	—	—	—	—
Dublin & Lucan Electric Railway	,, 19	125	132	—	— *h*	—	—	Dec. 31	5,796	364,796	102,087	3·81	13·62	859	7·68
Dublin U. T., electric cars	,, 17	4,190	4,133	—	} + 330	46	46	March 31	126,121	24,553,133	3,429,356	1·23	8·82	2,741	5·06*h*
Dublin S. District, Electric	,, 17	1,068	1,191	− 67											
Dundee City Tramways	,, 15	834	718	+ 116	—	22	22	May 15	35,874	9,084,522	752,814	0·93	11·276	1,630	—
East Ham Corporation	,, 20	719	526	+ 193	+ 3,431	10·75	7·52	March 31	25,341	9,971,337	650,224	0·61	9·35	2,357	—
Farnworth U.D.C.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Glasgow Corporation	,, 18	96,529	84,354	—	—	124	101	May 3	653,200	177,179,549	14,008,750	—	—	—	—
Halifax Corporation	—	—	—	—	—	30½	27¾	—	—	—	—	—	—	—	—
Huddersfield Corporation	,, 6	1,406	1,045	+ 361	—	34	35	March 31	56,631*h*	9,758,213	1,218,539	1·4	11·14	1,618	6·38
Hull Corporation, E. S.	,, 18	1,874	1,816	+ 57	+ 1,651	19	19	,, 31	87,707*h*	21,065,999	2,218,696	1·00	9·49	5,004	5·07
Ilkeston Corporation	,, 16	207	—	—	—	—	—	—	—	—	—	—	—	—	—
Kirkcaldy Corporation	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Leeds Corporation	,, 18	5,709	5,530	+ 179	+ 5,634	77	—	March 25	252,656	57,239,779	5,773,651	1·11	10·91	3,283	—
Liverpool Corporation	,, 11	10,602	10,407	+ 195	+10,557	101	95	Dec. 31	504,304	108,906,472	11,705,425	1·11	10·34	5,000	6·88
Liverpool Overhead Railway	,, 19	1,742	1,633	+ 109	+ 320	15½	15½	June 30	79,252	10,466,726	986,185*a*	1·82	19·30*a*	5,110	— *a*
Newcastle-on-Tyne Corporation	,, 18	3,283	2,791	—	—	36	36	Dec. 15	127,852	28,411,899	2,767,444	1·08	11·09	3,551	—
Portsmouth Corporation	—	—	—	—	—	29	29	Sept. 30	47,651	9,168,137	868,157	1·24	13·17	1,643	—
Rochdale Corporation	,, 20	157	164	− 7	—	4½	—	March 31	5,416	925,281	127,456	1·38	10·27	—	7·66
Salford Corporation	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Sheffield Corporation	,, 19	4,483	—	—	—	53½	46¼	Mar. 25*g*	216,709	56,812,049	4,926,083	0·904	10·428	7,510	7·03*f*
Southampton Corporation	,, 9	1,122	1,091	+ 31	—	11	11	,, 31	35,874	9,084,522	752,814	0·946	11·436	3,760	—
Sunderland Corporation	,, 20	1,222	1,352	− 130	+ 592	18·48	17·18	,, 31	59,930	13,987,121	1,270,957	1·03	11·3	3,243	6·43
Wallasey U.D.C.	,, 18	852	771	+ 81	+ 1,529	10·5	10·5	,, 31*g*	31,307	5,690,378	654,553	1·32	11·47	2,981	6·97

* Includes maintenance of permanent way and proportion of profits paid to the tramway companies for term of unexpired lease. *a* Train mile.
h Half-year's figures. *e* Include rail and tram. *f* Including one section of horse traction. *g* 1903.

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NOTES.

Electric Tramcar Brakes.—At a recent trial at Havre of the new Westinghouse brakes, a tramcar, weighing complete nine tons, was stopped under 11 yards when travelling at a speed of 20 miles per hour. The rails were dry at the time, but the test shows excellent control over a very heavy vehicle.

Eton College Fire-Alarms.—One result of the recent fire at Eton College is that the Urban District Council is about to equip a complete electric fire-alarm system througout the town. All the houses in each college will be put into electrical communication with the fire station. This is obviously the right thing, and it may prevent an even more disastrous fire than the last one.

Large Incandescent Lamps.—At the Sunderland convention of the Incorporated Municipal Electrical Association, Mr. J. W. Swan held out hopes of great improvements in the efficiency of the carbon-filament lamp, especially in the larger sizes. We now hear that a lamp made in Chicago is said to have an efficiency of 1·9 watts per candle for the 25-c.p. and 55-c.p. sizes. Naturally, the light obtained is an exceedingly white one, but no information has reached us as to the life and average watts per candle-power during that life. From the illustrations it would appear that the lamps have large globes which would tend to keep down the blackening.

Consulting Engineers.—Elsewhere in this issue will be found a notice which will be of great interest to consulting engineers in Westminster. It is that a small town in Scotland is thinking of having electric light, and is prepared to receive tenders from consulting engineers for advising them as to what to do and the best way of doing it. Full particulars of the applicant's career are to be given, but we are afraid that the modesty of some of our best men will prevent them from applying. We cannot congratulate the authorities of the above town on their ideas of the best way to select a professional man.

Depreciation.—The question of depreciation, like the poor, is always with us, and we are not surprised to find that Huddersfield is in the throes of correspondence on the subject. If any critic of a corporation department wishes to find fault with it, he has only to exercise a liberal view of what it should allow for depreciation to draw the conclusion that it is losing money rapidly. Thus, the Corporation tramways at Huddersfield are said to have lost £1,700 in the last quarter. The simple fact is that on the last quarter's working there was a credit balance of £1,200 after all expenses and the interest and sinking fund on the capital had been paid. The fictitious deficit above mentioned is arrived at by assuming that some £2,900 should be written off during the quarter for depreciation.

Sprague Multiple-Unit System.—Mr. Frank J. Sprague has been awarded the Elliot Cresson Medal by the committee on science and art of the Franklin Institute in respect of his multiple-unit system of electric traction. The main features of the system, which represents an important advance in the operation of electric railways, have already been described in these columns. Briefly, the object of the invention is to permit the operation of electric trains made up of any number of units, and to enable the train to be rapidly accelerated and maintain the maximum tractive effort on the wheels. This is accomplished by making each unit a motorcar and attaching a controlling cable to all controllers, so as to enable the various units to be combined in a train and operated by a single controller at each end of the train.

Wireless Telegraphy.—Dr. Blockmann, of Kiel, has been experimenting with lenses made of resin, paraffin, glass, and other materials of high dielectric constants with a view of controlling Hertzian wave propagations to definite directions. He claims to have succeeded fairly well at moderate distances, and, if this is so, there is more chance of wireless telegraphy being of real service at sea during a fog. With such an apparatus a ship could ascertain by wireless telegraphy the direction in which the signalling station lies, which is not the case at present Another item of information concerning wireless telegraphy was elicited in the House of Commons the other night. It was to the effect that all battleships and a large number of cruisers in our navy have now wireless telegraphy equipments. The average expenditure on the system is about £20,000 per annum, a good part of which goes to the Marconi Company. The service is likely to be greatly extended in the future.

Unhappy St. Marylebone.—Yesterday afternoon the Council of the metropolitan borough of St. Marylebone had to consider the report of their Electric Lighting Committee, in which it was stated that the St. Marylebone Electric Supply Company intended to apply to the Board of Trade in December for a provisional order authorising them to supply electricity within the borough. The Council will, of course, adopt their committee's recommendation to oppose the granting of this new proviaional order. We have little doubt that their opposition will be successful, but, on the other hand, the new company will be able to make out an exceedingly strong case in favour of competition. It will not only be able to urge the hackneyed plea of inefficient municipal control, but also that the St. Marylebone Council have grossly over-capitalised their undertaking to the disadvantage of the consumers within the area. In fact, they could make out a stronger case against the Council from a consumer's point of view than was made out when a competing order was issued for the city of London.

Kew Magnetic Observatory.—The Kew authorities have now decided to remove the whole of their magnetic instruments for the absolute determination of the earth's magnetic field to a new site on the farm of Nether Cassock, in the parish of Eskdalemuir, Dumfriesshire. A description of this site, which has been obtained from the Duke of Buccleuch, makes one desire to be one of the Kew officials. In the words of our informant, "it is far from the maddening crowd, situated on a slope, with a view of apparently endless hills." It is far from railways, tramways, ironworks, and even iron ore, and would seem to be an ideal spot for the recording of the vagaries of the earth's magnetic field, the causes of which are yet to be thoroughly explained. Surely it is right that this change in location of the Kew instruments should be made, rather than that, as was once suggested, the whole of the population round Kew should be debarred from having an economical system of electric tramways. We wish Dr. Cree every success in the erection and equipment of this new national observatory.

Electric Cable Truck.—An electric automobile truck for handling telephone cables has been recently put to work in New York by the telephone company. It is designed to serve two purposes. The first is the transportation of the heavy drums of cable which are required for the underground service. After these drums have been hauled to the position in which they are required, the electric motor on the automobile is then used for drawing the cable into the conduits. When doing such work a device is attached to the front of the truck, which device projects down into the manhole and forms a rigid support

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for the pulleys over which the hauling cable runs. The speed of hauling can be varied from 10ft. to 40ft. per minute. The actual weight of the automobile complete is 4¼ tons, the accumulators alone weighing 1¼ tons. The guarantee given with this vehicle is that it should carry a load of five tons for 15 miles on one battery charge, and haul in the cables so transported. The range would be 25 miles if the cable had to be transported only. The vehicle is said to be doing excellent work.

All Space Full of "Juice."—According to the *Electrical World*, advices from Denver, Colo., state that a representative of the Whitney Electric Development Company is there to arrange for transporting a 13in. cannon to the summit of Pike's Peak or some lofty pass in the mountains to prove the theory of Mr. Whitney, of Chicago, that by penetrating the atmosphere surrounding the earth he can secure from the electrical sea above unlimited current for earthly power plants. Mr. Whitney, when he secures and locates his monster gun, will fire a spherical iron magnet vertically. To this projectile will be attached a coil of wire 20 or 30 miles in length. Mr. Whitney believes that, once beyond the pale of the law of gravitation, the magnet will be drawn into the electric sea, the wire will hold it, and by attaching larger wires he can draw from above limitless electric power. It will be a great pity if this theory is not allowed to demonstrate its insanity—or its soundness. It is further stated that a private test of the Whitney electric ladder has been made on a small scale in New Mexico and that it was successful, incandescent lamps being lighted by the electricity brought down from the electrical ether. The object of securing a mountain peak in Colorado for further operations is that the mountain tops there are all attained with comparative ease, and the atmospheric conditions at the altitudes reached are such that men can stay there continuously, if necessary, without any serious effects.

Frictional Trains.—A whole column of one of our esteemed daily papers is given to a remarkable American invention which is to transport, or which might transport, people from London to Glasgow in two hours. The inventor of the system is Prof. Albert C. Albertson, who hails from the University of Copenhagen. The great feature of the system is that the train is to be lifted by a magnetic suspension in such a way that nearly the whole of the weight is removed from the rails. The inventor proposes to use accumulators for giving this magnetic lift, and he must be a happy man to have such faith in accumulators. He also appears to have exceedingly hopeful ideas as to the grading of his high-speed tracks and of the acceleration which he can obtain from a locomotive which has practically no adhesion on the rails. We would suggest to Prof. Albertson that if he were to provide a vacuum in a tunnel or housing for the railway, he could still further increase his speeds by reducing air friction. The most remarkable thing about the notice of the invention is that there are editors of responsible daily papers in this country who will print such utter rubbish. Also, we should at least have expected a professor of the Copenhagen University to know something about eddy-current losses caused by moving magnetic fields.

Official Salaries.—At the recent meeting of the Incorporated Municipal Electrical Association, the president, Mr. J. F. C. Snell, touched on the vexed question of remuneration. He rightly pointed out that a frequent change in staff was by no means conducive to good work. The reason too often for these frequent changes is that a man in a responsible position, in charge of a corporation undertaking, finds that the work he is doing is not appreciated by the corporation; or, we would say, the work is appreciated, but the corporation will not recognise the same by increasing his salary as his responsibilities increase. In consequence, a new position is sought in which a higher remuneration is attached, and the town who refused a moderate increase in salary lose a man who was thoroughly conversant not only with their undertaking, but also with the best way in which it should be developed. The new man who comes in at the old salary or less is likely to make alterations which involve a considerable waste, because he does not rightly understand the views of his predecessor. It is, therefore, clearly to the advantage of corporations to keep men in their employ when they have proved that they are capable organisers and reliable advisers as to new departures. A case in point is that of Leeds, where the tramway manager has been given a considerable increase in order to keep him in charge of the tramway department. As is only to be expected, this increase has caused a great outcry in the town from men incapable of recognising the true facts of the case. We trust that the Corporation will not be moved by this outcry, but will adhere to the money-saving policy they have adopted. It will be noticed that Leeds is more progressive than London in this respect.

Electric Lifts.—The working of lifts by electricity is or is not advisable from a central-station point of view according to the nature of the rest of the load. If the works from which they are to be supplied have a good motor load, there is no doubt that the addition of lifts will offer no great objection from the regulation of voltage point of view. We know of one town, however, which has a supply on the single-phase alternate-current system in which the supply of an electric lift was the cause of endless trouble. The lift was worked very seldom, and the bill for the whole year did not pay the interest charges on the cost of the supply main, etc. When, however, the lift was started through the day the induction drop most seriously affected the pressure on adjacent lamps, as it made a large proportionate increase in the load on the small plant at work. It further became a great question as to whether the Council were obliged to supply the consumer, whose load was such that it involved the running of a large machine all day in order to prevent it from interfering with other consumers. A similar case occurred recently at Poplar over the County Council lifts at the end of Greenwich Tunnel. Here the lifts are exceptionally heavy, and when starting cause considerable fluctuations in the supply pressure. Due to this, the Poplar Borough Council have allowed the work to be taken over by the London Electric Supply Company, who have yet to learn what the effect will be on their system. We notice from the County Council agenda that the Bridges Committee have undertaken to supply motor-generators, switchboards, and high-tension feeders through the tunnel, and to pay from 1½d. to 2d. per unit for the power supplied. The highest charge of 2d. per unit is to be reduced to 1·8d. on condition that the lifts are not worked on Sundays. Thus a most intermittent load has been taken on at factory rates.

Trolley Insulator Specifications.—At the last meeting of the American Institution of Electrical Engineers, Prof. Samuel Sheldon and Mr. John D. Keiley read a paper entitled "Some Recommendations Concerning Electrical and Mechanical Specifications of Trolley Insulators." After a series of tests, the authors recommended the following specifications for such insulators: All samples tested shall break in the eye. The average ultimate tensile strength of all samples subjected to mechanical test shall not be less than A pounds, and no individual sample shall show a tensile strength of less than 85 per cent. of the average tensile strength of all the samples that are tested.

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The average breakdown voltage, for samples which have been broken in the eye in the mechanical test, shall not be less than B volts, and no individual sample shall break down at less than 90 per cent. of B volts. As to the values to be specified for ultimate tensile strength and breakdown voltage, the following are suggested where high-class insulators for use on 500-volt lines are to be specified:

	Ultimate tensile strength in lbs.	Breakdown voltage.
2½in. globes	6,000	7,000
3in. globes	9,000	10,000
Small Brooklyns	9,000	10,000
Large Brooklyns	18,000	10,000

Owing to the comparatively low softening temperature of the insulating materials generally used, and to the close proximity of the working conductor when in service, it is important that specifications for round-top hangers should impose a test for softening temperature, and the following is suggested: Round-top hangers when suspended free from draught in an inverted position by means of a bronze ear weighing 8oz., and being 5½in. long, the ear clamping the middle of a round rod of soft iron ¼in. in diameter, and of at least 20in. length between connectors, must be able, without breaking down or becoming permanently deformed by more than $\frac{1}{16}$in., to sustain a weight of 200lb. from the cap for one hour, a current of 200 amperes being passed continuously through the iron rod, the rod being cold at the start.

Magnetic Manganese Alloys.—At a recent meeting of the German Physical Society, Berlin, Mr. Fr. Hensler made an interesting communication on magnetic manganese alloys. Both pure manganese and copper-manganese are known to be quite non-magnetic, but the author has found certain other alloys of the metal to exhibit strongly magnetic properties. The following metals and metalloids will thus give more or less magnetisable manganese alloys, free from iron:

Tin.	Antimonium.
Aluminium.	Bismuth.
Arsenic.	Boron.

The most interesting results are derived from a thorough investigation into the behaviour of manganese-copper-aluminium alloys. As commercial copper-manganese always includes small quantities of iron, it was first ascertained that even a copper-manganese to which material amounts of iron were added, was not magnetisable. It was next shown that, with equal percentages of manganese, the susceptibility will increase for increasing percentages of aluminium up to a maximum corresponding to equal atomic amounts of both metals. This fact is the more noteworthy as the researches of Wiedemann, Quisicke, Du Bois, and others have shown aqueous manganese salt solutions to possess a magnetic susceptibility somewhat higher than the corresponding ferric salt solutions. There is a striking analogy in both the salts and certain alloys of the non-magnetic manganese metal showing strongly ferro-magnetic properties. This suggests a possible comparison of the manganese-aluminium bronzes with a salt solution where the copper would play the part of solvent; the above combination of equal atomic amounts of manganese and aluminium having to be considered as solved salt. Keeping manganese-aluminium-copper alloys for some time at a temperature of 110deg. C. will reduce them to a state of stable equilibrium, corresponding with a maximum susceptibility. The transition points beyond which these alloys become non-magnetic are relatively low, a gradual rise being, however, noted with increasing amounts of either manganese or aluminium. As adding other metals will strongly lower the position of the transition points, the latter may be varied at will within an interval ranging from 60deg. to 310deg. C.

Electricity for Small Hospitals.—At the recent meeting of the Sanitary Institute Mr. W. Noble Twelvetrees read an interesting paper on the above subject, in which he gave full consideration to the actual cost of supplying hospitals with electrical energy. He comes to the conclusion that in most towns it is more economical for hospitals to have their own plant than to take supply from the public mains. This, we think, is borne out in practice, as the majority of hospitals are so equipped. Owing to the fact that they are obliged to have a certain amount of steam for various purposes, the cost of supervision in electric lighting is not so heavy as it otherwise would be. In a typical example of a small installation in which the first cost for plant was only £675, the author estimates that the average cost per Board of Trade unit for electric lighting only will be 3·37d., out of which 1·20d. is for interest and repayment of capital. If the same installation supplied motors, the cost would come down to 1·49d., owing to the much larger output. In the next part of the paper some interesting statistics are given to show the relative vitiation of the air by various illuminants. The author's conclusions given at the end of the paper are as follows: (1) that electrical energy can be generated in a hospital of moderate size, even under unfavourable conditions, at a cost considerably lower than the average rate charged by public supply corporations; (2) that economical production is greatly aided by utilisation of the generating plant for power as well as for light; (3) that under favourable conditions energy can be generated at such cost that electric lighting becomes less costly than direct gas lighting when ordinary burners are employed, although more costly than gas lighting by incandescent burners, and more costly than direct lighting by oil lamps; (4) that, in view of its deleterious effect upon the atmosphere, the combustion of gas and oil for the direct lighting of hospitals is distinctly inadvisable, and that these substances may be more advantageously employed in the provision of motive power; (5) that the facilities offered by modern gas and oil engines are such as to place electricity within the reach of all hospitals, for which the outlay upon generating plant has hitherto been regarded as unjustifiably heavy.

L.C.C. Capital Expenditure.—From this week's agenda it appears that the Finance Committee of the London County Council is trying to close a firm hand on the purse strings against the demands of the various other committees of the Council for further expenditure. There is a certain amount of humour in these internal disagreements between the committees of this large London authority. For instance, the Finance Committee has agreed to pass forward the capital expenditure in connection with the tunnel under the Thames at Rotherhithe, on which £1,340,000 is to be spent. It explains that this money will not be all spent at once, but will take seven years for the Bridges Committee to get through the money. This argument, however, did not succeed in the case of the rebuilding of the Lambeth Bridge, and, in spite of the wishes of the Bridges Committee, the chairman of the Finance Committee is to move an amendment to the effect that this work should be deferred. In this amendment he is to express the opinion of the Finance Committee that the rebuilding of the Lambeth Bridge is one of those schemes, which although desirable in itself, the Council could without grave inconvenience postpone until some of its present commitments have been cleared off. It is well, in our opinion, that the Finance Committee should in this way try to keep down expenditure which is bound

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to affect the cost of carrying on business in London. We do not, however, envy it its task. Another point which this committee has had to deal with recently is that of the St. Marylebone electric lighting undertaking. It will be remembered that in June last the Council refused the application from the metropolitan borough of St. Marylebone for a loan of £1,274,000 for the purchase of the electric lighting undertaking within its area. It has now been decided that if the Corporation of St. Marylebone obtains an electric lighting license from the Board of Trade the loan can be granted for seven years. This period of seven years will then be altered to a longer period after the undertaking has been paid for and an electric lighting provisional order obtained. We were under the impression that the Board of Trade had decided to issue no more electric lighting licenses, but perhaps they will for this once do so to assist both Councils out of the difficulty in which they are placed.

Cathode Rays as Wave Indicators.—At the recent convention of the American Institute of Electrical Engineers, Prof. Ryan read a paper on an alternate-current wave indicator which works with cathode rays. For the following abstract of this paper we are indebted to the *Electrical World*. The author displaces the oscillating of light in an oscillograph by a cathode beam impinging on a fluorescent screen, and caused to oscillate by the magnetic influence of coils supported close to the walls of the tube and traversed by the alternating current. The cathode beam is spread out into a band, similar to the galvanometer band. Similarly the cathode beam may be analysed optically by a revolving mirror. Prof. Ryan prefers, however, to dispense with the revolving mirror, and employ a known perpendicular component of motion to obtain a cyclically re-entering closed curve of light, or, in fact, an indicator diagram. The engine indicator diagram combines a cyclically varying component of motion of excursion proportional to the instantaneous steam pressure in the cylinder, with a perpendicular motion obtained from the piston. In Prof. Ryan's apparatus the perpendicular component is not a uniform to-and-fro movement, but a simple harmonic movement, or pendulous movement. This is obtained by using another pair of coils magnetically acting upon the cathode beam perpendicularly to the first pair, and exciting these with an alternating current from which the harmonics have been practically all weeded out by the aid of resonance. It is the same sort of diagram as would be obtained from the steam-engine cylinder if the horizontal component of motion were a simple harmonic motion, or were taken from an eccentric driven by the uniformly rotating engine shaft. The cathode-ray diagram may be photographed. It has then to be expanded horizontally to reduce the simple harmonic motion to corresponding uniform motion. This may be done either with the aid of specially prepared ruled paper, in which the spacing of abscissæ follows the inverse of the simple harmonic law, or the same result may be obtained by a method of projections described in the paper. It is curious to observe that no such reduction of the diagram to uniform motion would be needed if the base component of alternating current were adjusted to the simple triangular or saw-tooth form, instead of to the simple harmonic form. The instrument has the advantage that the cathode rays are practically inertialess, and thus respond fully and immediately to fluctuations in the current strength. On the other hand, it takes several seconds of exposure and cyclic repetition to secure a photographic record. The instrument is remarkable as requiring double excitation—namely, first, by high-pressure or Wimshurst machine, with a cathode ray-producing current of about half a milliampere; and, second, by the base component of simple harmonic current of about one ampere. While the oscillograph has the advantage over the apparatus of Prof. Ryan in giving a direct trace of a wave, which trace can be observed continuously, the latter admits of adjustment whereby a detail of a wave which it is desired to study may be exaggerated.

Separation of Dynamo Losses.—Whereas out of the losses by friction observed with electrical machines the brush friction, especially after the more general introduction of carbon brushes, has been duly considered, the friction of the air and of the bearing journals is, as a rule, accounted for together, presuming that the former is only a few per cent. of the aggregate friction. This, however, as shown by Dr. L. Finsi in an article recently published in the *Elektrotechnische Zeitschrift*, is not generally true. In modern engines a special point is made of securing good cooling; both the speed of air and the amount of air carried along are, therefore, increased as much as possible, the cooling surface being augmented by means of convenient ventilating slots and conduits. Rotating poles of high-speed alternating-current machines and the front connections of rotating armatures will, moreover, act as ventilating vanes, the efficiency of the machine being highly increased. As, however, at the same time the losses by ventilation are materially augmented, the friction of air reaching and exceeding the amount of the remaining losses, the latter will be worthy of special consideration, a separation of the losses by friction thus becoming desirable. The friction of the brushes may be immediately calculated as the difference of the determinations both with and without brushes of the losses by friction, all the remaining conditions being equal. The author accordingly terms "total friction" the sum of the friction of the air and of the bearing journals, the brush friction being deducted from the aggregate amount. A means of separating the air from the journal friction is afforded by their different behaviour with regard to the temperature, of the journals. Whereas the effect of the friction of the latter in the case of sliding journals, and of temperature ranging from 15deg. to 80deg. C. may be taken as inversely proportional to the temperature, t, of the journals (in centigrade degrees), the effect of the friction of the air is of necessity independent of the latter. The total loss by friction, R (deducting the effect of brush friction), may accordingly be represented by an expression of the form

$$R_t = a + \frac{b}{t} \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

Measuring the total loss at two different temperatures will therefore enable the two constants a and b to be determined by means of the equation. Having measured the total friction with the speed and at different temperatures, this straight line will be obtained by taking the reciprocal values of the temperature as abscissæ and plotting the corresponding values of the total friction as ordinates A simpler method consists in presuming the resistance o air to be proportional to the square of the speed, and the coefficient of friction to be proportional to the square root of the latter, when the total friction will be given by

$$R_n = c\,n^3 + C\,n^{1.5} \quad . \quad . \quad . \quad . \quad . \quad (2)$$

where n is the number of revolutions of the machine, c and C two constants, the first term again corresponding to the air friction, the second to the friction of the journals. Measuring for two values of n, the corresponding values of the total friction will allow of calculating the coefficients c and C. These methods are of no greater scientific value than the hypotheses they are based upon. Being empirical as the latter, no mathematical accuracy is claimed for

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them; as, however, they control one another, they will enable the practician to arrive at a reliable gauge of the amount of both losses separately.

Utilisation of Energy in Wireless Telegraphy.—This was the subject of a paper by G. Ferrié recently read before the Paris Academy of Science. As the energy utilised in wireless telegraphy transmissions with Tesla transformers depends on the capacities inserted in the exciter circuit and on their discharging potential, it is advisable to give the antennæ a large surface, so that tuning is possible with an exciting circuit including high capacities. If, however, induction coils be used, a certain limiting value of the capacities should not be surpassed, as the working of the coil might otherwise be endangered; the antenna will accordingly have to be kept within certain limiting dimensions. As, on the other hand, the discharging potential is nearly inversely proportional to the capacity, the energy utilised will be practically constant. In this case the capacities of the existing circuit should be chosen so as to allow of the antenna being tuned with only three or four turns of the Tesla secondary. It is, however, possible to use several induction coils with the same antenna, connecting them either to one or to different Tesla coils, the secondary circuits of which are connected in parallel or in series to the antenna. Using commercial transformers will afford the advantage of enabling very large capacities (utilising high amounts of energy) to be employed in the exciting circuit, as the discharging potential within certain limits augments along with the capacity, owing to the resonance phenomena exhibited by the instrument. If, however, given antennæ are to be used, it is not possible to increase very much these capacities, as syntony has to be effected between the antenna and the exciting circuit, the discharging potential being limited. The amount of energy which can be utilised with this arrangement is, therefore, limited as well. Marconi has avoided this drawback by using first the total amount of energy available to produce oscillations of any period in a first circuit including as high capacities as possible, these oscillations being next raised to a rather high tension by means of a Tesla coil, by which another chosen capacity will be charged so that the period of its discharge may be tuned with the antenna by means of another Tesla transformer. The author has found it more suitable to divide all the capacities liable to be charged by a commercial transformer into two or more groups, inserted in different oscillating circuits, but connected to the same oscillator. All these circuits, regulated so as to give rise to oscillations of equal periods, will act on the antenna by means of an equal number of Tesla coils, the secondary circuits of which are connected either in parallel or in series to the antenna. Tuning is effected with the help of the readings of a hot-wire ammeter by acting in the same way on the secondaries if these be connected in parallel, or on one of them if they be in series. As the vibratory motion imparted to the antenna has a period equal to that of each of the exciting circuits, the energy available may be better utilised, while using only the desired wave length. As regards the most suitable form of antennæ, numerous experiments have shown that transmissions would be the more efficient as the ammeters gave higher readings. As, on the other hand, the intensity of the stationary wave will decrease from the ground to the top, it is advisable to secure to this intensity a high value at the greatest possible height of the antenna. Antennæ of great height are, therefore, from this point of view as well, particularly advantageous, though their upper part is in reality of little value. It is possible also to use disymmetric antennæ arranged so that their upper part represents the greater part of the quarter of a wave given by the whole of the antennæ, a considerable intensity being thus obtained over a great part of the height of the antennæ. As to the intensities indicated by the hot-wire ammeters, the author calculates, for an antenna 35m. in length and a reading of two amperes taken at a distance of 1m. from the ground, the mean efficient intensity of each of the oscillations is about 100 amperes.

M.E.A. Parliamentary Committee's Report.—We have now received copies of this report, of which only a brief abstract was given in the report last week of the annual meeting of the Incorporated Municipal Electrical Association. The full report is interesting reading, and shows that the committee is moving in the right direction. For instance, it has taken up the question of the value of electrical undertakings by the rating authority, and by quoting statistics from a number of towns is likely to get the matter placed on a more equitable basis. The committee has appointed the president of the association and Alderman Smith, M.P., of Barrow-in-Furness, to represent them and to give evidence before the Royal Commission on Municipal Trading. The remarks of the committee on the Board of Trade's Electric Lighting Act, 1903, are to the point, and it is explained that in certain respects the Act will operate against municipal electrical enterprise. In one clause the Bill is to be highly recommended; it is the one which reads "a person shall not be entitled to demand a supply for any premises having a separate supply, unless he has agreed to pay such annual sum as will give a reasonable return on the capital expenditure and will cover all standing charges to meet the possible maximum demand." A full history is given of the opposition which the Willesden District Council has had to meet from the local gas company, which was successful in obtaining what is known as the Bermondsey clause. This was inserted in the following slightly modified form: "The Council shall, once in every year after the first year's working of the electric lighting undertaking, cause to be laid before them a statement and balance-sheet of the accounts of the electric lighting undertaking, drawn up in accordance with the form of accounts prescribed by the Board of Trade for a local authority under the Electric Lighting Acts, 1882 and 1888, and the Council shall thereupon fix annually the charges to be made for the supply of electrical energy in the then ensuing year at such rates (not exceeding the maximum rates specified in the order of 1898) so that so far as is reasonably practicable the revenue for that year should not be less than the estimated amount of the expenditure and of the charges for interest and sinking fund for that year." The gas company also endeavoured to prevent the Willesden authority from carrying out free wiring, but the opposition was unsuccessful, as the *locus standi* on this matter was not allowed. The Council also asked for the following clause: "The Council may refuse to supply electrical energy to any person whose payments for the supply of electrical energy or for the hire or sale of any lamp, motor, electric line, fitting, motor, apparatus, or thing let or sold in pursuance of this part of this Act, are for the time being in arrear, whether any such payments be due to the Council in respect of a supply to the premises in respect of which such supply is demanded or in respect of other premises"; but the examiner deleted the words "or for the hire or sale of any lamp, motor, electric line, fitting, motor, apparatus, or thing let or sold in pursuance of this part of this Act," although the clause as it stood was allowed only last year. Application to suspend the repayment of the money for the first few years was struck out by Lord Morley.

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CHELSEA GENERATING STATION.

The following is an outline description of the Chelsea generating station now being constructed by the Underground Electric Railways Company of London, Limited.

The capacity of the building at normal load is 57,000 kw. On this basis the cubic feet per kilowatt (including office building) is 139, and the square feet per kilowatt is 1·36. The steel frame of the building will be closed in with brick and terra-cotta; the roof and most of the floors will be concrete. In general details the building will be

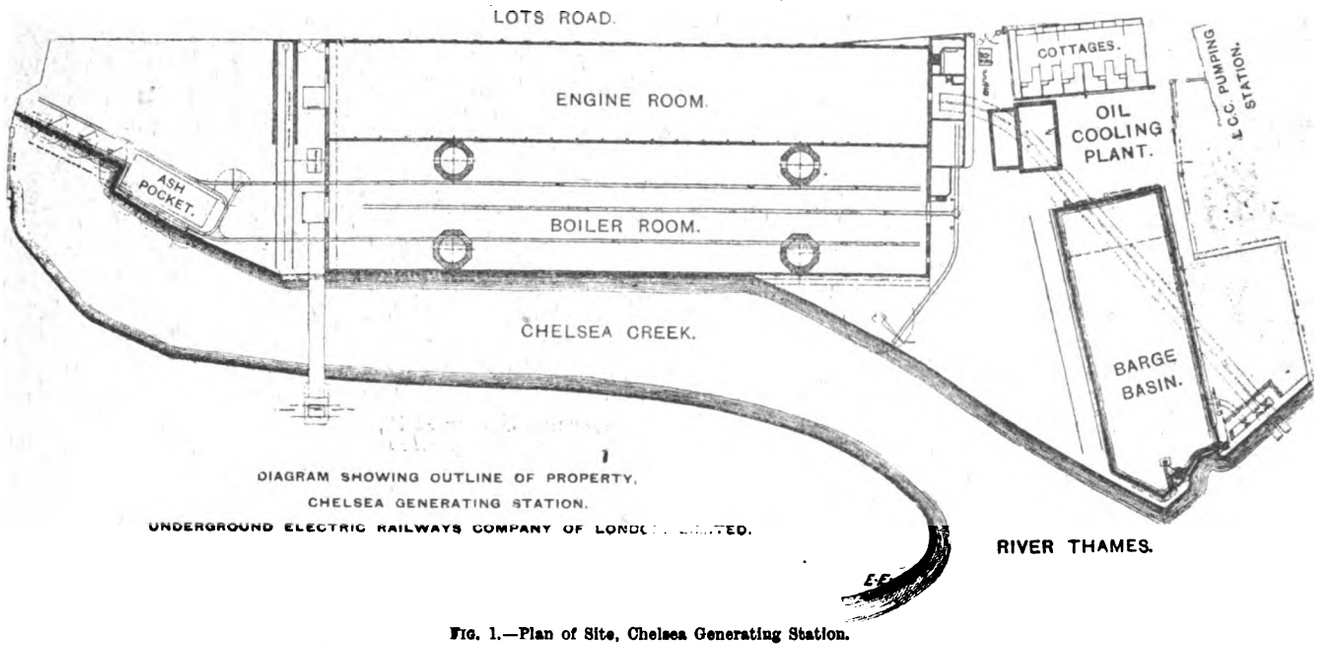

FIG. 1.—Plan of Site, Chelsea Generating Station.

The site (Fig. 1) comprises 3·67 acres of land with a water frontage on the Thames and on Chelsea Creek of 1,100ft., and a frontage on Lots-road, Chelsea, of 824ft. The building (Fig. 2) is 453·5ft. by 175ft., and 140ft. in height from the ground floor to the peak of the roof. The office building adjoining on the east measures 81ft by 25ft., and will have three floors, the lower of which considered as a factory for the production of a commodity, and there will be no ornamental features.

The south side of the building will contain 80 water-tube boilers arranged two storeys high, and carried directly on the steel frame of the building (see Fig. 4). Each boiler has 5,212 square feet of heating surface and 672 square feet of superheating surface. The boilers will

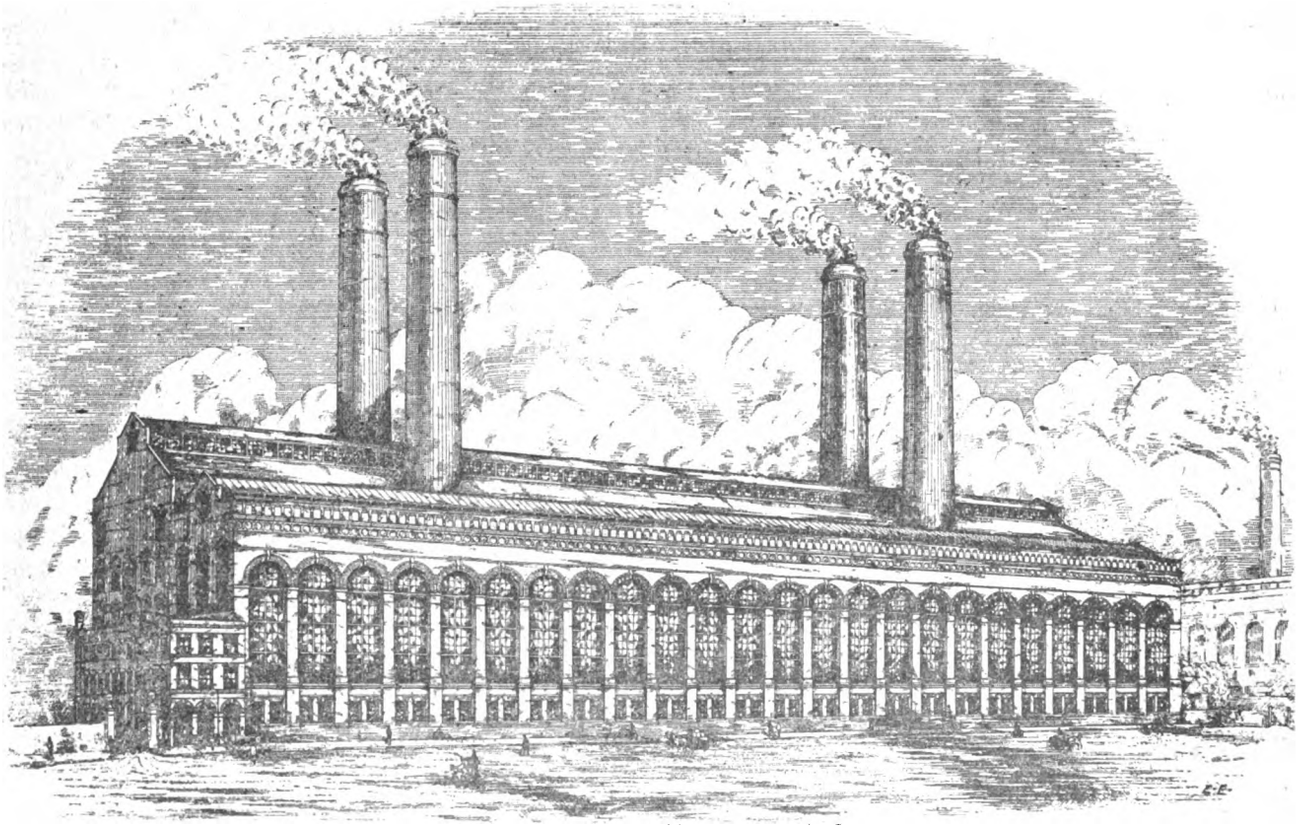

FIG. 2.—Lot's Road Elevation, Chelsea Generating Station.

forms the machine shops. The main building will have a self-supporting steel frame weighing about 5,800 tons. There will be four chimneys, each 19ft. internal diameter and 275ft. high. The foundations for these chimneys are 42ft. square and 34ft. 6in. below the ground-floor level. There are 2,200 cubic yards of concrete in each foundation.

be piped in groups of eight, each group supplying the steam for one electric generating set and one feed pump, there being no steam connections between the several groups, except that a supplemental header at the east end of the building is connected to two groups. This header supplies the exciter engines, air compressors, house pump,

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etc. Chain-grate stokers under each boiler have 83 square feet of surface. Economisers, with tubes 10ft. long and 1,540 square feet of heating surface is provided for each boiler.

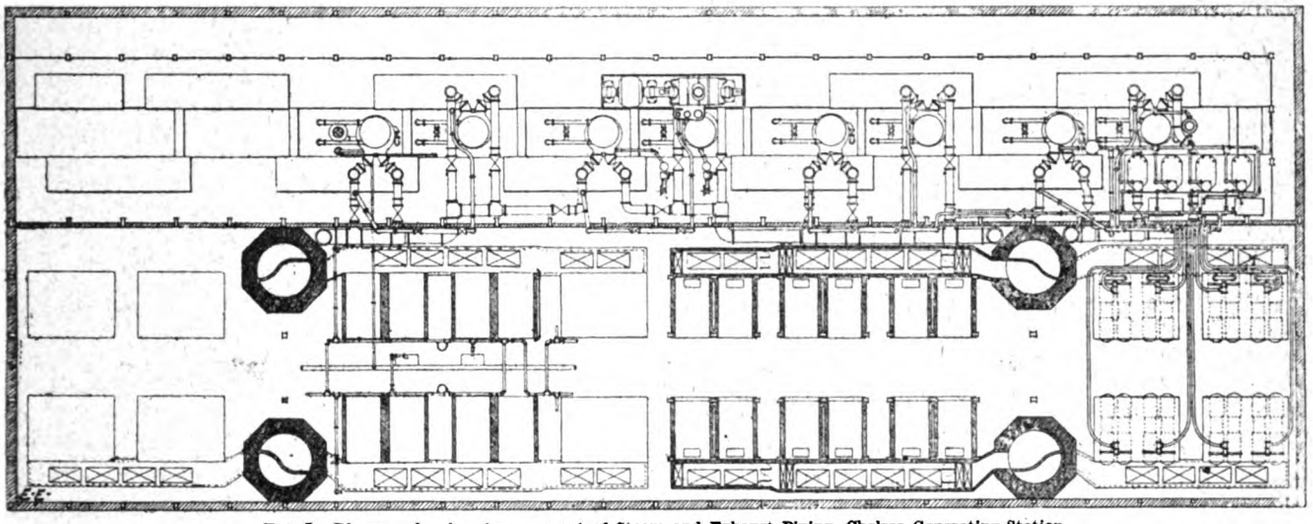

FIG. 3.—Diagram showing Arrangement of Steam and Exhaust Piping, Chelsea Generating Station.

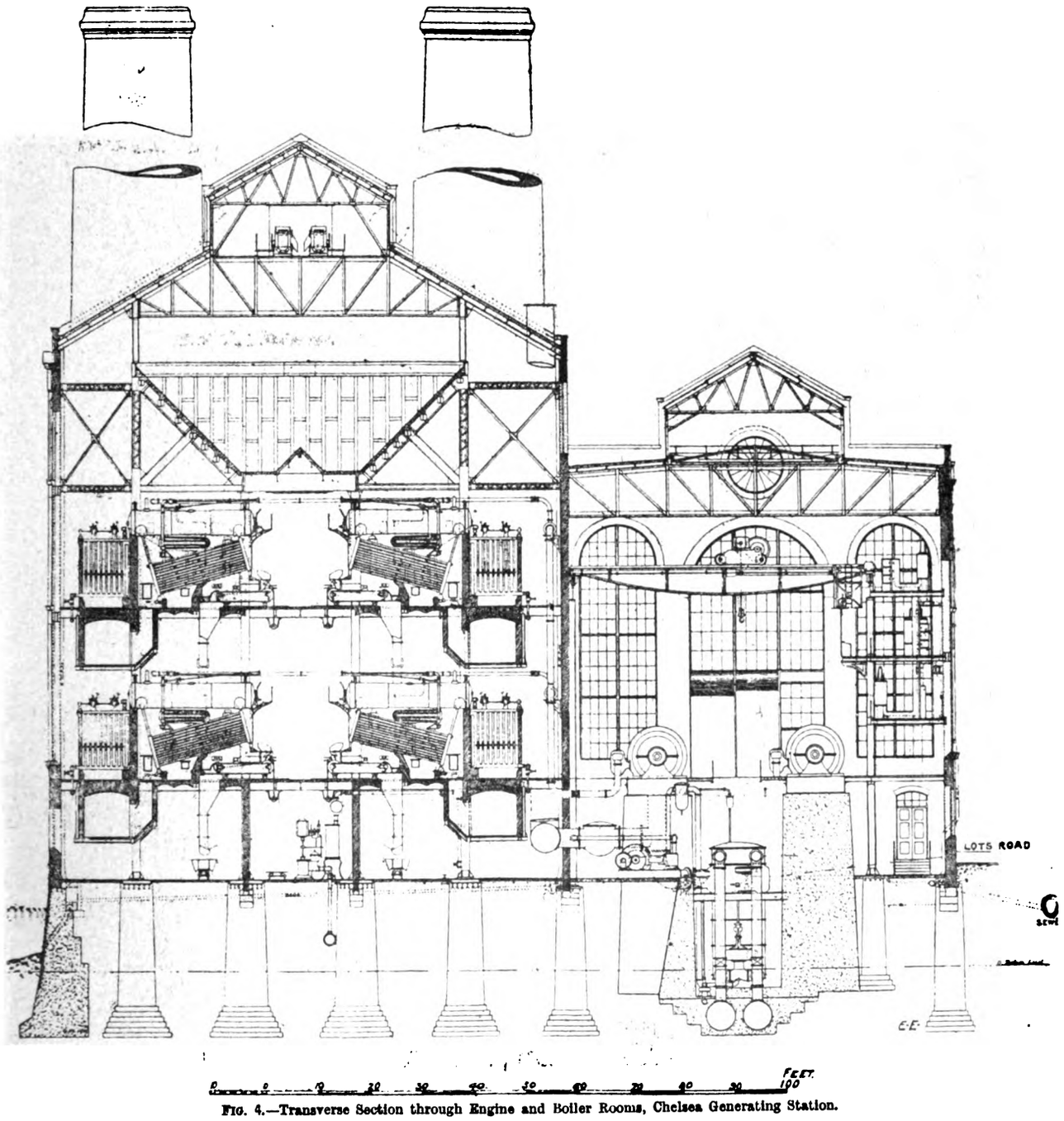

FIG. 4.—Transverse Section through Engine and Boiler Rooms, Chelsea Generating Station.

placed wider apart than the usual practice, are grouped behind the boilers, with the customary by-pass flues; Boiler feeders are placed on the ground floor and supply ring mains on both the boiler-room floors.

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The main generating sets each consist of a horizontal turbine engine running at 1,000 revolutions per minute, and a three-phase generator wound for 11,000 volts 33⅓ cycles; there will be 10 such sets, with floor space for one of half the size. The normal rating of each generator is 5,500 kw., but they will carry an overload of 50 per cent. for two hours at practically the same steam consumption per kilowatt-hour. There will be four 125-kw. 125-volt steam-driven exciter sets, running at 375 revolutions per minute.

The condensing system consists of vertical condensers, each with 15,000 square feet of cooling surface. These are located in pits between the engine foundations. The circulating water is supplied by 66in. pipes laid to the edges of the channel of the Thames. Each condenser has a 20in. centrifugal pump. The duty of this pump is simply to overcome the friction of the pipes, as the system is arranged on the siphonic principle, the top of the condensers being within 29ft. of minimum low tide, and the circuit is closed. The intake and discharge mains are arranged for reversible flow. The condensers are designed to work on the dry vacuum principle, the air-pump and the water-pump being separate. All the condenser pumps are electrically driven.

The switchboard is carried on three gallery floors extending across the north side of the engine-room with returns across the east end. All high-tension switches will be motor-operated, and the feeder system extending to the 23 sub-stations will be in duplicate. A line of 64 ducts is being constructed to carry these feeders to the nearest point on the District Railway at Earl's Court.

Coal will be received on lighters in a tidal basin at the east end of the station, or by rail at an unloading point of the West London Extension Railway on the opposite side of Chelsea Creek. For unloading barge coal the basin is spanned by two travelling cranes, each working a one-ton grab; the coal is weighed in the tower at one end of each of these cranes and dropped on to a belt conveyor, thence by duplicate inclined elevators 140ft. high to the top of the building. Rail coal will be taken from a hopper under the coal wagons by an inclined elevator to the top of the building at the opposite end. The distribution over the bunkers is by duplicate belt conveyors so arranged that the direction of travel of both belts can be reversed so as to handle coal coming in at either end. The storage capacity of the bunkers is 15,000 tons. The daily consumption will reach 800 tons, and six of the largest river barges can be placed in the basin at each tide. Ashes will be removed by an industrial railway worked by a storage battery locomotive; two lines of rails will be laid under the ash hoppers on the ground floor. The ashes will drop into self dumping buckets to be unloaded into barges by pneumatic hoists on the dock wall at the west end of the premises, or stored in an adjoining bin if no barge is available. The capstans, barge basin gate mechanism, and many of the large valves in the building will be worked by pneumatic motors. The electric motors on the travelling cranes over the engines, as well as those on the oil switches, will be direct-current, 125 volts. All other motors will be three-phase, 220 volts; most of the lighting will be on the latter circuit.

It is expected that a portion of the plant will be in working order by the latter part of 1904.

MUNICIPAL TRAMWAYS ASSOCIATION.

ANNUAL CONFERENCE.

(Concluded from page 80.)

We have already reported the first day's proceedings in connection with the above conference, which was held in Glasgow on July 8, 9, and 10 last. Previous to the conference being resumed on the second day, the association held their business meeting. The vice-president, Mr. C. R. Bellamy, general manager of the Liverpool Corporation tramways, who was unfortunately unable to attend the meeting owing to business engagements elsewhere, was elected president in succession to Mr. Young, Mr. Alfred Baker, chief officer of the London County Council tramways, being appointed to succeed Mr. Bellamy as vice-president. The further business consisted in the election of six new members to the Executive Committee, as follows: Councillor Walter Paton, Glasgow; Councillor Boyle, Manchester; and Councillor Smithson, Leeds, representing corporations; and Mr. C. J. Spencer, general manager of the Bradford Corporation tramways; Mr. P. Fisher, manager of the Dundee Corporation tramways; and Mr. H. England, general manager of the Sunderland Corporation tramways, as representing tramway managers. It was decided to hold next year's conference in Liverpool.

The conference having been resumed, Mr. C. J. Spencer (Bradford) read a paper in which he briefly compared tramway conditions in America and Great Britain. This paper we reproduce—with the exception of some minor deductions—in the author's own words:

Tramway Conditions in America and Great Britain Compared.

BY CHRIS J. SPENCER.

I was in the States and Canada in the latter part of April and the early part of May, 1902, and whilst there visited the cities of New York, Pittsburg, Cleveland, Buffalo, Boston, and Philadelphia, and Toronto and Montreal in Canada, so that the impressions gathered of American and Canadian practice were from the above-mentioned places. My British comparison was the state of affairs in Bradford, a city in the West Riding of Yorkshire, with a municipal tramway system of about 230 cars, serving a population of 281,000 (each of whom had a different opinion on tramway administration), scattered over an area of 22,800 acres of very hilly ground, so that the lines in Bradford present, in addition to traffic problems, engineering difficulties.

Fares.—I found that in the majority of cities the fare problem as we know it in England did not exist. We all, no doubt, have met the man who requires a stage 100 yards or so further along the route, nearer a point where he happens to live—not, of course, because it would in any benefit himself, but for the welfare of the city. On the other side of the Atlantic the universal five-cent fare does away with the stage system. I believe that to this universal fare system the Americans owe a great measure of their success. We all know that tramways are achieving a great social reform in this country—that the health and happiness of the community is being directly benefited by the removal of the crowded population from the restricted area of the centre to the broad acres of the suburb. To achieve this, cheap long-distance fares have to exist. Unfortunately, in England, the penny seems to be the only universal fare that can be considered, and, as most systems depend upon the receipts from the short-distance passenger, it is often found that traffic returns will not allow more than about two miles for this fare. The possibilities of the nimble penny are certainly wonderful, but they are limited. Compare this with the American (2½d.) fare. We must remember that the receipts from the short-distance passengers are 150 per cent. higher than we obtain in England. Not many tramway committees would, I venture to suggest, consider very long what to do did they know that their passengers would be willing to pay 2½d. where they now pay 1d. for short distances, on consideration that all stages be abolished. True, wages and perhaps some other expenses are higher in the States than here, but not by any means are they *pro rata* with the fares. Apart altogether from the outcry of the public, an increase in the minimum fare on British tramways would not pay. Englishmen will walk short distances rather than pay even 1d. (Scotchmen, I am informed, are much worse), not so the American; he realises that time is money, and that the expenditure of a five-cent fare is small compared with the saving of time. I have heard it suggested that the street railway companies always manage to have the streets in a state that makes walking nearly a craze for the bold and brave. I have, however, no evidence to offer on that point, and do not desire to commit myself. We are, it is said, being Americanised, and perhaps even the American universal

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fare will yet come as a boon and blessing, and a balm for all our sorrows in respect to fares.

Fare Collecting.—Everything in America appears to be standardised, and the system of fare collecting is no exception to the general rule. No conceivable system could be simpler. The conductor receives his five cents, and registers the fact on the clock-face indicator by pulling the indicator cord running the full length of the car. The check, I was informed, is the fear of the unknown passenger, who can easily see if any roguery is taking place. Should a man be reported by a "spotter" for sharp practice, his chances for further employment as a car conductor for the company by which he was employed, or any other, are remote. His photograph is sent round to each line, along with the cause of his dismissal. On the face of it this system seems good, and should be very effective, though one is inclined to think that the amount of power in the hands of the spotter is a trifle excessive. Yet, I regret to state, I saw three or four distinct cases of fraud on street cars. In two cases my own fare was taken by the conductor, who failed to register it. I had the pleasure of discussing the matter with a street railway manager, who admitted freely the weaknesses of the system. I naturally asked if the bell punch and tickets had been tried, and he replied, "Yes, but I guess it takes too much gilt off the nickel." I also asked if they had tried a locked fare box, similar to what we use in Bradford and those I had seen in Montreal and Toronto. His reply was, "Yes; and that would have been all right, but our passengers thought the conductor was carrying a spittoon, and used it for that purpose." Fare-collecting systems are determined by the conditions that determine fares, so that a simple system similar to the American is only possible where fares are simple also.

Traffic Catering.—So far as the frequency of service, etc., is concerned, I saw nothing different to the usual practice in this country; the service run on any particular section is determined by the earnings per car mile. Americans are, perhaps, as may almost be expected, just a little more enterprising in this direction than the average tramway manager here. For example, in one city visited I noticed on a traffic return sheet that a certain section was earning not more than six or seven cents (3d. or 3½d.) per car mile, and that a fairly good service was being run. Upon enquiry, I found that this particular section had been laid for the purpose of developing an estate (which I presumed was owned by the Street Railway Company). At Cleveland a line had been laid from that city to a small lake-side pleasure resort, chiefly noted for drinking and consequent rowdyism. I was astonished and pleased to hear that the result of this line had been to quite reform the place. Car-loads of temperance reformers, etc. (I do not know whether the company supply these), had been dumped down, and had had due effect. I was especially pleased to note this, for our experience in Bradford, I am sorry to say, has been the opposite. Instead of sending loads of temperance reformers to our previously quiet suburbs, car-loads of quite a different kind of human being ride out of the city on Sunday afternoons in quest of the advantages to be obtained by the three-mile limit.

Pleasure Traffic and Advertising.—Our traction friends of the States quite appreciate the effect of good pleasure attraction at the outside terminus of a line. In many places I found street railway companies owning and running pleasure parks, etc., and advertising with due modesty the wonderful beauty and suitability for pleasure purposes. In these matters we certainly have something to learn. I believe that many lines which are at present non-paying could be improved by a little judicious expenditure in the direction just mentioned.

Speeds.—To mention speeds to a British tramway man is almost like waving a red rag to a bull. It is unnecessary to state that speed limits in America are very different from what obtains at this side of the "pond." Though they are fixed by the various cities in which the street railway companies operate their lines, yet it seems to be recognised that the speed per hour allowed is the average schedule speed, and not the maximum attained between any two given points. On the other hand, cars do not travel in the busy streets of the cities much quicker than they do here. I heard it stated, for example, that the average speed, including stops, was 10 miles per hour on Broadway, New York. I tested this one morning when I was in a hurry, but if the average speed exceeded three miles per hour on that occasion I am very much surprised; so I found that the American tramway manager can no more perform miracles than his English brother. Much, however, is made of quick acceleration, and a good average speed is obtained more by this means than by running at the high maximum rate. The controlling pointer is shifted from the zero position to full speed in an incredibly short space of time, and it is as well that American passengers have become accustomed to it. I am afraid that did we in Bradford commence to accelerate our cars at such a rate as, say, in New York, the number of nervous ladies clinging to stout old gentlemen, who in turn would be compelled to sit down hurriedly on the laps of other ladies, would be appalling, and cause quite a public uproar. We have, however, something to learn with regard to acceleration, and I do not think its benefits have yet been fairly recognised in England. In Bradford I have for 13 months been gradually increasing the acceleration, with a result that my average speed has increased from about 5½ to 6¾ miles per hour on all sections, the current consumption falling from 1·6 to 1·4 units per car mile. The passengers can be educated to the quick start, and its benefits are far reaching. True, the wear and tear on the equipment is increased, but, to use a trite Americanism, "it pays." We have been successful in Bradford in getting increased speed, and our maximum, previously eight, is now twelve miles per hour. We have had this granted—so say the Board of Trade—due to our good conduct, and it is held out that some time in the dim future (if our conduct is still good) that on certain quiet country roads we may be allowed to run as high as 16 miles per hour. I am afraid that by the time our conduct has attained such perfection nature will have provided for us wings, and new legislation for aerial navigation will be required.

Outward Appearances.—In outward appearance the average American system does not strike an Englishman favourably. The overhead equipment is generally put up roughly, cheap, and nasty. The cars are far from clean, and the track in many instances bad. Neither can the average conductor be complimented on his civility. I must say that my remarks do not apply to all the systems I saw. Several are the very opposite, and rank, I should say, among the smartest and best tramway organisations of the world. After dealing with merely outside appearances, one must acknowledge that the facilities which the tramways give the public in the way of rapid transit from one point to another, with frequent quick services, are excellent. In no case did I see a slower service than a five minutes', and in the busy parts of the cities there was a continuous stream of cars going in both directions. In fact, everyone seemed to be riding and no one walking. I am told that the American cannot afford to walk—he has not time. Trams are therefore to him not a luxury, but a necessity.

Overhead Equipment and Permanent Way.—I saw nothing in the overhead department very different from our standard practice here. I was very much interested in the different systems of permanent-way construction, the electric-welded joints in Buffalo and cast-welded joints in other cities visited providing interesting matter for British consideration. As this subject, however, is being dealt with in another paper before the conference, it is unnecessary for me to go into further detail.

Rolling-Stock.—On the question of design, upkeep, and care of cars, I found that matters stood pretty much the same as they are here. Engineers have different ideas, and work differently. In some cities I found the engineer advocated a regular overhaul of the equipment. At others it was considered good policy to allow the motors, etc., to run until they showed distinct signs that, unless an immediate overhaul was made, a breakdown would occur. At Cleveland, Ohio, I found a system of inspection of equipments that I considered very good, and have since adopted the principle at Bradford with excellent results. Motors, controllers, etc., are examined daily whilst the cars are in service at some convenient

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terminus. It thus becomes unnecessary to employ a large staff of night men for inspection on small work repairs. The motor inspector notes any defect which is developing, and orders the car to remain at the repairing depôt; he is better able to find and hear of the little faults in the daytime and during service hours. This, to my mind, seems better than either of the extremes—viz., waiting for breakdowns to know that something is wrong, or incurring heavy expenses by a regular and periodic overhaul. I found many useful practical hints, especially in the workshop and car-repairing department. As the majority of the workshops that I visited were originally built for other purposes, I did not find that the buildings themselves were very well adapted for the work for which they were employed. I found, however, all sorts of little plans of overcoming what might be termed natural difficulties, and a great number of labour-saving devices in the way of machinery employed to bring down the cost of running. In all the workshops I came across a compressed-air plant was in operation, which was used for various purposes—cars were swept out, motors cleaned, and building surfaces cleaned by air jets. Pneumatic tools—drills, chisels, hammers, lifts, etc.—in successful operation, connected to the compressed-air main, laid in the shop. We have, since my visit, adopted a compressed-air plant in our own repairing shops, with corresponding benefits.

General.—I fail to see that we are behind America in this country with regard to tramway matters, and whilst we may learn much from our friends across the Atlantic, yet, in some things, I feel that the Americans would equally benefit by a visit to this small island.

With the discussion which followed the above paper the business of the conference practically terminated. In the afternoon visits were paid to the Pinkston power station, car works, etc., and at night, commencing at seven o'clock, the association's dinner was held.

The third day was devoted to a pleasure excursion to Inveraray per the turbine steamer "King Edward,' and thus ended a most enjoyable meeting.

MUNICIPAL ELECTRICAL ASSOCIATION.

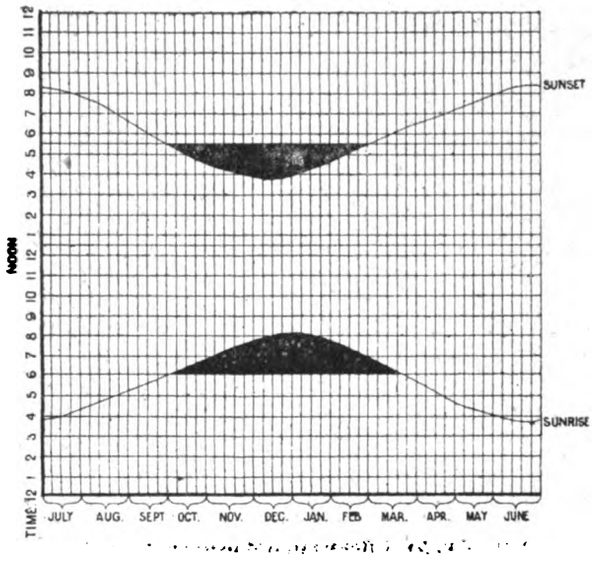
After the discussion on Alderman Pearson's paper had been completed at Middlesbrough on Friday, the 17th, the following paper was taken as read :

Some Observations on Electricity Supply and Methods of Stimulating Demand.

BY COUNCILLOR J. E. PANTON, M.D. (MEMBER OF COUNCIL), CHAIRMAN OF THE BOLTON ELECTRICITY COMMITTEE.

About 25 years ago the writer spent one summer evening on the Thames Embankment waiting for the twilight, when the electric arc lamps (the old Jablochkoff candle) would become illuminated, so that he could, for the first time in his life, see the effect of the "new" light, and, about five years later, while passing daily to and fro along Holborn Viaduct, he watched with considerable interest the process of installing incandescent electric lamps in the various business establishments along that route, and also in the gas lanterns for street-lighting. At that time, and for some years later, electric lighting was an expensive luxury, with current at from 10d. to 1s. per Board of Trade unit, and incandescent lamps at 5s. each. The light also had a tendency to be erratic, and had a nasty way of going out, without previous notice to the consumer, and of remaining for a longer or shorter period (mostly longer) in that deplorable state of uselessness. Even now, in these twentieth-century days we have our breakdowns, but we are getting somewhat nearer the ideal in reliability of supply, and, in all probability, greater improvements will be made in the future than have been in the past. In 1882 electric supply companies were booming, and during that one year over 12½ millions sterling of British capital was invested in such supply companies. But there was a rude awakening for investors, and in the following year only two millions was so invested; in 1884 half a million, and in 1885 but £58,000. In 1886 the tide commenced to turn, and investors' capital again flowed into electricity supply. This condition of affairs has continued, with more or less regularity, up to the present time. To-day electric supply undertakings in this country represent 45 millions sterling, of which municipal supply works can claim slightly the larger share, so that it is quite evident this industry has come to stay.

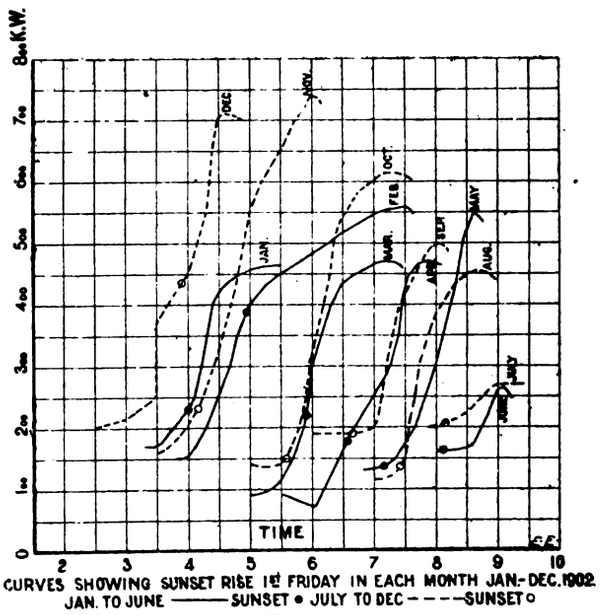
Some enthusiasts would adopt electric lighting whatever the charge per unit might be. If, however, we are to increase materially the demand for electric energy, we must be able to claim that our price (*qua* price) is as low per candle-power-hour as any other illuminant. At the same time we may claim, for the users, the added advantages of cleanliness, convenience, healthiness, absence of noxious fumes which damage pictures, wall and ceiling papers, curtains and tapestry



CURVE, SHOWING TIME OF OVERLAPPING OF MOTOR AND LIGHTING LOADS. DARK PORTION, 6 A.M. TO SUNRISE AND SUNSET TO 5.00 P.M.

FIG. 1.

work, and corrode metal work, such as picture chains, thus endangering the stability of heavy pictures, etc. Similarly with motive power. No very great progress will be made until it is demonstrated that, commercially, it is cheaper to drive by electricity than by any other means. For both lighting and power purposes the confidence of consumers must be obtained as to the continuity and reliability of such supply. It is also necessary that the public should have confidence in the financial stability of supply undertakings, so that they may have reasonable expectations of retaining, for such number of years as they may need it, a continuous supply night and day,



CURVES SHOWING SUNSET RISE 1ST FRIDAY IN EACH MONTH JAN-DEC. 1902.
JAN. TO JUNE ——— SUNSET • JULY TO DEC - - - SUNSET o

FIG. 2.

Sunday and weekday, at the same price per unit, or at a lower price than that which induced them to embark on electric lighting or driving.

In the opinion of the author nothing is so calculated to dispel the confidence of consumers as a constant fear of breakdowns, and a price which has a tendency to fluctuate up and down. To increase the demand we must diminish the price, and to diminish the price we must increase our economics in production and learn the most economical manner in which electric energy can be produced and distributed. For a purely private lighting supply the load factor obtainable, except in the

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Metropolis or very large cities, will rarely be above 10 per cent., but for a station solely supplying motive power the load factor would probably be 30 to 35 per cent. In the first case the whole of the standing charges would fall on the lighting consumer, and in the second case on the power consumer. But if we combine the two undertakings in one, the standing charges (including interest, etc., on mains) would be divided, and both classes of consumers would benefit. This combination of loads would not give such a good load factor as the purely motive power station, but the writer thinks a load factor of 25 per cent. may be obtained in any supply station if the units sold for purposes other than lighting or tramway traction represent 75 per cent. of the total sold for all purposes. In such a station, although the load factor would be lower than in the purely motive power works, the earning capacity or commercial efficiency would be greater, on account of the plant being employed during the

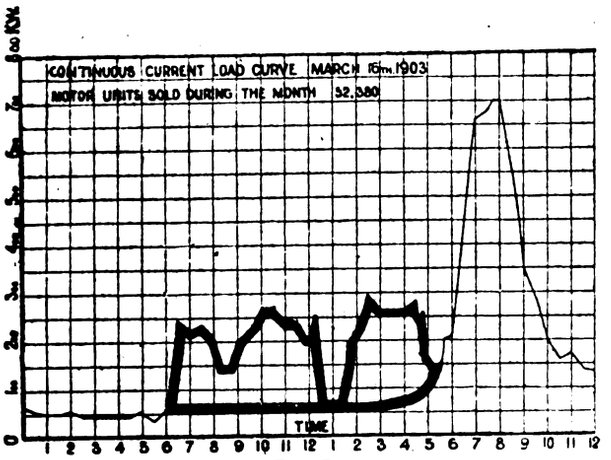
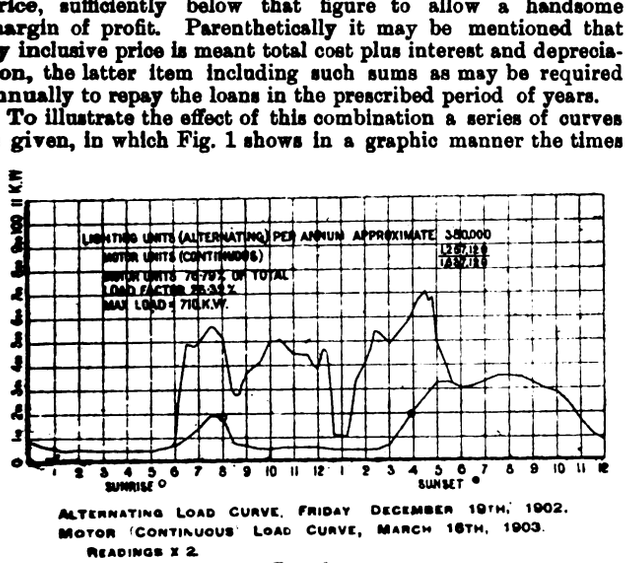


FIG. 3.

hours of darkness in generating current for lighting, which plant would otherwise be idle, or approximately so. Also one set of mains would serve both purposes. When this result can be obtained, the author ventures to predict that the selling price for motive power will average about 1d. per unit, and for lighting 3d. per unit. This would give an average all-round price per unit sold of 1·5d., and there is probably no one in this room who will dispute the feasibility of producing and distributing current under these conditions at an inclusive price, sufficiently below that figure to allow a handsome margin of profit. Parenthetically it may be mentioned that by inclusive price is meant total cost plus interest and depreciation, the latter item including such sums as may be required annually to repay the loans in the prescribed period of years.

To illustrate the effect of this combination a series of curves is given, in which Fig. 1 shows in a graphic manner the times



ALTERNATING LOAD CURVE, FRIDAY DECEMBER 19TH, 1902.
MOTOR (CONTINUOUS) LOAD CURVE, MARCH 16TH, 1903.
READINGS X 2.

FIG. 4.

of sunrise and sunset for each week during the year, the shaded portions showing the times when the motor and lighting loads would overlap. This presumes that the rise of load for lighting purposes commences about sunset. That this is so is demonstrated, so far as Bolton is concerned, in Fig. 2, which shows the rise which occurred about sunset for the first Friday in each month of the year 1902, Friday having been chosen owing to the fact that it is a heavy lighting evening, so that on these days any overlapping which exists would be shown at its worst. Fig. 3 represents the load curve (continuous current) for March 16, 1903, on which day the sun sets at 6.1 p.m. The portion of this curve presumed to be motor load is shaded. It will be noticed that the motor load is practically off before the lighting rise commences. In Fig. 4 the lower curve denotes the alternating (lighting) load for Dec. 19, 1902, and above it is superposed the motor load for March 16, 1903, this latter being doubled in height to produce the desired percentage. The actual number of units sold for power purposes in March, 1903, was 52,380, and, assuming that doubling the output would not alter the contour of the curve, and that it would remain much the same from month to month, this would represent an output per annum of:

	52,380 × 2 × 12 = 1,257,120
Alternating units sold (approximate)	380,000
	1,637,120

Motor units, 76·79 % of total; max. load, 710 kw.; load factor, 26·32 %.

To produce some such percentage as above mentioned for lighting and other purposes, the writer would urge the management of all (particularly municipal) supply undertakings to encourage a day load at practically any price per unit above their works cost. Such a price may be remunerative even if it be below the so-called total cost of production.

It is desirable, however, that the average price for motive power should not be less than one-fourth the average price for the lighting supply, the writer being of opinion that the most equitable ratio is about 1 to 3 for power and lighting supply. As the greater part of a day load will necessarily be for motive power, it is desirable that it should be considered from that point of view, and even if our prospective consumer has been persuaded to adopt motor driving, he may not be able to afford the necessary outlay for the installation, or, if able to command the necessary capital, he may not be disposed to invest it in motors of which personally he has little or no knowledge. Here is a case in which it is essential that the supply undertaking should take the responsibility of buying the motors and hiring them out to the consumers. Many corporations are now doing this and also some companies, the Bradford Corporation being the first to embark in this motor-hiring business, and all honour to them for leading the way. As, however, corporations cannot legally do this without special parliamentary powers, the Corporation with which the writer is connected got the following clause inserted in its parliamentary Bill in 1901: "The Corporation, if they think fit, may purchase, provide, sell, let for hire, and fix, set up, alter, repair, and remove, and otherwise deal in (but not manufacture), lamps, electric lines, electric motors, fittings, apparatus, and things for lighting, warming, ventilating, the cooking of food, and for motive power, and for all other purposes for which electric energy can or may be used or be otherwise necessary or proper for the supply, distribution, consumption, or use of electric energy, and may provide all materials and do all works necessary or proper in that behalf, and may require and take such remuneration in money, or such rents and charges for and make such terms and conditions with respect to the sale, letting, fixing, setting up, altering, repairing, or removing of such lamps, electric motors, electric lines, fittings, apparatus, and things, as aforesaid, and for securing (both as regards the consumer and third parties) their safety and return to the Corporation as the Corporation may think fit or as may be agreed upon between them and the person to or for whom the same are sold, supplied, let, fixed, set up, altered, repaired, or removed. Any lamps, motors, lines, fittings, apparatus, and things, as aforesaid, let for hire under the provisions of this section, shall not be subject to distress, or to the landlord's remedy for rent, or be liable to be taken in execution under any process of any court, or any proceedings in bankruptcy against the persons in whose possession the same may be. Provided that such lamps, motors, lines, and fittings have upon them respectively a distinguishing metal plate affixed to a conspicuous part thereof, or a distinguishing brand or other mark conspicuously impressed or made thereon, sufficiently indicating the Corporation as the actual owners thereof." Various corporations have obtained similar parliamentary powers.

In Bolton, the cost of the motor and fixing with starting switch is ascertained, and a rental of 10 per cent. per annum on the capital cost is charged. Some discussion has arisen lately as to whether that charge shall be 10, 12½, or 15 per cent., but the writer is of opinion that, for the time being at least, 10 per cent. is enough, because although that sum may not recoup the supply undertaking for the outlay and upkeep, a motor load is so all important to a station that it is better to lose a little on the motor hiring, and make it up, perhaps, a hundredfold in increased output of current and the revenue derived therefrom. The actual increased cost to the station for every unit sold for private motor supply is very little more than the cost of coal to generate that unit, and if that be, say, ·5d. (a figure which is higher than the cost of coal in a great many works), and the unit is sold for 1d., there is a profit of 50 per cent. on revenue for motive power to help to pay the standing charges, which would otherwise fall wholly on the lighting consumer. It may be mentioned here that the cost of upkeep for hired motors in Bolton was—

For the year ended March 31, 1902,	£2 13 0.	Rental, £108.
Ditto ditto March 31, 1903,	£20 10 11½.	,, £235.

Canvassers might with advantage be employed to go the round of small workshops of whatever trades are established in

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the district, and point out to the proprietors thereof the many advantages of motor driving, and in many cases they might go the length of offering to instal motors for a month or two free of all cost, except current used, the motor to be removed also free of cost, if the customer wished it, at the end of the probationary period. If, however, the consumer is satisfied, motor rent would have to be paid from the date of commencement of supply.

In one or two cases which have come under the writer's notice, the hirer of the motor has expressed himself perfectly satisfied with the motor and its work, but has complained of the cost being 20 per cent. more than the motive power previously used. When this is enquired into the consumer produces his coal bill for three months and his bill for current for three months, at about 1·13d. per unit, the latter being about 20 per cent. more than the former. On his attention being called to the fact that he has either dismissed his fireman and engine driver, or put him to another job, he begins to see that electric driving is saving him about the same sum as he previously professed to be losing by it. The canvasser might also visit electroplating works and works where electric welding is at that time or is likely to be adopted, and offer the low motive power price for the purposes above mentioned.

The parliamentary powers cited above also give permission for the Corporation to undertake wiring work, and it would be well at this juncture to consider the advisability of corporations embarking in this business. Bolton took over its gasworks in 1872 from a private company, in conjunction with which was a fittings department, and so it was quite an easy matter for them to glide almost imperceptibly into the electric wiring trade. Although the average profit from this wiring department has been about £800 per annum for the last five years, the writer is of opinion that it is best left to private enterprise, as each electric wiring firm employs canvassers, who, without any real intention of so doing, really canvass without any fee or reward for the supply works. In several towns electrical exhibitions have been held, under the auspices of the supply works, and the writer would imagine these to be very beneficial, where motors and other consuming devices might be seen at work. The enumeration of the various apparatus on show would be out of place here, but amongst them might be mentioned electric radiators, grillers and cookers, electric desk fans, etc. At the same time, of course, the various kinds of wiring, switches, and lamps would be on view. Meters, prepayment and otherwise, would also find a place in the exhibition, and everything connected with the supply undertaking could be demonstrated to all and sundry who were interested therein. Our municipal technical schools should also be invited to assist the supply works by instituting lectures on motor drivng and its beneficial effect on all industries, both on a large and small scale. Huddersfield at one time sold a large quantity of energy to a carbide works, and if a sufficiently low price can be offered, there is no reason why other generating stations should not do the same.

In connection with the hiring of motors, the question of hiring arc lamps, electric radiators, and grillers might be considered, but although these may be of considerable importance, they are far less so than motor hiring. In the first place, because no very great amount of revenue is likely to be obtained from them, except in the case of arc lamps ; and, in the second place, they are all of them likely to be in use at the time of the maximum load on the station, and are therefore less worthy of being pushed. At the present time there is probably only one supply undertaking in this country which receives 10 per cent. of its revenue from its output for purposes other than lighting and tramway traction. It therefore becomes necessary for us to consider if we are making the most even of our lighting supply.

As the writer mentioned earlier in this paper, the most cogent method of increasing the supply is to lower the price, and if consumers can be shown any material saving from the adoption of electric lighting, our lighting output will largely increase in spite of the proportionately heavy cost of installation. Possibly the cost of electric wiring and fittings will be diminished in the near future, but even if the lowest limit be reached, there are many people who would not be able (or if able, willing) to pay the cost, as they may not happen to live in their own houses, and are, therefore, unwilling to wire a house out of which they may be liable to be turned at three or six months' notice. The landlord also, having paid for the gas installation, is not willing to undertake the financial responsibility involved. In such cases the so-called free wiring might be adopted, which has been brought to the notice of this association in a paper read at one of the previous conventions. The writer understands that this has proved very beneficial to several supply works, but he is not in favour of it, as in most cases an increased cost per unit of ½d. or 1d. is put upon the consumer for all time. He would prefer to adopt what he ventures to call "assisted wiring," which could be brought about by the corporation paying for the wiring being done by one of a number of wiring contractors approved by the corporation, such contractor guaranteeing to maintain the wiring in a good condition for three years, lamps, of course, being renewed at the expense of the consumer. The wiring and fittings to be the property of the corporation and the tenant to undertake to pay 9 per cent. of the total cost as rental quarterly with his account for current, the landlord or other approved guarantor to sign the agreement to pay the quarterly rental if the tenant fail to do so within a prescribed period. At the end of three years, the rentals having been duly paid representing the total cost of installation plus 8 per cent., which percentage the corporation would retain to cover interest on capital outlay and any slight cost entailed in collecting the amount by instalments, the installation would then become the property of the hirer. If, however, 9 per cent. per quarter pressed too hardly on the small consumer, 8, 6, or 5 per cent. might be charged as rental for a proportionately longer period. If this principle were adopted many cottages and small residential houses might obtain the benefits of electric lighting, and the supply station would benefit enormously by the acquisition of such a load, which would undoubtedly be a very good steady load all the year round, much better as far as it went than a smaller number of larger houses and villas, which are very often left by their owners for months at a time and which produce only a fitful revenue. In connection with assisted wiring, prepayment meters could be adopted, the supply works being secured from any loss by the constant moving about of some members of the artisan class whose memories are so defective that they forget to pay the gas bill or even the rent to the landlord.

Meter rents are also a matter worthy of consideration, and as the revenue derived therefrom forms such a small percentage of the total revenue of any electricity works, they might well be abolished, or if not abolished largely reduced. This is a matter which deserves earnest attention, as meter rents fixed ten or even five years ago, even if equitable at all, were based on the then cost of meters, which cost has diminished almost 50 per cent. since that time. Some electricity undertakings have already abolished meter rents, and the small amount of revenue which other undertakings would lose by following their example would probably be recouped by an increased demand for current. The cost of a service for electricity supply is relatively large, especially for a high-tension supply, and no means should be lost sight of for cheapening such cost, consistent with getting a reliable job and one which would not be specially liable to break down.

Street-lighting should undoubtedly be encouraged, and current sold for such a purpose at a very low price. This is a case in which a load factor of from 25 to 30 per cent. is often obtained, and supply authorities should not forget this in arranging their charges. In the writer's opinion a great many stations charge a price for this out of all proportion to the cost of production, and thus brings electric lighting of streets into such bad repute on the question of price.

Tramway supply also gives an excellent load, which should be got if possible, but it is too large a subject to be treated in this paper. Still, it must be remembered that, as in the case of street-lighting, the greatest demand on the supply works comes at the same time as the maximum lighting load. The writer is, therefore, of opinion that the price charged for current for tramway traction should be higher than for private motor supply, which gradually tails off from 5 to 6 o'clock each evening.

The charging of storage batteries in connection with electric motorcars should also be catered for, for in all probability this will be an important branch of supply in the near future.

No paper on this subject would be complete without some mention of methods of charging, and although this may not be in agreement with the general trend of opinion at this meeting, the writer is bound to confess that he is considerably out of love with the maximum demand method of charging, except in cases specially selected. Theoretically, this system of charging is unassailable, but there are many practical difficulties in the way of its beneficial use by a large number of consumers. For instance, although churches and chapels have a large maximum demand and a relatively small consumption of energy, yet they are good consumers, as their supply is mainly taken on a Sunday, when all shops and business premises are shut up. Glasgow has recognised this by allowing a specially low rate for churches and chapels. Then again, assembly rooms, where dances and evening parties are held, are in a somewhat similar position, for their load rarely, if ever, comes on the peak, but at a time later on in the evening, and on to the "wee sma' hours." Furthermore, the capital cost of installing demand indicators, and the extra cost of taking records, is out of proportion to the benefits obtained, especially when a large number of very small consumers have to be connected. If electric energy could be used for lighting, and lighting only, there might be a strong argument for the universal adoption of the maximum demand system, but the amount of motor driving now in operation, and the immense progress likely to be made in that direction in the near future, compel the writer to the opinion that such methods of charging are eminently undesirable in a general supply. What he would recommend is a reasonably low flat price for lighting, say not

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more than 3½d. or 4d. per unit, leaving the committee in charge of the undertaking to give special terms to any large customer or special class of consumer. This might be a specially low flat price, calculated on the maximum demand principle, or on a quarterly rental per kilowatt installed, plus the charges for the time being adopted for motors, or any other method commending itself to them. Again, if slot meters be adopted, a flat rate must of necessity be given to such consumers, and if to them, why not to all?

Supply authorities have, in the author's opinion, done too much in the past to discourage the short-hour lighting consumer, and too little to encourage a day load, and if for a time they directed as much energy in the direction of encouraging the demand during the hours of light load, there would be much more likelihood of a magnificent harvest in the direction of a greater output, a better load factor, and a corresponding diminution of cost of supply, with the usual result of largely increased profits. Whatever may be said of the disadvantages of the maximum demand method of charging for lighting can be said with redoubled force for a motive power supply, for in this case the diversity factor is so great that it makes practically no difference to the supply undertaking whether the motors in any particular works are run continuously or intermittently. In this case also a flat rate should be adopted, with an initial higher price for the first 500-1,000, or any greater or less number of units per quarter which each undertaking can fix for itself before the really low flat price is obtained. In Bolton the charge is 2½d. per unit for the first 500 units per quarter, less 10 per cent. if the account be paid within 21 days of being rendered, then 1½d. per unit for the second 500 units per quarter, less 10 per cent., and any further quantity at 1d. per unit net. The reason for this is that there are many consumers whose consumption is so very small that, if 1d. per unit were charged from the start, the revenue derived from such consumers would barely pay interest, etc., on cost of services, cost of meter inspection, and cost of collection. This method of charging works very well, and is easily understood by any consumer. This also is for the general supply, but, as in the case of lighting, the author would leave the management of the undertaking to bargain with any specially large consumer, or for any supply demanded under special conditions. How these special conditions are to be met each committee and its technical adviser can devise for themselves, whether by a two-rate meter and time switch, giving a low price during the light load and a higher price during certain hours, or by any other method which they may deem expedient.

Consumers do not, as a class, understand the maximum demand principle of charging, and if it be explained to them with great care their intelligence seems to break down, although they may be in every other respect capable business men. This want of understanding engenders distrust, which is one of the greatest factors, not in stimulating the demand for electric energy for all purposes, but in materially retarding the same.

Bailie MACKENZIE, of Edinburgh, opened the discussion, and said it looked very suspicious to be frightened of opposition. He thought the Bermondsey clause was a most stupid one, as if an undertaking was not paying its way it would make matters worse to decrease the demand by increasing the rate of charging for electrical energy. He advocated that a corporation should supply good consumers at a price very slightly above works costs, but said that it was not easy to persuade colleagues on the council that it was often advantageous to charge often even under the average works cost. Thus, in Edinburgh they had a contract with the North British Railway Company to supply 1,000,000 units at 1½d. This had prevented the company putting in their own plant, and he was sure that both parties would gain from the contract. He advocated street-lighting as a means of advertising the undertaking, and had recently got through the Council an order for 100 more arc lamps at a price equal to 1½d. per unit.

Bailie WILLOCK, of Glasgow, said that they supplied churches and chapels at cheaper rates because they used their lights at a time when the ordinary load was not high. He agreed with the last speaker as to giving exceedingly low rates, and had agreed to supply at 1½d. to the Clyde Trust and to the railway companies. By so doing they had secured one half of the lighting of the Clyde Trust.

Mr. J. G. GRIFFIN, of Swindon, said that the local gas company had prevented them from carrying out their free-wiring system, but they had, with the help of free-wiring contractors, evaded the difficulty.

Mr. MCCOWEN, of Belfast, asked for information as to the success of schemes which discriminated in favour of motors not worked on peak load.

Mr. W. G. WALL, of Birkenhead, gave some interesting figures as to the reduction of cost by the introduction of a good motor load He did not, however, think it paid to supply power at 1d. per unit. He asked for information as to the best way of dealing with consumers in small houses, in order to avoid the comparatively heavy capital charge on the service and meters.

Mr. L. ROBINSON, of Hackney, said they had evaded the trouble of not having power to hire out motors by arranging with a manufacturer to act as agent for them. They hired out these motors on either a one, two, or three year agreement, and had secured a 400 h.p. motor load in a very short time.

Mr. A. B. MOUNTAIN said there were cases in which 1¼d. per unit even was much too high a charge. He had supplied a temporary carbide of calcium plant with a steady 24-hour load at ½d. per unit, the consumer bearing the capital outlay on the cables. They were also charging now $\frac{9}{10}$d. per unit to a large engine works with a 20 per cent. load factor.

Mr. A. E. HOADLEY, of Maidstone, said he had recently gone into the question of the actual cost of supplying a 60-h.p. motor in a refrigerating plant in a brewery, which plant was only required in the summer. He found the average load to be 38 kw., and that on a 10-hour day it only necessitated 1cwt. of coal extra over what was burned before. The extra oil and coal worked out at 0·3d. per unit, and they charged the consumer 1d. on the condition that the plant was never used during the lighting peak. He had had experience at Barking in the supply of small houses, for which only one service was run for eight houses. The connection was made through from house to house.

Mr. J. CHRISTIE, of Brighton, described a system he had introduced of supplying loads which were not to be used with the peak load at 1d. per unit. For this purpose a time switch was introduced. He had found that breweries and laundries had modified their hours of working to avail themselves of this cheap power. As no extra capital charge was involved it paid well. They had no trouble over their free wiring, having adopted a three-party agreement. They supplied motors driving the blowing apparatus of church organs at 1d. per unit.

Dr. PANTON only replied to one or two queries, and reserved the bulk of his reply for the printed discussion owing to the limited time available. A hearty vote of thanks was passed to him for his paper.

QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any questions should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

605. What are the advantages and disadvantages of hammering electrical cables out of the ordinary round shape?—T. H. P.

606. It is required to obtain current at 200 volts from two shunt-wound dynamos, each giving 100 volts, and it is found that if the two machines be simply connected in series, with the shunt of each machine across its own brushes, the field of one dynamo dies away and is then reversed in direction, whilst if the field windings are connected in series and not connected at the intermediate point between the two armatures, the machines run all right. Explain this.—W. S. P.

[N.B.—Will H. F., who sent in Question No. 600, kindly forward to us his full name and address.—ED. *E. E.*]

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Answers.

Question No. 597.—Describe the electrical equipment of an electric automobile, with special reference to the motor, or motors, and wiring.

Best Answer to No. 597 (*awarded* 10*s.*).—That the electromobile has passed beyond the experimental stage has been successfully demonstrated by a car named the "Powerful," which completed a tour of over 2,000 miles in the autumn of 1901, and no apology need be made in placing this car before others. The "Powerful" belongs to the Kriéger class of electromobiles, following the designs by M. Kriéger, of the Compagnie Parisienne des Voitures Électriques, of Paris. This company is represented in England by the British and Foreign Electrical Vehicle Company, London. The carriage is a little over 10ft. in length, with a width over the axles of 6ft. 4in., the wheel base being the same length. The front wheels, to which the motors are attached, and which are also the steering wheels, have a diameter of about 3ft., and are fitted with Michelin pneumatic tyres with a tube diameter of 120mm. (4¾in.). The rear wheels have a diameter of about 3ft. 4in., and have similar tyres.

The accumulators are carried in two groups, 25 in a case immediately over the front wheels, and 25 in a similar space over the rear wheels, below the seats for driver and

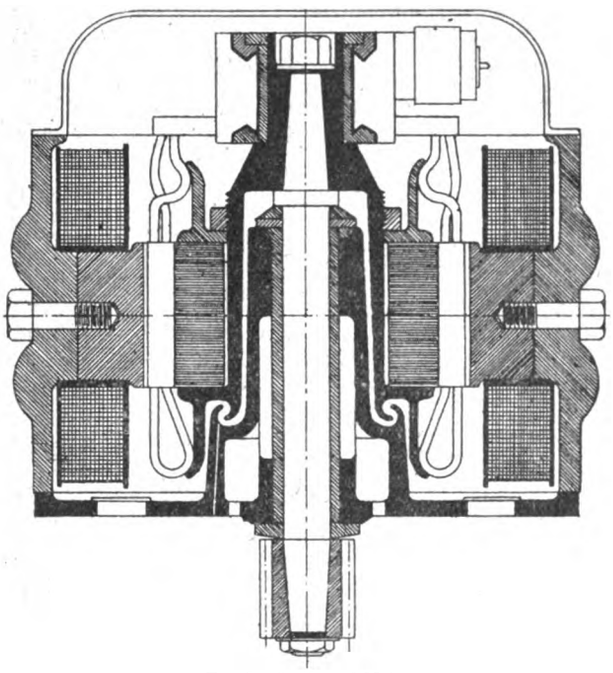

Fig. 1.—Section of Motor.

passengers. Each battery case contains five boxes, each measuring 2ft. 1in. long, 7in. wide, and 16in. deep, and holding five accumulator cells, 6¼in. by 4¾in. and 14½in. high. The design of these accumulators is due to Mr. Henry Leitner, and takes the form of thin perforated sheets of lead with a slightly raised undercut ridge along the edge of the perforations, thereby stiffening the plate, and also preventing the active material from falling out. Each cell contains six pairs of plates, separated by perforated grids of ebonite; the two outer negative plates in each cell are of half the thickness of the other plates, being 3mm. instead of 6mm. This form of accumulator has a high capacity per unit of weight—a very important consideration in electromobile traction. The total weight of the 50 cells is 22cwt., and the weight of the car complete with its batteries is 42cwt.

The motors, as previously stated, drive the front wheels and work independently of each other. They are of the four-pole iron-clad type, a longitudinal section being shown in Fig. 1, in which some rather novel points in the design will be noticed. The armature spider is of gunmetal secured to the shaft at the commutator end and recessed to admit the bearing. This bearing is very long, and supports the armature at about its centre of gravity. It is of gunmetal, forming one casting with the end plate. A solid bronze bush is driven in this casting, which has a slot cut through it, longitudinally, for about one-third of its length. Automatic lubrication is effected by means of a piece of wick dipping into an oil well in the casting and placed in this slot, similar to the method of lubrication in traction motors. The poles have each a shunt and series winding, the latter being placed on the top of the former. The armature is of the usual slotted-drum type, with a four-circuit winding. The winding is cross-connected, so that only two brush sets are required, the brushes being of carbon. The motors are enclosed in light iron casings provided with ventilating apertures, the latter being covered with very fine wire gauze. The attachment of the motors to the main frame of the carriage is by a simple arrangement of springs and levers, so that any relative motion of the motor takes place in an arc concentric with the axle. The motors drive the wheels by spur gearing, the "gear ratio" being nearly 1 : 12—*i.e.*, the pinion has 11 teeth and the spur wheel 133 teeth. The pinions are made out of rolled steel, tempered after being cut, and each spur wheel is firmly fixed to a front wheel of the carriage. The output of each motor is 4½ b.h.p., with a normal current of 40 amperes at 100 volts for continuous running, the speed being 2,000 revolutions per minute. Each motor weighs 150lb., thus making the weight per brake horse-power equal to 33·3lb., a result comparing very favourably with steam and other motors.

The system of control adopted is extremely interesting and ingenious, being the "series-parallel" arrangement with considerable modifications. The controller surrounds the steering bar, and consists of a cylinder of insulating

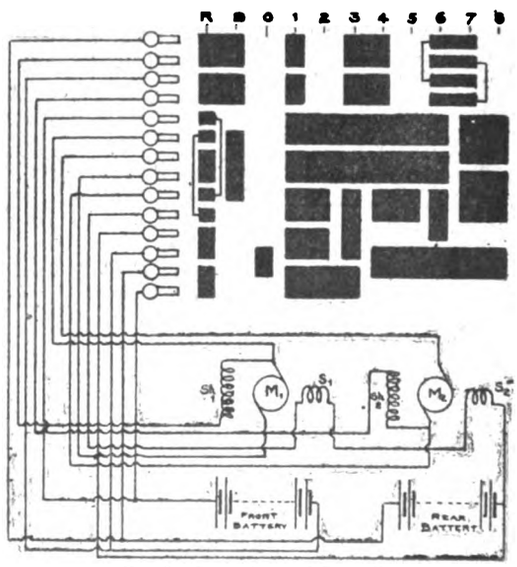

Fig. 2.—Connections of Controller.

material with pieces of copper mounted on it for about half of the circumference. Fig. 2 shows the "development" of this controller, in which the copper contacts are shown black. Pressing against these are 14 copper brushes connected to various parts of the system, as shown in Fig. 2. On the top of the controller case is a dial, divided through a little more than half its circumference into 11 divisions, marked respectively R, B, O, and numbers from 1 to 8. A pointer on the controller spindle indicates the position of the controller. In the system of control adopted on the "Powerful" all the notches are "running" notches, there being *no* resistances used whatever. The economy resulting from this method will be at once obvious. In Fig. 3 are given the connections for each notch of the controller. M_1 M_2 are the armatures of the motors, S_1 S_2 the series coils, and Sh_1 Sh_2 the shunt coils of each motor respectively. The diagrams need little explanation. The reversing notch, R, is useful when the car is required to "back," and gives a speed of about three miles an hour, the motors in this case being connected as compound. The electric brake, B, is intended as an emergency stop, the armatures in this case being short-circuited. Notch No. 1 connects the motors as compound. This gives a full field and a very good starting torque, the speed in this case being about three miles an hour. Notch No. 2 is useful for running behind slow-moving traffic, the speed being about four miles an hour. The motors are connected as

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shunt machines in notch No. 5. This gives a very good braking effect when going down hill, and at the same time recharges the batteries as soon as the speed raises the armature voltage higher than that of the batteries. From the fourth notch and onwards the batteries are in series. Notch No. 4 gives a speed of about eight miles an hour on the level, and is very useful for hill climbing. In notch No. 6 the motors are capable of recharging the batteries, though this time the braking effect is not so great as in notch No. 5. The maximum speed (about 24 miles an hour on a level road) is reached at notch No. 8, the armatures in this case being in parallel.

A useful addition to the control of the car is a cut-out operated by the same foot lever which applies the mechanical brake to the rear wheels. Another addition is a double-contact switch to enable the batteries to be charged in parallel as well as in series. The headlights are taken direct off the batteries.

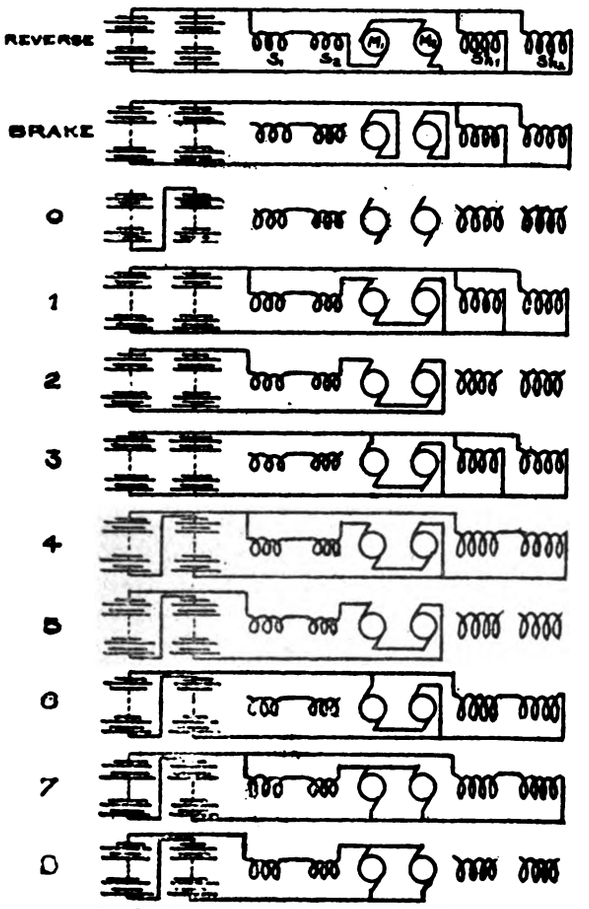

FIG. 5.—Connections of Motors at each "Notch."

It may be mentioned that the tour included some of the steepest gradients in the country (in some cases being 1 in 7½), and these the car took without any mishap whatever. During the whole tour, which totalled over 2,000 miles, no difficulties were encountered in getting the accumulators recharged, and the "Powerful" could run 95 miles on a single charge. The total expenses for charging during the tour amounted to 2½d. per car mile, or 0·65d. per passenger per mile, there being four passengers carried. The renewals required for the accumulators was practically *nil*, notwithstanding the very severe test they were put to in surmounting some of the hills in Cumberland.—A. D.

Question No. 598.—In order to test high-tension cables, it is necessary to have ready means of varying the pressure to suit the test specified. Can this be done best by adding to or reducing the number of transformers in series, or what is the best way?

Best Answer to No. 598 (*awarded* 10*s.*).—Though the method of varying the voltage by cutting different transformers, or different coils on one transformer, in or out of circuit (Fig. 1) is in fairly common use, it is not the most satisfactory, as it necessitates the full voltage being switched on at once. When dealing with high tensions and cables of large capacity, such sudden changes of voltage may lead to an excessive rise of potential due to resonance effects. Sometimes this difficulty is partially got over by arranging the switch (Fig. 2) to make contact at one step before breaking with the last (a resistance being inserted between the front and back parts of the switch to prevent an excessive current passing in the short-circuited coil), thus permitting the voltage to be increased

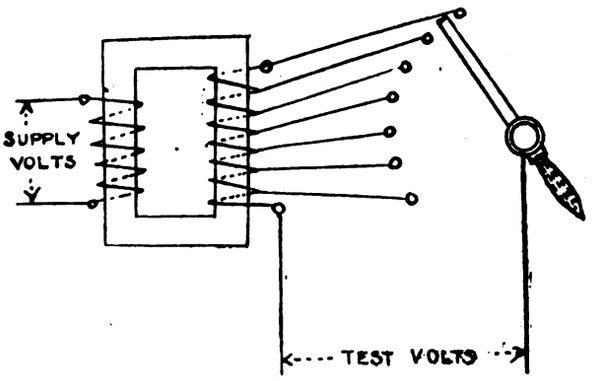

FIG. 1.

gradually and without flashing at the contacts after connecting the cable.

A better method of adjusting the voltage is to have a single transformer giving the maximum secondary voltage ever required, when the full available primary voltage is in use, and to obtain lower secondary voltages by inserting either a finely subdivided resistance or an adjustable

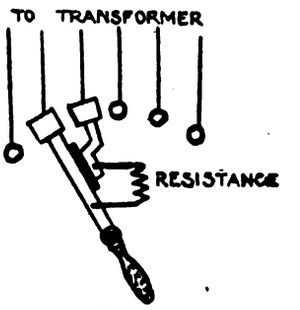

FIG. 2.

choking coil in the primary circuit (Fig. 3). In this way, by using a sufficiently large resistance or choking coil, the secondary voltage can be reduced to a very low value at first, and can then be gradually increased by cutting out steps of resistance or drawing the iron core of the choking coil further and further out of the coil. A still better arrangement as far as efficiency and the gradual change of

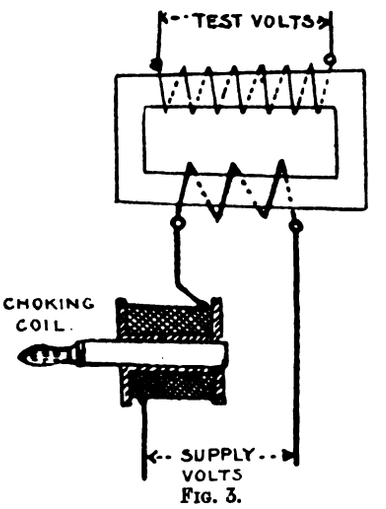

FIG. 3.

voltage are concerned, though a rather more expensive one, consists of a transformer built on the Cowan and Still voltage-regulator principle (Fig. 4). In this the primary is wound on a core capable of being rotated through a quarter of a circle, so as either to link the whole of its flux effectively with the secondary winding, thus giving the maximum voltage (core vertical in Fig. 4), or else linking its flux in

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such a way that the volts induced in the secondary cancel out (core horizontal in Fig. 4). By placing the core in

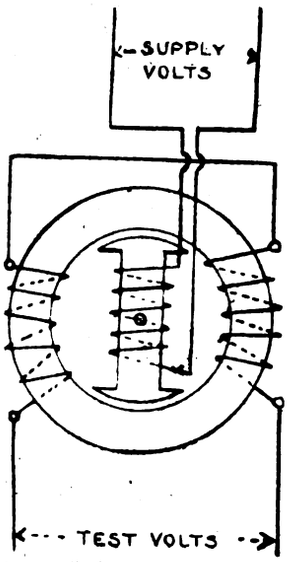

FIG. 4.

intermediate positions, any required intermediate voltage can be obtained with the greatest exactitude.—Q.

Answer to No. 598 (*awarded* 7*s.* 6*d.*).—Cable manufacturers now have a very perfect system of testing the insulation of high-tension cables This system may be divided into two distinct tests—viz., the low-tension and the high-tension.

The low-tension test is made in the usual way by means of a Silvertown or Kelvin testing set, to ensure the absence of moisture and other causes of a dead short-circuit when a high voltage is applied to the cable under test. If the low-tension test is satisfactory, the cable is subjected to an alternating voltage of from 1,000 to 5,000, and in some extreme cases to as much as 20,000 volts. Fig. 1 shows the connections of one method of making a high-voltage test, in which it is possible to obtain widely-varying voltages up to 9,000 volts if desired. K is a two-pole switch; C is a circuit breaker, which opens when low insulation allows too large a current to pass; A is an ammeter; P is the primary coil of a variable transformer, T, designed for a high voltage; L is a pulley, round which is wound a card,

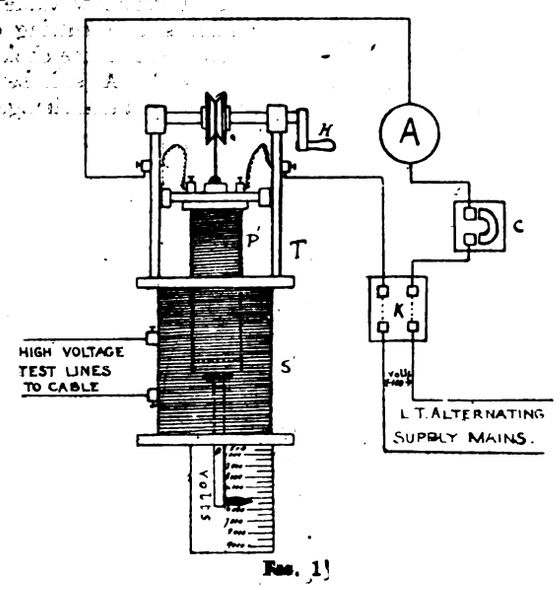

FIG. 1.

attached to the primary coil, which slides in and out of the secondary, S, when handle, H, is turned. To the bottom of the primary is fixed an arm carrying a pointer, which moves over a calibrated scale, so that the voltage at the terminals of the secondary may be read off for any position of the primary coil. Although the theory of the action of this transformer will be understood, it will not be out of place to give it here. When the primary coil is right inside the secondary, all of the latter's coils are cut by the primary's line of force, whereas when outside, only a few of the lines reach it; consequently the secondary voltage is correspondingly lowered. It will, therefore, be seen that it is possible to obtain varying voltages in a very simple manner.

Having explained how a high voltage is obtained, it might be well to make a few remarks on the carrying out of a test. After the test lines from the "secondary" terminals of the transformer have been firmly attached to the insulation to be measured, raise the primary coil till it is near the top of the "secondary"; this will prevent too high a voltage being suddenly applied to the insulation. Switch, K, may now be closed, exciting the primary off the 100-volt mains of an alternating-current system. The handle, H, is now turned, letting down the primary into the secondary, until the insulation under test either breaks down or stands the full voltage obtainable. It is well to have an opposing weight acting on the pulley, as this prevents the voltage being raised too suddenly, besides automatically returning the coil to its zero position—*i.e.*, top of the secondary—should the operator accidentally leave it in the position of full voltage. An electrometer or electrostatic voltmeter (not shown in figure) is put across the secondary terminals, its readings being a check against the readings on the transformer scale. When switch, K, is closed ammeter, A, indicates the primary current, which should remain constant if the insulation is perfect, as in this case there is no reaction on the primary, owing to no current in the secondary coils. Should the insulation break down a large current flows through the secondary, which reacts on the primary, lessening its induction. This causes a larger current to flow through the primary. As the circuit breaker, C, is set to open when a small increase of current takes place, the exciting circuit for the primary is broken.

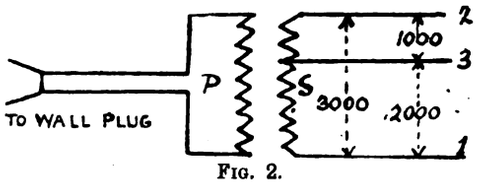

FIG. 2.

It will be seen that all switching is done on the low-tension side, thus minimising the risks attending all high-tension work. Another method, which is perhaps more flexible than the first, is shown in Fig. 2. P is the primary of a transformer, having its ends attached to a plug capable of being inserted in a lamp socket on the alternate-current lighting mains. The secondary coil, S, has several leads brought out, by means of which different secondary voltages may be obtained. Suppose that by using the two outside leads the voltage is raised to 3,000, then between leads 1 and 3 there will be 2,000 volts, and between leads 3 and 2 1,000 volts. These steps may be increased within the limits by putting on extra leads.—J. W. R.

Answer to No. 598 (*awarded* 5*s.*).—In order to test high-tension cables, it is necessary to have a ready *means of varying the pressure*, etc. The variation of the voltage to suit the tests can be obtained by connecting the primaries (thick coil winding) of the transformers in parallel and the secondaries in series, but this method, in the writer's opinion, does not admit of a very quick and easy means of regulation, unless elaborate switchgear be employed. The best arrangement for testing in this case would be to have a special transformer, a variable non-inductive resistance being inserted in the primary circuit. The following is a description of a transformer suitable for "high-tension" testing, the design of which is due to Mr. H. F. Parshall.*

In Fig. 1 and 2 are given sketches showing the arrangement of the coils and magnetic circuit. It will be noticed that the primary and secondary are wound on the opposite "legs" of the core. This is of great advantage in testing work, as, even with a "dead short" on the secondary (due to the breaking down of the specimen under test), no great flow of current takes place in the primary on account of

* A very interesting series of tests made with a transformer of this design are described by Messrs. Parshall and Hobart in their work on "Electric Generators," pp. 47 to 57.

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the magnetic leakage. With ordinary transformers, on the other hand, this result would probably be accompanied by the blowing of the primary fuses.

The core is of the single magnetic circuit type, and built up of iron punchings 1¼in. by 7¾in. and 1¼in. by 4¼in. for sides and ends respectively, and 0·014in. thick. The net sectional area of iron in the core is 3·65 square inches. With an impressed E.M.F. of "form factor" = 1·25, the density is 36·4 kilo-lines per square inch. (The term "form factor" was introduced by Prof. Fleming to denote the ratio of the square root of the mean of the squares of the equi-spaced ordinates of a curve to the true mean value of the equi-spaced ordinates.*) The primary and secondary are wound on opposite legs of the core (see Figs. 1 and 2). The primary consists of two former-wound coils slipped into place side by side. The conductor is No. 13 S.W.G. double cotton-covered wire, and each coil consists of 75 turns wound in three layers, thus making the total number of primary turns 150. The secondary is wound in six sections on a wooden bobbin, as shown in the figures. The conductor in this case is No. 33 S.W.G. double silk-covered wire, and each coil consists of 1,600 turns, giving a total of 9,600 secondary turns. The primary coils are wrapped with a layer of tape half lapped and shellaced, and are slipped over a layer of composite mica on the core. The secondary coils are wound direct on the wooden bobbin, which is thoroughly baked and shellaced, and are covered on the outside with a few layers of tape. The ends of each secondary coil are brought out to a connection board and the ends of the primary are brought out to a similar board, which admits of various groupings of the coils. A water rheostat is connected in series with the primary, and forms a ready means of varying the secondary voltage.

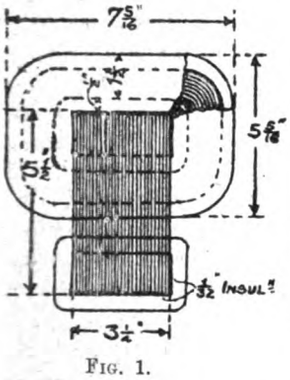

FIG. 1.

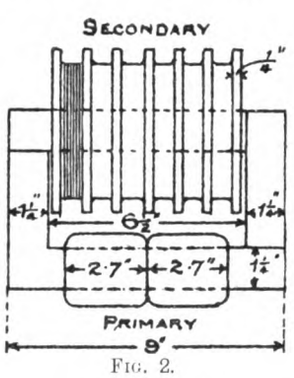

FIG. 2.

The transformer as described was used for testing materials, the secondary voltage being varied in the tests from 2,000 to 8,000 volts. The windings, of course, can be proportioned for higher voltages to suit the specific requirements of one particular branch of testing. In the writer's opinion, such a transformer offers several advantages over the method of grouping several independent transformers in series, the primaries, of course, being in parallel across the mains. A transformer of this type is also very compact, the main function of such a transformer being simply to transform a low voltage to a higher one, and, therefore, the conditions are very different from those met with in ordinary lighting transformers.—A. D.

LONDON TRAFFIC COMMISSION.

Sir David Barbour presided over a further sitting of the Royal Commission on London Locomotion at Westminster on Friday.

Mr. H. E. Haward, the comptroller of the London County Council, was the witness, and offered evidence as the financial position of the tube railway companies of London. He stated, in reply to questions, that the capital involved in tube railway undertakings, existing, authorised, and proposed, amounted to £50,257,000. This sum was made up as follows: tube railways now in operation, £7,518,000; in course of construction, £18,493,000; authorised, but not yet commenced, £3,680,000; new railways, including extensions of existing railways, proposed by Bills as introduced into Parliament this session, £20,586,000. In regard to the financial position of existing tube railway undertakings, he gave details of the Central London, the City and South London, and the Waterloo and City Railway. He wished to make the following observations as a result of his consideration of the financial particulars of the various companies. With regard to the raising of capital, he said that great difficulty had been experienced in raising capital for those enterprises. The Central London made more than one unsuccessful attempt to issue its capital to the public in the ordinary way, and its stocks were finally syndicated and issued in blocks. The Electric Traction Company, Limited, had allotted to it £672,000 of the 4 per cent. debenture stock. The Electric Traction Company was formed to construct the Central London Railway. He understood that the issue of the Great Northern, Piccadilly, and Brompton guaranteee stock this year was unsuccessful, the underwriters having been left with 50 per cent. of the total. The methods of the Yerkes group of financiers illustrated very clearly the difficulty experienced in inducing the public to find the necessary capital for tube railways. Dealing with the cost per mile, he said that that varied very considerably. The Central London cost about £554,000 per mile, the Waterloo and City less than £400,000, and the City and South London £350,000. The traffic receipts of all three companies were increasing, and in this connection it was to be noted that each of the railways delivered its passengers right into the heart of the City. Working expenses he found ranged between 45 and 55 per cent. of the gross receipts, and showed a tendency to the former figure. Dividends, while showing an upward tendency, had been very moderate, in no case exceeding 4 per cent. Dealing with the question of raising the further capital required for tube railways, witness said that the public was interested in the raising of such capital in the most economical manner, and that was not likely to be done by a company which was unable to induce the public to subscribe readily its stock. The effect of an extravagant method of raising capital would be to inflate the capital of the company. Continuing, witness said that a company that could not readily obtain capital was also unlikely from time to time to take steps to improve its accommodation or extend its facilities where such involved the expenditure of capital. If all the parliamentary powers sought in the session of 1903 were ultimately obtained, the public would be asked to subscribe a further £38,500,000 for tube railway undertakings. The prospect of that sum being raised at all was, he thought, remote, and he considered it improbable that any considerable sum could be raised economically. To pay working expenses, 5 per cent. interest on share capital and 4 per cent. on loan capital would require the conveying of nearly 600,000,000 passengers at a fare of 2d. each, which was a somewhat higher average fare than was probable. The three tube railways in operation carried less than 70,000,000 passengers per annum. Witness then dealt at considerable length with the financial inter-arrangements, so far as known, of the Underground Electric Railways Company of London, Messrs. Speyer Bros., and the various statutory tube railways and other companies, and concluded by submitting a statement showing the total sums spent or voted by the London County Council on capital account for tramways up to March 31 last. In that statement he had included an approximate computation of the further outlay involved in the schemes for purchase of further lines, construction or extensions, and the conversion of horse lines to electric traction. The amounts expended or voted up to March 31 last was £3,650,000 for lines and equipment, including purchase, and £750,000 for power supply. The further outlay in prospect was estimated to be as follows: purchase of undertakings, £200,000; conversion of remaining undertakings, £2,720,000; and new lines already agreed to by the Council, including proportion of cost of street widenings to be charged to tramways account, £1,077,000. The total outlay, including addition for street widenings and contingencies, being estimated to amount to £11,422,000. There would be a substantial decrease, no doubt, in the working expenses. The horse-car system was worked at about 9½d. per car mile, while the estimated cost for electrical working was sometimes put as low as 6d., including all expenses connected with the supply of power.

The Commission then adjourned for the summer vacation.

* See "The Alternate-Current Transformer," vol. 1, p. 583, second edition.

APPOINTMENTS VACANT.

Assistant Superintendent, Indian Telegraph Department, Rs. 4,200 a year. Apply, Secretary, Judicial and Public Department, India Office, Whitehall, London, S.W., Aug. 1. Advertisement in previous issue.

Electric Wiring Clerk of Works, Parish of St. Pancras, £3 per week. Advertisement in last issue.

Estimating Engineer for large electrical works in the Midlands. Advertisement in last issue.

Electrician (working) for collieries near Durham. Advertisement in last issue.

Representative.—Firm of manufacturers require energetic representative for developing sale of new type of transformers. Advertisement in last issue.

Switchboard Attendant, Corporation of Swindon, 27s. 6d. per week, Aug. 3. See advertisement in last issue.

Consulting Electrical Engineer.—The Town Council of Bo'ness, N.B., being about to introduce an electrical installation into the burgh, for which they have obtained a provisional order, are in want of the assistance of an electrical consulting engineer to consult and advise with them now and during the execution of the contract. Applications by Aug. 1.

Instructor in Mathematics.—The Governing Body of the Northampton Institute invite applications for the post of mathematical instructor, Aug. 24. See advertisement.

Tramway Car Draughtsman. Permanent and improving position to right man. See advertisement.

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IRON AND STEEL.

Political matters must as a rule be eschewed by technical papers, but when the political matters relate to economic questions they can only be dealt with properly by those well versed in business problems. At last Tuesday's meeting of the London County Council a very interesting topic was mentioned, about which a little more information is wanted. It was pointed out that the Council wanted some forty-two thousand pounds' worth of steel girders. They asked nine firms to tender to supply within twelve months. Only four firms had tendered and each had asked for eighteen months, on the ground they were so busy. The other firms had declined to tender at all for the same reason. And then the *Chronicle* remarks, it throws a little light on the question of "dumping." It does, but not in the manner the *Chronicle* would have us believe. With regard to this transaction there are many questions we should like answered. Who selected the nine firms, and why were those firms selected? Why was not the want advertised openly, and the work tendered for openly? Does Mr. Benn, or whoever may be the leading spirit in these hole-and-corner proceedings, wish us to believe that Great Britain cannot execute an order for forty-two thousand pounds' worth of girders under eighteen months? What about the specification for the work? Is it of the usual London County Council type—interfering with business organisation that does not concern it at all, and compelling British makers to comply with certain things that foreign makers cannot be made to comply with, thus giving the foreign makers a huge preferential tariff, against which British makers are powerless. Why should manufacturers be harassed by any council? We have throughout this country a set of blatant humbugs—gentle and simple—crying "free trade," "free trade." "Anathema to all who doubt free trade." And yet these same men, whenever they have an opportunity, are the first to be protectionists, yes, and protect foreign competitors against their own neighbours whose money they are so lavishly spending. The firms selected by the wire-pullers of the County Council no doubt gave one reason, and that a valid one, but we very much doubt if it was the real one for not putting themselves to much trouble about the County Council or its requirements. We have never favoured this system of tender by selection. It has some excellent qualities, but, on the other hand, is open to every evil known in business circles. Some time ago it was a case of tramrails going to Continental makers; will these girders go likewise? As a plain matter of fact the action of the London County Council, as do the actions of other councils, play into the hands of manufacturers unfettered by restrictions, so that the competitors do not start level. If that is the conception of free trade or fair trade held in the Council, the sooner the fight of fiscal reform comes on the better. In the recently published return on iron and steel we get these figures with regard to steel. During the period 1890-1901 the production of steel in this country increased about 33 per cent., in Germany 300 per cent., in Belgium over 100 per cent. It is a serious question to consider what part of this increase, say, in Belgium, is due to the action of members of councils insisting upon certain clauses in specifications which are very pertinent here, but practically a dead letter there. But the Government also has much to answer for in its treatment of manufacturers. During the late war the navy and military authorities were somewhat hampered by the fact that all the carbons required for their search-lights had to be obtained from Germany. Concern was expressed by the responsible heads of these services that there were no

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English manufacturers of carbons. This state of affairs is now altered, but the following approximate figures, the general accuracy of which we can guarantee, show what our English manufacturers have to face. Previous to January, 1899, the wholesale price of a certain size of carbon stood at 72s. per thousand feet. Owing to competition in Germany the price then fell slowly to 64s., which killed the new German manufacturer. Immediately the price was raised by the ring to 82s. 6d. This was in April, 1900, and it stood at that figure until works had been established in England. The prices in Germany have not, we believe, been altered appreciably since, but the price for English contracts has been brought down to 53s. 8d., which is quite an unprecedented figure. It can fairly be presumed that it is an unremunerative one, as at 64s. a German competitor was compelled to close his works. The English factory is, of course, losing money, and the whole of the Government orders and those for corporations are going abroad on account of price. The starting of the English factory has reduced prices in England by 35 per cent., but only by reason of "dumping," in which the *Chronicle* does not believe. Probably they will say it is just what any business folks would do to crush a rival. We agree, but would ask the *Chronicle*, What chance has the English manufacturer of crushing his German competitors with the same weapon?

SUMMER YEARNINGS.

The brasswork's bright and burnished, the tiles are shiny clean,
And the paint on the machines is flaming new:
But there's nothing in the summertime like grass or arbor green;
Unless it is the shade of ocean blue.
The armatures are humming, as they take the load with ease,
And the piston's throb makes tremors on the floor:
But let me hear the rustling of the West wind through the trees,
And the banging of the surf upon the shore.

There's warmth from muck-lagged steam-pipes, there's light from arcs galore,
There's a perfume of sulphuric from the cells:
But O! for solar rays that from the outer heavens pour;
And, for preference, the farmyard's soothing smells.
The stokers chant their vespers, and the drivers breathe their woes
("By-our-Lady" is the term they most adore):
But let me hear the bleat of sheep, the ripple song that flows
From the moorland to the sand-befringed shore.

Hail the time of tidal motors! Hail the time when mountain's flood
Twists the winding on the spindle past the pole!
When the men who pull the switches will not hanker for the blood
Of the fiend who first proclaimed the use of coal.
For the summertime is with us, the load curve shrinketh small,
And the lust for Nature sweats from every pore.
Take away that blasted feed pump! take away that glazed brick wall!
Give me sunshine, and God's Peace, upon the shore.

B. C. H. J.

FORTHCOMING EVENTS.

Iron and Steel Institute.—Summer meeting, Barrow-in-Furness, September 1-4.

Municipal and County Engineers.—Meetings: Aberdeen, Aug. 20, 21, and 22; Hastings, September 11 and 12. Detailed programmes will be issued when definite arrangements are made.

THE VERBAND DEUTSCHER ELEKTROTECHNIKER.

(Continued from page 929, Vol. XXXI.)

The following is a translation of one of the papers read before the above institution at their annual meeting in Mannheim.

The Parallel Running of Alternators.

BY H. GÖRGES.

The steady running of alternators in parallel is a question which is still fraught with great importance. While, on the one hand, the increasing employment of the steam-turbine tends to lessen its import; on the other hand, the construction of large gas-engines has given the problem renewed prominence. Nor can it be denied that the difficulties of solution have increased with time. The causes of this are to be found, as we shall presently see, in the adoption of slower speeds and the greater economy effected in the use of materials, as a consequence of which the momentum of the moving parts for the same output of machine has been reduced. The phenomena which pertain to parallel running, more particularly in regard to the oscillations which occur, are of such a complex nature as to defy full appreciation without the employment of mathematics or graphic methods of illustration. But it will be useful, nevertheless, to attempt at least a qualitative explanation by simple argument. The principle of the conservation of energy is best adapted as a basis from which to trace the phenomena. But as we have here to deal exclusively with practically constant speeds, we shall do well to confine our attention to the consideration of the output. We will assume, in the first place, that one machine only is running and supplying current to an incandescent lamp load. In this case the flickering of the lights due to unsteady running will be inappreciable. There will, of course, be slight changes in the speed due to uneven turning moment, but the variation from the normal speed will affect the total output so little that we may neglect the variation and regard the speed as constant. In spite of this, the variations in speed have an important bearing, since the excess of energy transmitted over the output yielded, neglecting for the moment the losses in the machine itself, must be stored up in the flywheel, and for this purpose changes of speed are necessary. The energy absorbed by the flywheel is proportional to the moment of inertia, the angular velocity, and the increase of the angular velocity per second. The moment of inertia is not quite constant, but varies slightly according to the position of the crank relative to the reciprocating parts. These variations are slight, however, as are also the variations in the speed, which we may assume to be the normal angular velocity. The flywheel may be regarded as an accumulator of energy, which exerts a steadying influence on the speed.

But the case is different if the machine works on an asynchronous motor load. The energy absorbed by the latter is proportional to the slip. When synchronism has been attained, it is approximately nil; it is positive for slower and negative for higher speeds. We must now determine the normal speed, and observe the variations from this. If the speed of the generator be increased, the output demanded from it will be greater accordingly, since the motor will then have a positive slip. While in the first case the load on the machine could be looked upon as independent of the slight variations of the speed, it is now directly proportional to these variations. The energy transmitted to the flywheel is proportional to the speed variation per second, the load represented by asynchronous motors depending upon the speed variations themselves. It is obvious that in the second case the variations in speed must be less than in the former; for as the speed increases due to an excess of input over output, the output grows, and relative difference in acceleration becomes less. This effect, which is directly proportional to the fluctuation in the speed, is called "damping." That is to say, asynchronous motors have a damping effect on the working of the primary machine. The regulating effect of the flywheel is naturally lessened. According as the slip of the motors at full load is reduced, the greater

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will be the damping effect. Assuming the damping to be very great, then a very slight variation from the normal speed will cause a considerable augmentation or decrease of the load on the primary machine. Hence the machine, without any considerable change in speed, has to accommodate its output to the fluctuating demand, while the revolving parts can no longer store up the excess energy consequent upon the variations in speed, upon which function their efficiency depends.

We might assume, as a third condition, that our machine is working on a synchronous motor load. In this case similar phenomena occur as when several machines are working in parallel on a common network. We will consider the latter case. For the sake of simplicity we will assume that there is a constant voltage at constant frequency on the 'bus bars. This will be the case if the machines which furnish this pressure run with absolute uniformity and the load on the network is constant. Let us further assume that our machine is coupled to the 'bus bars. It receives a certain constant or periodically varying input from its driving engine, and yields a certain output to the 'bus bars, which output we have now to consider. The excess must be absorbed by the moving parts, and the amount of deficit made up from the store so provided. But this is only possible if variations of speed occur.

In the first place, the machine must run in synchronism—that is to say, with an equal number of poles at the same speed and with an unequal number of poles at speeds inversely proportional to the number of poles. It is further necessary that the phases of the E.M.F. supplied by the individual machines shall be approximately alike, and this necessitates a certain relative position of the rotating parts of the individual machines at each moment. We may therefore speak of a normal position which the machine should occupy at each moment. According to our assumption, this normal position would be maintained constant if it were once fixed and the machine then worked at absolutely constant speed. If, however, fluctuations occur in the speed, the rotor of the machine will vary from the position which it should occupy at any given moment, thereby causing lag and lead of the phases.

Broadly speaking, in the case of machines running in parallel, it is the difference between the E.M.F. on light load and the pressure at the 'bus bars which governs the current yielded by the individual machines. If we regard the pressure at the 'bus bars as constant, then this difference in the case of continuous-current machines, though very small, is directly dependent on the speed. With alternating-current machines the difference is very much greater, and far less dependent on the speed than upon the lead and lag just mentioned. We may in the first approximation neglect the direct influence of the speed, and have, therefore, a different set of conditions than with the continuous-current machines. While, with regard to the latter, the armature position does not matter, it is of great importance with alternating-current machines. We regard as the normal position of the armature that in which the output obtained equals the mean input. A lead increases, a lag diminishes the output. We may regard the variation as directly proportional to the angular deviation from the normal position.

Let us assume for the moment that the input be constant. Then, apart from the losses, the input and output at the normal position are equal—every lead results in an excess output and every lag in an excess input. A braking effect, therefore, results from the lead, and an accelerating force from the lag. This force, which obviously tends to bring the armature of the machine again into its correct position and so maintain the synchronism, is called the "synchronising torque." To be more accurate, we may describe the synchronising torque as that due to the difference between the input and output which occurs within unit deviation. So far we have not considered the damping. Let us now assume that the machine possesses either a natural or an artificial damping. Damping invariably exists if eddy currents can circulate in the field-magnet poles. In massive poles it will exist to a greater extent than in laminated poles, and where a damping winding is provided in a very much greater measure. In order to observe the effects of the damping, we will assume the continuous-current excitation to be cut off. The machine then behaves like an asynchronous motor connected to a live network. It runs light when exact synchronism has been attained. If its speed is too low the machine absorbs current, and if too high it yields electrical energy. Hence we have exactly the same behaviour as in the case of the generator, previously described, which supplied current to asynchronous motors. Its work is positive or negative and exactly proportional to the difference between the actual and the normal speeds. If we close the continuous-current field circuit, then we shall have to distinguish between two parts of the output yielded. The first part depends upon the lead or lag, and is independent of the speed; the second part depends upon the deviation from the normal speed, and is independent of the armature position. In parallel running we have, therefore, different outputs, whose algebraical sum must be approximately zero at any instant. Of these outputs one is absorbed in the machine, and two different kinds are yielded up. The difference between the energy transmitted and the total output yielded is represented by the energy transmitted to or drawn from the flywheel at any moment. It is obvious that exchanges will occur among the different outputs, which exchanges will vary widely according to the given conditions. In examining the phenomena it will be best to take simple cases first.

Let us assume that the output of the driving engine is constant and that no damping exists, as is the case with turbines. If, now, for any reason—for instance, an error of judgment in paralleling—a lead occurs, the output yielded will exceed the input at that moment. The flywheel is called upon to make up the deficit by yielding up the necessary energy at the expense of the speed. Although the lead is thus eliminated, the speed has now become too low, and a lag must consequently arise. But this is tantamount to reducing the load on the machine, and tends to an acceleration of the speed, so that the latter is gradually corrected, the proper speed being maintained when the amount of lag corresponds to a certain value.

The oscillations of the revolving part of the alternator round the normal position may be compared to the action of a pendulum. As with the pendulum kinetic energy is converted into potential energy and inversely. We have alternately an increase and decrease of kinetic energy, and corresponding to these changes a decrease or increase of the energy transferred to the mains. Further we have a potential energy which is proportional to the lead. By means of the lead the machine is enabled to do certain work, whereby the lead is gradually eliminated. This conversion of energy from potential to kinetic takes place in a period which may be termed the periodic time of the revolving part. This cycle, as in the case of the pendulum, is proportional to the square of the moment of inertia and inversely proportional to the square of the moment of synchronism. The length of swing—that is to say, the value of the lead—is determined by exterior causes. Just as we may give a pendulum a greater or lesser length of swing at will, the length of swing in regard to the lead is governed by chance irregularities in the driving.

Should there also be damping, then a new source of energy will be present proportional to the variation of speed. Thereby the cycles will be more or less hindered in their succession. Whereas previously a lead had as its only result an increase of the speed of the armature above the normal, we now obtain as a second consequence a direct increase of the output yielded. This also occurs when, perhaps, there is no lead. Thus we obtain in the damping a means of eliminating the oscillations more or less quickly, and in so far the damping is always useful. When opposed by a very strong damping, the oscillations of the moving parts are entirely prevented.

(To be continued.)

Electric Tramways Construction and Maintenance Co.—The petition of E Horton and others, creditors, for the winding-up of this company has been ordered by Mr. Justice Byrne to stand over till next sittings, negotiations being in progress for the sale of orders for the construction of certain proposed tramways.

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UNIPOLAR MACHINES WITHOUT IRON.*

The writer had two models of unipolar machines without iron made up, one being a motor and the other a generator. The former rotates due to a purely electrodynamic force when current is supplied to it. The latter delivers a current due to electromagnetic induction. As the inducing field was produced by an exciting coil, it was possible, partly by calculation and partly by measurement, to determine the flux for various positions of the circuit, and some interesting conclusions as to the action in unipolar machines could therefore be drawn.

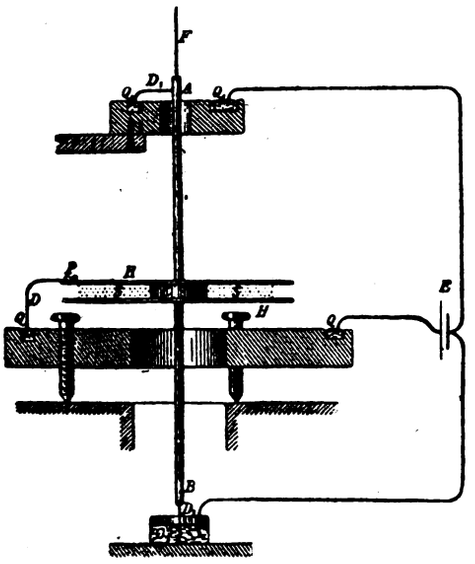

FIG. 1.

Fig. 1 shows the construction of the motor diagrammatically. The brass cylinder, A B, carries a brass disc, C, metalically connected to it. On this the coil, C, is wound between hard rubber flanges, H H. One end of this coil is connected to C and the other to the screw, P. The current comes from the source, E, to the mercury trough, Q, passes up the bent wire contact, D, into the coil and on to C, and then back to the source, E, through both ends (A and B) of the spindle. The motor rotates continuously on closing the circuit—a current of 20 amperes passing. The direction of rotation is independent of the direction of the current. In the case in question the rotation was counter-clockwise looking from above, exactly as would have been the case if a permanent magnet were employed.

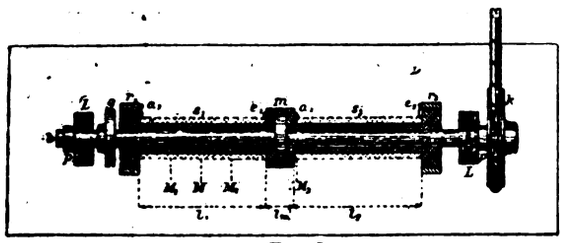

FIG. 2

The generator is shown in Fig. 2. Two coils, s_1 and s_2, wound in the same direction, are carried on the brass spindle, $b\,b$. Current is passed through these coils from a battery by means of the slip rings, r_1 and r_2. The induced current is collected at the brass discs, m and g, by means of contact springs. On connecting a mirror galvanometer between these two contacts, and rotating the apparatus by means of the cord k, a current is indicated which has the same direction relatively to the exciting field as in the case of an ordinary machine.

If the machine is rotated in the same direction as that of the current in the coils, an induced current flowing in the spindle from g to m is set up. On reversing the rotation, the current direction is also reversed.

In order to bring the measurements into agreement with the calculations, various modifications of existing ideas were necessary.

* O. Grotrian in *Annalen der Physik*, 1903, p. 270.

BIRKENHEAD ELECTRICITY ACCOUNTS.

The capital expenditure on March 31 last amounted to £73,841. Below we give abstracts of the revenue account and balance-sheet for the past year.

REVENUE ACCOUNT.

Expenditure.	£	s.	
Generation of electricity	1,964	13	0
Repairs and maintenance	292	11	8
Distribution	513	7	1
Miscellaneous	244	16	9
Management expenses	752	7	9
Balance carried to net revenue account	5,856	9	11
	£9,624	6	2

Income.	£	s.	d.
Sale of current	9,065	10	11
Rental of meters	496	9	10
Rental of motors	7	19	0
Charges for work done	54	6	2
	£9,624	6	2

BALANCE-SHEET.

Property, Outlay, and other Assets.	£	s.	d.
Lands	£2,786	15	10
Buildings	7,190	0	8
Machinery	19,953	8	10
Accumulators	1,847	6	4
Mains	34,730	17	10
Meters	3,403	0	6
Electrical instruments, etc.	1,668	10	8
Engineer's commission, etc.	1,791	14	0
Printing, stationery, etc.	196	7	7
General stores	35	15	3
Public lamps	2,149	11	1
Noctorum	5,510	11	0
Tranmere	2,911	11	4
South station	9,072	19	1
Motors	95	13	11
Sundry debtors	3,468	3	7
	£96,812	7	6

Liabilities.	£	s.	d.
Loans on mortgage	68,264	2	3
Sinking fund	3,735	17	9
2¾ per cent. redeemable stock	18,608	12	8
Stock redemption fund	1,391	7	4
Sundry creditors	178	17	1
Renewals accounts	996	0	10
North and South Wales Bank	3,637	9	7
	£96,812	7	6

WIMBLEDON ELECTRICITY ACCOUNTS.

The capital expenditure on March 31 last amounted to £100,201. Below we give abstracts of the revenue account and general balance-sheet, together with statement of electricity sold, generated, etc.

REVENUE ACCOUNT.

Generation of Electricity.	£	s.	d.
Coal or other fuel	3,876	15	7
Oil, waste, etc.	449	3	7
Wages	921	13	9
Repairs and maintenance	284	15	6
Distribution of electricity—repairs, maintenance, etc.	114	19	7
Public Lamps.			
Attending and repairs	784	0	3
Renewals of lamps	91	13	4
Rents, rates, taxes	439	19	10
Management Expenses.			
Salaries—viz.: Engineers' department	724	18	7
Clerical staff	261	12	3
Stationery and printing	127	14	3
General establishment charges	182	18	7
Law and parliamentary and special charges	104	7	5
Total expenditure	8,364	12	6
Amount carried to net revenue account	7,107	13	6
	£15,472	6	0

Cr.	£	s.	d.
Sale of current per meter	9,650	7	7
Contracts	13	5	0
Public lighting	5,403	11	2
	15,067	3	9
Less bad debts written off	67	16	4
	14,999	7	5
Rents and sundries	473	18	7
	£15,472	6	0

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BALANCE-SHEET.

Dr. Liabilities.	£	s.	d.
Capital account	102,857	4	8
Sundry creditors	1,895	15	6
Reserve fund account	500	0	0
Due to treasurer on revenue account	3,914	10	5
	£109,167	10	7

Cr. Assets.	£	s.	d.
Capital account	100,201	13	0
Stores on hand	1,628	16	0
Sundry debtors	3,914	10	5
Securities held (cost price)	500	0	0
Cash	2,922	11	2
	£109,167	10	7

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T. units		1,157,084
Quantity sold { Public lamps	511,152	1,011,998
Quantity sold { Private consumers by meter	500,846	
Quantity used for works lighting		18,214
Total quantity accounted for		1,030,212
Quantity not accounted for		126,872
Total maximum supply demanded (kilowatts)		603

Number of public lamps: 1,091, equivalent to 4,486 8-c.p. lamps.

TRADE NOTICES AND NOVELTIES.

Edgewise Instruments.

The illustrations herewith show a departure made by Messrs. Everett, Edgcumbe, and Co., 151-152, Great Saffron-hill, Holborn-circus, London, E.C., in the manufacture of their

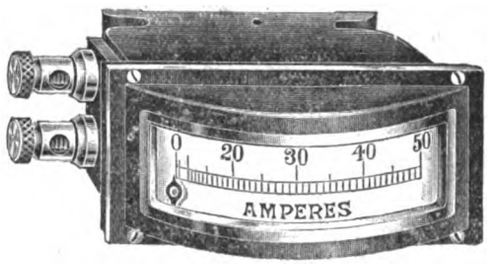


FIG. 1

small ammeters and voltmeters. In these edgewise instruments a scale 4½in. long is obtained—that is to say, of the same length as the ordinary round instruments 7in. or 8in. in diameter—whereas the actual space occupied is only 6⅝in. by ⅞in. The actual saving in space is really considerably greater than these figures would seem to indicate, owing to the fact that from their convenient shape they enormously simplify the setting out of the board, as they can be fitted in between switches, etc., or can be placed horizontally along the top of the board.

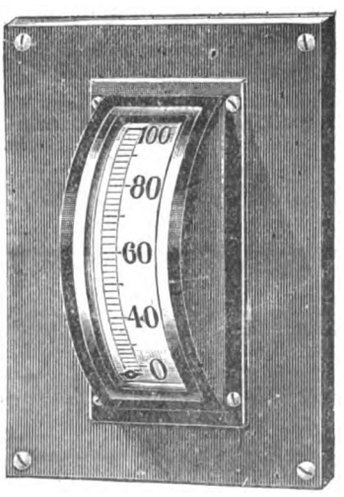
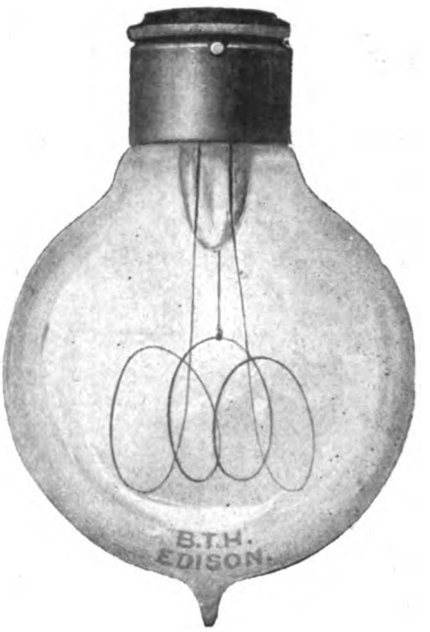


FIG. 2.

The meters are supplied in two distinct forms either for mounting on the surface of the switchboard (Fig. 1), or for letting into it (flush type, see Fig. 2). Each type can be supplied either with horizontal or vertical scales, as preferred. Messrs. Everett, Edgcumbe, and Co. supply these instruments either of the dead-beat moving-coil type or of their moving-iron type. The latter are fitted with their well-known "air-damping" arrangement, whereby, without any friction whatever, that absolute dead-beatness is obtained which is so essential for motor work. Now that such compact and workmanlike meters are obtainable at a reasonable price, everyone installing an electric motor should make a point of including, if not a voltmeter, at any rate an ammeter, to act not only as a check on the efficiency of the motor and the plant which it is driving, but also as a great preventive of breakdowns.

British Thomson-Houston Round-Bulb Electric Lamps.

For window or other decorations, and for all installations where a short bulb is desirable, the British Thomson-Houston Company supplies a specially-designed round-bulb lamp. As apparent from the accompanying illustration, this lamp is neat and compact, and readily lends itself to artistic treatment. The filament is arranged in spiral form, and is supported by a single anchor, which gives mechanical strength to the carbon without casting shadows or interfering with the life of the lamp. The cap is fixed to the glass with a non-hygroscopic material. This construction renders the lamp suitable for use in damp or exposed places. The round-bulb lamp is 3¼in. long and 2¼in.



in diameter. The efficiency of this lamp for different candle-powers and voltages is given in the following table:

Voltage.	Candle-power.	Efficiency.
100 to 125	8	4 watts per c.p.
100 to 125	16	3·5 ,,
200 to 250	8	4·5 ,,
200 to 250	16	3·8 ,,

LEGAL INTELLIGENCE.

TELEPHONE COMPANY'S POWERS.

On the 23rd inst., in the City of London Court, Judge Rentoul, K.C., heard an application by Mr. Henry Lazarus, Bushey Heath, Herts, for an interim injunction restricting the National Telephone Company, Limited, from disconnecting his telephone.

Mr. Murphy, for the plaintiff, said that the case was of immense importance to all users of telephones, especially as there was a competitive system in the shape of the General Post Office. Plaintiff had been on the telephone for two years, and he paid £3. 10s. a year. Five days before the second year was completed he received a letter from the company saying they intended increasing the charges, and if he did not sign the new agreement sent him he would be cut off. And, much to his inconvenience, he was. Six months' notice should have been given of the intended disconnection.

Mr. Gaine, for the Telephone Company, said they were not bound to give the plaintiff any notice of their intention to cut him off the service.

Judge Rentoul remarked that that was a very strong proposition. Some men would rather remove than be without the telephone. He did not think the company ought to treat the plaintiff as they had done. They ought to give him reasonable time to make other arrangements. At the same time he could not grant the interim injunction asked for as the wires had been severed. There was no means to enforce the Court's order if it were to make one.

ALLEGED DEFECTIVE FITTINGS.

At the Portsmouth County Court, before his Honour Judge Gye, Mr. T. E. Fiford, electrical engineer, of Southampton, sued Mr. Scullard, of Totterdell's Hotel, Portsea, for £75. 3s. 2d., less £35 paid on account, for the installation of the electric light at the hotel. Plaintiff deposed that he put in electric light and bells in 1902, and the fittings passed the Corporation tests. Within a day or a day and

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a half of the tests being completed, to meet the insurance company's conditions, plaintiff was refused admission. The plaintiff, closely questioned, declared that the wire was properly insulated, and that the work was well and properly done.

Mr. W. S. Foal, superintendent of the Portsmouth Corporation electric supply works, said a test was made at the end of February of last year, but it was not satisfactory. Another test was made, at which he was not present, but his assistant was. It was a test of the insulation, and the assumption was, if satisfactory, there would be no leakage of the wires. It was no part of the duty of the Corporation to pull up the work and examine it.

Mr. C. F. Quick, an electrical engineer, for the defence, said he made a careful survey of the fittings at the hotel alleged to have been made by the plaintiff, and he declared that they were dangerous. It was not indiarubber that was used on the wires for the insulation, but a composition, and he considered the switches very defective. They were of a German make. The whole of the place had to be re-wired.

His Honour gave judgment for plaintiff for £3 on the claim.

LONDON MOTOR OMNIBUS COMPANY.

In the Chancery Division on Friday, Mr. Justice Byrne, in the case of Hart *v.* the London Motor Omnibus Company, Limited, appointed a receiver of the company's property. The plaintiff is a holder of debentures which had become payable; interest was in arrear, and execution had been threatened. Several other actions had also been instituted against the company.

COMPANIES' MEETINGS AND REPORTS.

CITY AND SOUTH LONDON RAILWAY.

The ordinary general meeting of the proprietors of this railway was held at the offices, Finsbury-pavement, on Tuesday, Mr. C. G. Mott presiding.

The report of the directors for the half-year ended June 30 stated that the receipts from all sources for the past half-year amounted to £81,770. 7s. 5d., and the cost of working has been £37,919. 3s. 3d., leaving a profit of £43,851. 4s. 2d. Inclusive of the balance brought forward from Dec. 31 last, the net revenue account shows an aggregate total of £45,378 2s. After making provision for the debenture stock interest, and the transfer to the renewal fund of £1,500, a balance remains available for dividend of £33,006. 9s. 11d. Out of this sum the directors recommended that the full dividend of 5 per cent. per annum be paid on the prefetence stocks 1891, 1896, and 1901, and that a dividend at the rate of 2¾ per cent. per annum be paid upon the consolidated ordinary stock for the half-year, leaving a balance of £1,500. 0s. 11d. to be carried forward to the next account. The directors regret that although the receipts of the line show a small increase over those of the corresponding period of last year, some addition to the expenses, together with a larger amount of interest payable on the debenture and preference stocks, have necessitated a decrease of ¼ per cent. in the dividend. The appeal in respect to the compensation to be paid for the site of the station under St. Mary Woolnoth Church having been decided against the Company, an order was made that the whole amount awarded should be paid into court together with the accumulated interest, amounting in the whole to £89,904. 4s. 3d. (in addition to £81,350 already paid into court), and this has been done, the necessary funds having been raised by the issue of preference and debenture stocks. The questions involved being of such great importance to the Company, the directors propose to carry the case to the House of Lords, where they hope they may obtain a more favourable decision.

The Chairman stated that the Bill which the Company had obtained this session for the extension of the line to King's Cross, St. Pancras, and Euston, including the transfer of the undertaking of the City and Brixton Railway to the Company, had not yet received the Royal assent, and therefore no business would be proceeded with under the notice which had been given that day for the extraordinary general meeting. He reminded the proprietors that when they met a year ago the directors were able to recommend an increase in the dividend over that for the corresponding period of the year before of no less than 1¼ per cent. This large increase was due, in the first place, to the extension to Islington, but also very considerably to the fact that the horse tramways were at the time being reconstructed so as to be worked by electricity. The Company this year had not benefited as they did a year ago by the interruption to the tramway service; on the contrary, they had to meet very considerable opposition from the improved working of the tramways. The result had been that a great deal of traffic—and especially short-distance traffic—had been attracted away from their railway for the time being. When he stated that nearly half of the fares taken by the electric trams did not exceed ½d. for each person, it would be understood that the competition with the railway was very keen, none of their own fares being less than 1d. He moved the adoption of the report and accounts.

Mr. C. S. Grenfell seconded the motion, which was carried unanimously.

GENERAL ELECTRIC.

The ordinary general meeting of the shareholders in this Company was held on Friday at the offices, Queen Victoria-street, Mr. G. Byng presiding.

The report of the directors for the year ended March 31 last states that the net trading profits and income from investments, etc., amount to £94,381. 14s. 4d.; less loss at Witton works, £20,001. 11s. 7d.; leaving £74,380. 2s. 9d. After deducting depreciation and debenture interest, amounting to £22,349. 0s. 7d., there remains a balance of £52,031. 2s. 2d., out of which the dividend on the preference shares at the rate of 5 per cent. for the year has been paid, absorbing £12,500, leaving an available balance of £39,531. 2s. 2d. The directors recommended that this sum should be appropriated as follows: payment of managing directors' and employés' bonus, £3,953. 2s. 2d.; dividend on ordinary shares at the rate of 5 per cent. for the year ended March 31, 1903, £14,419; reserve account, £21,159. The reserve account stands in the accounts at £39,051. 2s., being the amount of undivided profits as at March 31, 1902. The proposed appropriation of the undivided profit of the year ended March 31, 1903, amounts to £21,159, giving a total of reserve account of £60,210. 2s. The trading profit derived from the general business of the Company has shown an increase in almost every department, and the net result must be considered satisfactory. On the other hand, the establishment of the new works at Witton, involving the teaching and training of new workpeople and entailing expenses inseparable from the creation of a new industry in this country, has occasioned a loss during the first year's working. The directors have thought it prudent to write off the whole of such loss this year. Nevertheless they have, by reducing the dividend on the ordinary shares, still been able to place an amount to reserve that is up to the standard of previous years. The engineering works at Witton are now well provided with orders, and there are indications that they will add materially to the profits of the Company in the coming year. During the year further 2,422 ordinary shares have been allotted to the directors of the Company and members of the staff at par.

The **Chairman**, in moving the adoption of the report, said that the feature of the balance-sheet was that all the money obtained when the Company was formed, and also some of the profits, had now been invested for the purpose stated in the prospectus—for building up a large manufacturing establishment at Witton, near Birmingham, in addition to the London and Manchester works. The item of £83,558 was almost entirely composed of additions to the buildings and plant at the works there. The Board had so far spent upon the Witton works about £250,000, and had created factories which in some respects compared with the best in England. To the large engineering and carbon works they had added during the year the extensions to the ironfoundry and the tube works. He regretted that the Board had to record a loss of £20,000, which considerably reduced the profits to be divided. This loss had occurred at the Witton works. The major part of this sum was due to exceptional circumstances, and really in no way detracted from the fact that the works themselves were in good condition. No fear need be felt of a recurrence of such a loss. The largest amount of the Witton deficit came from the carbon works, and it was mainly due to what must be called unfair foreign competition. The Company were making carbons even better in quality than the German production, and the three largest foreign manufacturers had now decided to reduce their prices to a level which would be unremunerative to the Company, and, with a view of killing the British manufacture, they were prepared to work at a loss to themselves in this country until they had achieved their object. The Admiralty, the War Office, and many other Government and public bodies had assured the Company of their support in spite of the price regulated in the way he had mentioned, and with this help, and the fact that they were able to obtain the raw material at a lower price than the Germans could obtain it, he still trusted to be able to keep the carbon factory going until the time came when the country saw the folly of free imports directed solely against the English manufacturer. The Company's experience in carbons must prove to anybody that to establish a new industry in this country was practically an impossibility under the present system. He hoped sincerely that manufacturers would eventually obtain their legitimate share in both the home and the Colonial markets. When that happened shareholders might see their large works extended enormously, and the number of their workmen, which now reached about 6,000, doubled very shortly.

Mr. Max Byng seconded the motion, which was adopted.

The **Chairman**, in reply to questions, said that the carbon works would in time have to be shut up unless the Company obtained protection.

EASTERN TELEGRAPH.

The general meeting of the shareholders in this Company was held at River Plate House, Finsbury-circus, on Wednesday, Sir J. Wolfe Barry presiding.

The **Chairman**, in moving the adoption of the report (*vide* last issue), said it should be clearly understood that the increase in the receipts was not owing to the reductions in the rates; in fact, the effect of these reductions in themselves was—at least at present—in precisely the opposite direction, for with the exception of the Cape joint-purse traffic, there was a considerable reduction in the amount received during the half-year from the places which had benefited by the reduced rates. One of the strong features of the Company was the variety of sources from which their revenue was derived. If there were a temporary reduction in the receipts from one or more sources, owing to reduced rates or other causes, there might be a corresponding increase in some other direction which enabled the Company, as in the half-year under review, to maintain their revenue. The Board had for some time been impressed with the necessity of the Company's being in the forefront of scientific developments in cables and cable instruments, and they decided, in conjunction with the Boards of the associated companies, to offer to Sir Oliver Lodge the post of consulting scientific adviser—a position which, he was glad to say, Sir Oliver Lodge had accepted. The whole of their present power to issue further capital was £168,685. The Board knew of nothing at present to necessitate any increase in this power, but, judging from past expe-

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rience, submarine cable enterprise developed rapidly, and it might, perhaps, be advisable before very long to ask the stockholders to grant them some little further power to increase the ordinary and preference capital, as well as the 4 per cent. mortgage debenture stock. The International Telegraph Conference was held in London from May 26 to the 10th inst., when various rules and regulations were discussed and amended, and some tariffs were revised, but the revenue would not be materially affected by any of the revisions adopted at the conference. He had nothing to add to what he had said on former occasions respecting the subject of wireless telegraphy, which the directors had always thought would not rival, but would prove a useful adjunct to submarine telegraphy. The Company had installed the system on some of their ships, and had found it useful. He next referred to the fact that after prolonged negotiations the Eastern Extension Company had come to a provisional understanding which, although necessitating considerable concessions, would bring them into intimate and satisfactory business relations with the Commercial Pacific Company. The latter's cable was open for traffic between Manilla and the United States on the 25th inst., and various reductions in the tariff by the Company's route were brought into force on the 15th inst. These reductions would no doubt have a considerable effect on the revenues of the associated companies, but he believed that they would in the long run not only prove of the greatest possible advantage to the telegraphing public, but that they would also put the companies on a very firm and solid basis in the Pacific Ocean.

Sir J. Denison-Pender seconded the motion, which was unanimously adopted.

NATIONAL TELEPHONE.

The ordinary general meeting of the shareholders in this Company was held at Hamilton House on the 23rd inst., Sir Henry Fowler, M.P., in the chair.

The **Chairman**, in moving the adoption of the report (*vide* issue of 17th inst.), stated that the net result of the half-year's working was a profit balance of £377,994. At their meeting six months ago he stated that the amount paid by the Company to the Post Office for royalties was £154,000 for the year 1902, and for the past half-year they had had to pay £81,930, which was a heavy burden on their income. The profit balance was £32,783 more in the past half-year than in the corresponding period of the previous year, but as they had had to pay £6,165 more to the Post Office the net increase in the Company's income was £26,618. The rentals carried forward for unexpired terms of running contracts amounted to £874,383, against £821,397 a year ago. The available balance of revenue was £239,748, out of which the directors proposed the payment of the half-yearly dividends on the first, second, and third preference shares, 6 per cent. per annum on the preferred stock, and 5 per cent. per annum, compared with 4½ per cent. hitherto, on the deferred stock. Their position was satisfactory both as to their plant and their staff. In the past half-year they expended on entirely new work £334,115, in addition to many thousand pounds more than the amount spent in the June half of 1902 in maintaining the efficiency and the full value of the existing plant. In a company like theirs everything depended on this being done, and as there was, perhaps, a more rapid depreciation in telephone plant than in many other plants, the directors intended, in order fully to maintain it, to continue to take large sums from revenue. The business of the Company in London was increasing very considerably, as was also that of the Post Office, and the present arrangement justified what had previously been said at their meetings—namely, that there was room in London for the systems both of the Post Office and of the Company. The number of their telephone messages—taking the call and the reply—reached the enormous figure in the past half-year of 922,875,000, compared with 787,311,000 in the June half of last year, while the number of the home telegrams of the Post Office for the year ended March 31, 1902, was 82,000,000. He thought that these figures gave an admirable summary of the Company's progress.

Mr. George Franklin (Sheffield) seconded the motion, and it was unanimously adopted.

EDMUNDSON'S ELECTRICITY.

The ordinary general meeting of the shareholders was held on Thursday last week at the offices, Broad Sanctuary-chambers, Westminster, Mr. Francis E. Gripper presiding.

The **Chairman**, in moving the adoption of the report, stated that the total profits from the various sources named amounted to £56,954, to which had to be added the balance of £6,179 brought forward. After paying the interest on the debenture stock and the dividends upon the preference shares, and after allowing for the interim dividend upon the ordinary shares, £37,257 remained to be dealt with. The Board recommended that £5,000 should be written off the goodwill account, that £9,274 should be added to the reserve fund, and that a dividend at the rate of 9 per cent. per annum for the half-year should be paid on the ordinary shares, making a total distribution of 7 per cent. for the year. This would leave £11,733 to be carried forward. That amount was larger than usual, but the directors felt sure that the shareholders would approve the Board's policy of conserving the resources of the Company as much as possible in the early years of their existence. During the year issues had been made of 20,000 preference shares and £40,000 debenture stock, and the premiums received on these issues, amounting to £16,725, had been added to the reserve fund. Including the sum proposed to be carried from the revenue account, the reserve would now be increased from £14,000 to £40,000. The fresh capital which had been raised had been required for the completion of new works and the necessary extensions of those already existing. Since the last report the Company had opened new electricity works in nine fresh towns. There were now 28 central stations actually at work, and during the year the increase in the lamp connections had been over 163,000, with an additional 38,000 applied for and waiting to be dealt with. The most important new work in view was in connection with the Lancashire Electric Power Company.

Mr. W. R. Davies seconded the motion, which was carried.

DUBLIN UNITED TRAMWAYS.

The half-yearly meeting of the shareholders in this Company was held in Dublin on Tuesday, Mr. William M. Murphy presiding.

The **Chairman**, in moving the adoption of the report, said the most interesting and the most encouraging item in the accounts was the continued increase in their receipts. This increase amounted in the half-year to £5,610. The traffic receipts actually increased by £5,749, but there was a falling off of £234 in the advertising receipts, but this reduction was owing to temporary causes, and the directors hoped not only to recover the loss, but to increase the receipts under this head. Looking back a year, the receipts for the last half-year were £10,730 more than they were two years ago, indicating a steadily progressive business. The company had effected a saving of £1,093 in the cost of generating electric current. Under the head of general maintenance there was an increase of £2,754, the increase in the cost of car bodies, car trucks, and electrical equipments accounting for £1,467. The maintenance of the engines, electrical plant, boilers, etc., at Ringsend exhibited a small saving, and there was an increase of nearly £400 under the head of buildings, which was occasioned by making good the effects of the great storm of February last. The increase of £760 in the maintenance of the overhead line was largely due to the same cause. The increase of the traffic expenses of £874 was nearly all in the item of wages, and this was duly accounted for by the fact that the mileage covered by the cars was more than 50,000 miles in excess of last year. The most serious increase in their expenses, amounting to £3,230, was to be found in the account for "general charges." The greater part of this increase—namely, £2,125—was due to rates and taxes, which reached within a few shillings of £10,000 for the half-year.

Mr. Percy Bernard seconded the motion which was adopted.

DIRECT UNITED STATES CABLE.

Presiding over the general meeting of the shareholders in this Company at Winchester House, E.C., on Tuesday, **Mr. E. M. Underdown, K.C.**, said that for more than a year the Company had had no expenses for repairs, and in this it was extremely fortunate, but this state could not be expected to continue, and renewals and repairs would have to be made from time to time. During 26 years the Company had received £255,532 in interest on the reserve fund account, or an average of £9,828 per annum; repairs had absorbed £228,829, or an average of £8,800, which was less than the interest obtained on the reserve fund, so that what was earned was clear profit to the business. Another favourable feature was that during repairs and interruptions the Company retained its same earnings during the first year owing to the fact that it shared in the earnings of the pool companies. With regard to Marconi and other wireless telegraphic systems, he never did, and did not now, think that they were to be taken seriously in regard to traffic across the Atlantic. Shareholders need not be under any apprehension in that respect. The International Telegraphic Conference had been held in England, and the results had not in any material degree affected the position of the Company.

The report was adopted.

ANGLO-AMERICAN TELEGRAPH.

The report of the directors states that the total receipts from Jan. 1 to June 30, 1903, including the balance of £1,706 brought forward from the last account, amounted to £184,461. The traffic receipts show an increase of £9,297 as compared with the half-year ended June 30, 1902. The total expenses for the half-year, including the repair of cables, etc., amounted to £65,893, being an increase of £6,962 as compared with the corresponding period of 1902. The cost of repair of the 1873 cable to June 30 amounting to £12,190, has been charged to the renewal fund. The directors, under the powers conferred upon them by the articles of association, have, before declaring the net profits, set apart the sum of £12,000 to the renewal fund, leaving a balance of £106,468. One quarterly interim dividend of 15s. per cent. on the ordinary stock and of £1. 10s. per cent. on the preferred stock was paid on May 1, 1903, absorbing £52,500, and a second quarterly dividend of 15s. per cent. on the ordinary stock and £1. 10s. per cent. on the preferred stock, amounting to £52,500, will be paid on Aug. 1, 1903. The balance of £1,468 will be carried forward to the next account. The cables and land lines of the Company are in good working order.

WATERLOO AND CITY.

The report of the directors for the half-year ended June 30 last states that there had been no change in capital account during the half-year. Gross receipts, less Government duty, amounted to £17,438, and the working expenses to £8,022, being at the rate of 46 per cent., as compared with 44 84 per cent. for the corresponding period of 1902 The balance available for dividend, after providing for interest on debenture stock, is £8,945, and a dividend at the rate of 3¼ per cent. per annum on the ordinary stock is recommended, leaving £170 to be carried forward. The number of passengers carried during the past six months, exclusive of season-ticket holders, was 2,281,133, showing an increase of 41,739 over the number carried in the corresponding period of 1902. The season-ticket holders on June 30 last numbered 1,244, as against 1,197 at the end of June, 1902.

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NEW COMPANIES REGISTERED.

Bath Electric Manufacturing Company, Limited.—Capital, £15,000. Objects: to adopt an agreement with H. V. Kramer and J. A Steven; to acquire and turn to account certain inventions in relation to electric motor controllers and resistance material, and the patent rights for such inventions, and to carry on the business of electrical engineers, electricians, etc.

Automatic Circuit Breakers, Limited.—Capital, £100. Objects: to acquire and take over the rights and obligations of H. J. Swirles, H. Swanton, and R. Starke, under an agreement between the said H. Swanton and R. Starke, and to carry on the business of electrical and general engineers, manufacturers of, agents for, and dealers in circuit breakers, dynamos, engines, electrical appliances, etc.

Electrical Engineering Company of London, Limited.—Capital, £1,000. Objects: to construct and maintain cables, wires, accumulators, lamps, and works; to generate and supply electricity; and to carry on the general business of electricians, electrical and mechanical engineers, manufacturers of and dealers in electrical apparatus, suppliers of electric light, etc.

Reliance Electric Company, Limited.—Capital, £1,000. Objects: to carry on the business of electrical and mechanical engineers, electricians, suppliers of electricity for light, heat, power, or otherwise, etc.

British Tramways and General Construction Company, Limited.—Capital, £300,000. Objects: to carry on the business of financiers, concessionnaires, capitalists, owners and workers of railways, tramways, electric light, traction, and power works, etc.

Torquay and District Motor Omnibus Company, Limited.—Capital, £10,000. Object: to provide a service of motor omnibuses for Torquay and district.

British Electric Separating Company, Limited.—Capital, £6,000. Objects: to acquire the business of tin strippers carried on at Swansea by H. A. Leaver as H. A. Leaver and Co., and to carry on the business of stripping tin from tinplate scrap and other articles by electricity or otherwise, and any other business connected with the electro-deposition of metals.

PERSONAL.

Engineers generally and tramway engineers in particular will join with us in congratulating Mr. A. Baker, general manager of the London County Council tramways undertaking, on his appointment to a similar position under the Corporation of Birmingham. In securing Mr. Baker to advise them in carrying out their scheme for electrifying the city tramways, the Corporation of Birmingham have accomplished a master stroke, and by his new appointment Mr. Baker will increase his salary from £1,000 to £1,500 per annum. During the time he has filled the responsible position of manager of the London County Council Tramways Department, Mr. Baker has proved himself to be an excellent administrator. His reputation as a tramway manager was made at Nottingham. Entering the service of the local company in 1878, he succeeded in bringing prosperity to the concern, so much so that the shares during the period of his managership rose from 50s. to par—*i.e.*, £10. He continued to control the undertaking when the municipality took it over from the company, and was responsible for the conversion of the lines from horse to electric traction. Mr. Baker has been with the County Council since 1899, so that a good part of the work consequent on the decision of the County Council to electrify their lines has fallen upon his shoulders, and his success in this direction specially recommend him to Birmingham, where a similar decision was recently come to. We wish Mr. Baker all success in the onerous and responsible duties which lay before him.

We understand that the Bradford Tramways Committee propose to increase the salary of Mr. C. J. Spencer, tramways manager, from £500 to £700 per annum, with a yearly advance of £100 for three years.

Owing to the illness of Mr. D. Scott, traffic manager in the tramway department of the London County Council, whose salary is £550 a year, the Highways Committee propose to terminate his engagement as from Dec. 31 next.

Messrs. A. H. Sears and T. W. Graves have been appointed electric inspectors under the London County Council at a commencing salary of £175 a year each.

The resignations of Mr. G. H. Rhodes, chief assistant in the electric lighting department, Birkenhead, and Mr. D. Williams, shift engineer, have been accepted.

Mr. Joseph Wilkinson, M.I.E.E., who has been in charge of the tramway power station at Hull for some time, has been appointed tramway electrical engineer at a salary of £300 a year under the direction of the city engineer.

Mr. R. L. Horsfall, chief clerk in the tramways department of the Bradford Corporation, has received the appointment of general manager of the Walsall tramways.

CONTRACTS FOR ELECTRICAL SUPPLIES.

Lisbon.—The Public Works Department require tenders for the public electric lighting of Macao. Tenders by Oct. 21.

Edinburgh.—The Corporation are prepared to receive tenders for the supply of arc-lamp posts. Tenders by Aug. 3. Advertisement in last issue.

Pemberton.—Tenders are invited for the electric lighting of St. John's Church. Particulars can be obtained from Mr. J. Baynes, 618, Ormskirk-road, Pemberton.

Brighton.—The Town Council invited tenders for the supply of meters for a period of one year from Sept. 1, 1903. Tenders by Aug. 10. Advertisement in last issue.

Halifax.—The Corporation invite tenders for the supply of an additional feeder cable, ·8 square inch, ·4 square inch, ·8 square inch sectional area. Tenders by 12 noon on Aug. 4.

Accrington.—Tenders are invited for the electric lighting of new Wesleyan Sunday School. Specifications can be had from Mr. Pollard Barlow, 6, Hest-bank, Rough Lee-road, Accrington.

Baltinglass (Ireland).—The Guardians are prepared to receive tenders for supplying and erecting electric bells throughout the workhouse, amounting to about 12 in all. Tenders by Aug. 8.

Barton-on-Humber.—The Urban District Council invite tenders for lighting the town by gas or otherwise from Aug. 30 next to May 31, 1904. Information can be had at the Clerk's Office. Tenders by Aug. 3.

West Ham.—The Borough Council invite tenders for traction switchboard, etc. Particulars from Borough Electrical Engineer, Abbey Mills, West Ham. Tenders by 4 p.m. on Aug. 21. See advertisement.

Middleton (Lancs.)—The Corporation invite tenders for the supply and erection complete at their electricity works of a grease extractor. Particulars may be obtained from Mr. S. Pauls, borough electrical engineer. Tenders by Aug. 11.

Swindon.—The Corporation invite tenders for the supply, delivery, and laying of all the rails, points, crossings, and accessories for the permanent way of the Corporation's tramways. Particulars from the engineers, Messrs. Lacey and Sillar, Manchester and Westminster. Tenders by Aug. 26. See advertisement.

Shanghai.—The French Colony propose to instal motor-propelled tramways. Tenders may be sent by Oct. 31, 1903, to Secrétariat de la Municipalité Française de Shanghai. Particulars may be obtained from l'Office National du Commerce Extérieur, Rue Feydeau, 3, Paris.

Launceston (Tasmania).—The Mayor and Aldermen invite tenders for the supply of 500 or more electric meters. Particulars may be obtained on application to Mr. William Corin, city electrical engineer, Launceston, Tasmania, or to Messrs. John Terry and Co., 7, Great Winchester-street, London, E.C. Tenders by Sept. 28.

Aldershot.—The Urban District Council invite tenders for the supply and erection at the sewage works of two 4in. motor-driven centrifugal pumps; also generator, battery, and automatic starting switch s. Particulars may be obtained at the office of the Engineer and Surveyor to the Council. Tenders by Aug. 4. Advertisement in last issue.

London, S.W.—The London County Council invite tenders for the supply and delivery of two low-tension feeder switchboards, and for the erection of one of them in each of the Council's sub-stations at Camberwell and New Cross respectively. Particulars may be obtained at the County Hall, Spring gardens, S.W. Tenders by 10 a.m. on Aug. 11.

Rochdale.—The Corporation invite tenders for the supply and delivery of 16 double-deck, double-truck cars, 20 double-deck, single-truck cars, and five single-deck combination cars, with all trucks, motors, and accessories. Particulars from Messrs. Lacey and Sillar, 2, Queen Anne's-gate, Westminster, and 78, King-street, Manchester. Tenders by Aug. 10. Advertisement in last issue.

Madrid.—The Posts and Telegraphs Department require tenders for the supply of 25 telegraph apparatus of the Hughes system and 25 motors with weight elevators for the same, for the service of the telegraph stations of the State, at the upset price of 2,530 pesetas, or about £73, for each apparatus with its accessories as detailed, and 408 pesetas, or about £12, for each motor with its corresponding elevator.

Cheadle.—The Urban District Council are prepared to receive tenders for the supply of materials and execution of works in the laying of concrete foundations, fixing rails, points and crossings for the tramway permanent way complete, including taking up present macadam and paving setts, but except fixing bonding. Particulars may be obtained on application to Mr. Chas. R. Brady, A.M.I.C.E., 13, Warren-street, Stockport. Tenders by 12 noon on Aug. 17.

Northampton.—The Corporation are prepared to receive tenders for the supply, delivery, and erection of the following in connection with the Corporation electric tramways: (Section No. 1) boilers, steam, exhaust, and water piping, condenser, cooler, water-softening plant, mechanical draught, etc.; (2) steam generators, dynamos, battery, and booster, switchboard, travelling crane, station lighting, etc; (3) overhead trolley equipment; (4) underground feeders, pilot, and telephone wires; (5) cars; (6) permanent way; (7) power station buildings; (8) car-sheds, workshops, offices, etc. Particulars on application to the borough engineer, Mr. Alfred Fidler, A.M.I.C.E., Guildhall, Northampton. Tenders by 12 noon on Aug. 15.

RESULTS OF TENDERS.

Swindon.—The Corporation have accepted the tender of Allbright and Co., Swindon, for the wiring of the technical school, at £325. 10s.

Nelson.—The Tramways and Electricity Committee have accepted the tender of Messrs. Dick, Kerr, and Co., of Preston, for the supply of two new single-deck cars.

Rochdale.—The Tramways Committee have accepted the tender of Armstrong, Addison, and Co., Sunderland, for the supply and delivery of creosoted beech paving blocks.

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Beckenham.—The Urban District Council have accepted the tender of the British Westinghouse Electric and Manufacturing Company for electric meters, at £492.

Ealing.—The Corporation have accepted the tender of Mr. J. Harvey for pipework required in connection with the new boiler and cooling tower at the electricity station, at £908.

Ipswich.—The Corporation have placed an order with the British Westinghouse Company, Manchester, for one watering and track-cleaning car, complete with all necessary electrical equipments.

London, N.—The St. Pancras Guardians have accepted the tender of Barlow Bros. and Co., Shaftesbury-avenue, W.C., for wiring for the electric light to Highgate Workhouse Infirmary, at £1,093. 12s. 6d.

Hammersmith.—The tender of the Reason Manufacturing Company, Limited, for supplying arc lamps and accessories required in connection with the electric lighting on the new tramway routes is recommended for acceptance at £373.

London County Council.—The Council have accepted the tender of J. Cochrane and Sons, Limited, for the construction of a pier, river wall, and water-condensing pipes in connection with the electricity generating station to be established at Greenwich, at £55,558. 19s. 9d.

Leicester.—The Tramways Committee report having accepted the following tenders: Dick, Kerr and Co., Preston, building and delivering 58 cars for the new electric tramways, £510 each; T. Hutchinson and Sons, Leicester, for the erection of the main car depot in Abbey Park-road, £16,845. 17s. 3d.

Radcliffe. — The Urban District Council have accepted the following tenders for the supply and erection of plant: G. Wolstenholme and Son, Radcliffe, Lancs., steam, exhaust, feed, and water pipes and accessories, £1,620; Crompton and Co., London-wall, E.C., balancer and motor-generator, £645; British Accumulator Company, Victoria-street, S.W., accumulators, £689. 15s.

Hammersmith.—The Corporation have received the following tenders for supplying the pumping plant required in connection with the extension of the condensing scheme at the generating station:

Witting, Eborall, and Co., Limited (accepted)	£1,000
Crompton and Co., Limited	2,543
J. Spencer and Co., Limited	2,622
Lahmeyer Electrical Company, Limited	2,713

London County Council.—Tenders have been received as follows for the wiring and fittings for the electric light and for an electric bell installation at the fire-station in Rotherhithe-street:

Oliver, Clark, and Co. (recommended for acceptance)	£211	0	0
F. J. Coleby and Co.	220	0	0
A. H. Marshall	220	0	0
L. Sunderland and Co.	221	0	0
F. A. Glover and Co., Limited	221	5	0
Alliance Electrical Company, Limited	233	8	6

London County Council.—Tenders have been received for the supply, delivery, and erection of the steelwork for the first portion of the Greenwich electricity generating station, as follows, the quotations having been invited from a selected list of firms:

J. Westwood and Co., Limited, Millwall	£36,808	14	6
Dorman, Long, and Co., Limited, Middlesbrough	39,831	7	4
Horseley Company, Limited, Tipton	41,517	6	5
Fulham Steelworks Company, Limited, London	45,297	0	0

The Highways Committee report that these tenders have been carefully examined by the architect, who was of opinion that the second—namely, that of Messrs. Dorman, Long, and Co.—amounting to £39.831. 7s. 4d., should be accepted, and with this view they concurred. In ordinary circumstances they would have recommended that the lowest tender, that of Messrs. J. Westwood and Co., amounting to £36,808. 14s. 6d., should be accepted, but this firm were not prepared to accept certain of the terms on which tenders were invited, and it was not, therefore, possible for their tender to be considered. The amount of the architect's estimate for the work was £40,500. The committee recommend the acceptance of the tender of Messrs. Dorman, Long, and Co.

Gloucester.—The City Council have accepted the following tenders in connection with the light railways scheme:

General Electric Company (1900), generating plant (including Willans engine)	£3,464	17	4
Summers and Scott, condensing plant and pipework	890	0	0
J. G. Statter and Co., switchboard and instruments	1,174	18	1
Crompton and Co., accumulators and reversible booster (including E.P.S. battery)	1,551	11	0
G. Law, rails and accessories, construction of permanent way (British rails)	47,655	11	2
British Electric Equipment Company, cables, troughs, and feeder pillars (Callender's vulcanised-bitumen cables)	5204	1	7
J. G. White and Co., poles	4,381	5	0
British Electric Equipment Company, overhead line materials and rail bonds, and erection of poles and overhead equipment	2,857	9	10
Brush Electrical Engineering Company, car bodies and trucks	5,417	0	0
Dick, Kerr, and Co., electrical equipment of cars	3,689	0	0

South London "Tube."—In a report presented to the Court of Common Council, it was stated that the City and South London Railway Company's Bill for extending their line from the Angel at Islington to Euston, and for taking over the powers of the City and Brixton Railway Company, had been passed by Parliament.

BUSINESS NOTES.

TRACTION.

Horwich.—The borough engineer has been authorised to obtain tenders for tramrails.

Birmingham.—A company has been allowed to start a service of motor omnibuses in the city.

Ilford.—The electric tramways have been opened for traffic along the main road from the parish boundary.

Birkenhead.—New tramway offices, which have been erected in Laird-street, were formally opened on Tuesday.

Southend.—Next session powers will be sought to widen certain thoroughfares for the extension of the tramways.

Perth.—The Corporation Tramways Confirmation Bill was considered in the House of Commons on Monday, and ordered for third reading.

Leith.—A special meeting of the Town Council has passed the statutory resolution to purchase the Leith tramway undertaking for £60,000.

Rowley.—Drafts of the proposed provisional order for the joint scheme for the construction of tramways have been received by the District Council.

Ashton.—The Board of Trade have consented to the light railway to Ashton on a gauge of 4ft. 8½in. with the maximum width of 6ft. 9in. for the cars.

Lowestoft.—As many as 10,197 persons paid fares for riding on the trams on the opening day last week. The takings for the half-day totalled nearly £60.

Erith.—All opposition to the Erith Tramways and Improvement Bill has been withdrawn, and the Bill has been transferred to the unopposed list in the House of Lords.

Vienna —Steam engines on the Vienna Metropolitan Railway are to be replaced by electric locomotives. The electric trains will be run every 2½ minutes at a speed not exceeding 25 miles per hour.

Llandudno.—At their last meeting the Urban District Council discussed the Colwyn Bay light railway scheme, upon which several recommendations were submitted by a committee and approved.

Cheadle and Gatley.—The Board of Trade have given permission to the District Council to borrow £19,740 to cover the cost of constructing the tramways in the district from Cheadle Heath to Gatley.

Dublin United Tramways Co.—The directors recommend a dividend at the rate of 5 per cent. per annum for the half-year ended June 30, transferring £2,000 to reserve and carrying forward £2,857.

South Staffordshire Tramways.—All opposition in the House of Commons to the South Staffordshire Tramways Bill having been overcome, the Bill has been relegated to the Committee on Unopposed Measures.

New South Wales.—The revenue from the tramways during the June quarter amounted to £194,394, as compared with £164,463 in the same quarter of 1902. The expenditure was £185,735, as against £155,640.

Village Motor Service. — A scheme to connect Brampton, Cumberland, with the North-Eastern Railway by means of a short motor line at a capital cost of £6,100 is being considered by the local authorities.

Nottingham.—The Market-street and Upper Parliament-street section of the Corporation tramways, which was inspected by Major Pringle on behalf of the Board of Trade a few days ago, has now been opened for traffic.

Swansea.—One of the first duties awaiting the Corporation Tramways Committee after the vacation is to invite tenders for the construction of the branch lines. It is expected that the latter will all be in use next summer.

Kilmarnock.—The Commissioners under the Scottish Private Bill Procedure Act have considered an application by the Kilmarnock Corporation for authority to construct electric tramways. The entire cost is estimated at £45,000.

Sutton Coldfield.—As a result of a vigorous opposition by the London and North-Western Railway, a committee of the House of Commons has thrown out the Bill to authorise the Corporation to construct a system of tramways in the district.

Heckmondwike.—A temporary supply of electricity will be required to run the tramways which have been laid down in the district by the British Electric Tramways Company. Negotiations are proceeding with the District Council to this end.

Walsall. — The Tramways Committee report having accepted a tender for relaying the existing tramway track in Lichfield-street and Lower Bridge-street, and for the construction of new lines in Park-street and on the Bridge at an estimated cost of £5,899.

Liversedge.—After his inspection of the Batley tramways on Tuesday, Major Druitt went on to Liversedge and inspected an extension of the British Electric Traction Company's system from Millbridge to Hightown. The extension is about 1½ miles in length.

Central London Railway.—Sir Michael Hicks-Beach has accepted the directorship of the railway rendered vacant by the death of Lord Colville of Culross. The directors have again declared a 4 per cent. dividend, carrying forward £45,000, as against £25,000 last year.

Waterloo and City Railway Co.—The directors recommend the declaration of a dividend on the ordinary stock of the Company at the rate of 3½ per cent. per annum for the past half-year, carrying forward £170. The dividend at June last year was 3 per cent. per annum.

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Paisley.—Mr. W. M. Murphy has written the local Ratepayers' Committee to the effect that his arrangements are now absolutely concluded, and all the necessary capital has been subscribed. The only delay now will be the delivery of the rails, which have to be specially rolled.

Brighouse.—The Halifax Tramways Committee have decided unanimously, and it has been confirmed by the Town Council, to extend their system from the present terminus at Hove Edge into the centre of Brighouse. The distance of the new extension will be 1 mile 6 furlongs.

Herts.—The County of Hertford Light Railways (No. 1) Order is now in its final stages before the Board of Trade. As to the Light Railways (No. 2) Order (Barnet and Bushey), it has passed through the hands of the Light Railway Commissioners, and will be dealt with by the Board of Trade.

Huddersfield.—A Bill to confirm a provisional order relating to the Corporation tramways came on Tuesday before the Deputy Chairman as unopposed, the measure having already passed the House of Lords. The Deputy Chairman ordered that the Bill be reported for third reading.

Rochdale.—At present the Tramways Committee buy their current at 1·50d. per unit, whereas it costs 1·86d. a unit to the Electricity Committee. There is, however, every hope that with an increased output, consequent on the electrification of the tramways, the cost of generation will diminish.

Ramsbury.—The Central Wilts light railway scheme has been before the Parish Council, and it was decided that the route at present proposed would be of no service to Ramsbury at all. The promoters are to be asked to include in their scheme the villages of Mildenhall, Axford, Ramsbury, and Chilton.

Halifax.—New tramway offices are to be built at a cost of £2,000. An indication of the effect which the electric tramways are having upon the railways is afforded in the case of Halifax. Owing to the severe competition of the trams, the Great Northern Railway have decided to close the Ovenden Station.

Cranbrook.—Notice was received at the last meeting of the Rural District Council from the Rother Valley Light Railway Company of a public enquiry to be held at Tenterden, on July 30, as to their intention to apply for an extension of time for the construction of the line from Cranbrook to Tenterden.

Brighton.—The Corporation Tramways Bill, which has already passed the House of Lords, came before a special committee of the House of Commons on Tuesday. All opposition was withdrawn, and the Bill passed and was ordered for third reading. The cost of the proposed extensions is estimated at £55,000.

Bury.—A special meeting of the Town Council will be held on Aug. 20 "for the purpose of taking into consideration the propriety of giving notice to the Bury, Rochdale, and Oldham Tramways, Limited, requiring the company to sell to the Council so much of their undertaking as lies within the borough."

Bradford.—On Tuesday the Tramways Committee further went into the subject of the proposed amalgamation of the tramways and electricity departments of the Corporation, and in the end they decided to ask the Finance and General Purposes Committee to appoint a special committee to enquire into the subject.

Aston.—The arrangements for the complete electrification of the Aston-Birmingham trams have been considerably advanced during the past few days, and there is now every probability that when the leases fall in on Dec. 31 next there will be very little, if any, delay in changing from steam to electricity as a method of traction.

Wandsworth.—The Borough Council, on the recommendation of the General Purposes Committee, have decided to adhere to their decision to have the Garratt-lane tramway constructed on the conduit system, but in order to save a delay of four years have consented to the other tramways being temporarily reconstructed on the overhead system.

Prestwich.—At a special meeting of the District Council it was decided to ask the Local Government Board to extend the time for the completion of the electric tramways to Sept. 1, 1904. It is intended to continue the line from the main entrance to Heaton Park to Besses-o'-th'-Barn, where it will join the existing tramline from Salford to Whitefield.

Lancaster.—There was a heated discussion at the Town Council meeting on Wednesday on a recommendation of the Tramways Committee to open up a new electric tramway route in the west portion of the town at an estimated cost of £1,610. One gentleman advocated electric omnibuses, and eventually the matter was referred back for further information.

Tees-side.—A conference of representatives of the Middlesbrough Corporation and of the Ormesby and Normanby Councils has instructed Mr. Hammond to prepare a scheme for the purpose of running a tramway between Middlesbrough and the extreme boundary of South Bank *via* Normanby, and to report as to whether such scheme would be remunerative.

Metropolitan District Railway.—Subject to final audit, the accounts will, after paying all prior charges, admit of a payment for the six months ended June 30 last of a dividend on the 4 per cent. guaranteed stock at the rate of £2 per cent. per annum, as against £3 per cent. per annum in the corresponding period of last year, carrying forward £342, as against £1,433 in the corresponding period.

Preston.—The following resolution has been adopted by the Council: "That Messrs. Harding and Co., Limited, be informed that the Corporation purpose that the working of the present tramways under the lease shall terminate with the expiration of the lease—namely, on Dec. 31, 1903—so that the Corporation may have possession of the whole system for the immediate laying of the electric trams."

Hamilton.—The Hamilton, Motherwell, and Wishaw tramways had a most successful opening last week. It was a public holiday in the district, and the company's resources were taxed to the utmost. The weather was delightful, and travelling on the cars was alike a novelty and delight. They run through a most interesting district, at once the busiest industrially and not the least picturesque in the West of Scotland.

Cardiff.—The provisional order relating to the extension of tramways in the town has passed the House of Lords and its second reading in the Commons. Acting upon a requisition signed by five members of the Town Council, the mayor has called a special meeting to reconsider, on Wednesday next, the question of the reconstruction of the tramway from the Monument to Clare-road. An interesting discussion is expected.

Aberdeen Suburban Tramways.—The prospectus of the company promoting this scheme has now been issued. The share capital is £72,000. As the name implies, the proposal is to construct electric tramways on the overhead trolley system in the suburban districts of Aberdeen. The estimated cost of the lines, electric equipment, cars, car-sheds, and the preliminary expenses of obtaining the provisional order is put down at £61,130.

Liverpool Overhead Railway Co.—The accounts of this Company for the past half-year show an available balance of £9,872, and the directors have resolved to recommend payment of a dividend at the rate of 5 per cent. per annum on the preference shares and 1¼ per cent. per annum on the ordinary shares, against 1 per cent. per annum on the ordinary shares for the corresponding period last year. The balance carried forward is £3,747.

Ventilation of the "Tube."—The completion of the air-extracting fan at Shepherd's Bush is announced, and it has commenced running regularly from the small hours of the morning. The fan, which measures 20ft. in diameter, is worked by an electric motor of 160 h.p. The working hours of the air-extractor are from 1.15 a.m. to 4.15 a.m., and during this time it causes a stiff current of air of some 10 knots strong to rush through the whole length of the two tunnels.

Keighley.—The Council are recommended to instruct the borough engineer and the electrical engineer to prepare all necessary plans, sections, specifications, and estimates for reconstructing and electrically equipping the existing tramways, and for the construction of a new electric tramway between North-street and Stockbridge, *via* Cavendish-street and Bradford-road. Application will be made to the Board of Trade for sanction to borrow the money necessary.

Stroud.—A committee of the House of Lords has been considering the Bill promoted by private enterprise for a system of electric tramways between Stroud and Painswick, Chalford, Nailsworth, and Stonehouse. The Bill has already passed the House of Commons, and it will be recalled that the proposal on some of the routes is to run trams by the overhead trolley system but without rails. The committee found the preamble proved, and the Bill will proceed.

Southport.—On Wednesday Major Druitt inspected a unique contrivance in the shape of a one-man electric car, for use on the Birkdale-Southport section of tramways. At the same time he inspected the Trafalgar-road extension of tramways. The new car is controlled by one man—the driver. The passengers enter by the front platform, and place 1d. in a slot. The driver raises a bar, which allows the passenger through, and this shuts off the current temporarily.

Bideford Light Railway.—Colonel Boughey and Mr. Henry Allen Steward, Light Railway Commissioners, have heard the application of Bideford, Westward Ho! and Appledore Railway Company to extend the line on the Broad Quay, Bideford, to near the end of Long Bridge, to make loop lines opposite Trewin's Stores and on the Pill, and to extend the line from Northam to Appledore. The scheme was sanctioned with the exception of the proposed extension on the quay.

Paris "Tube."—A clever engineering feat was accomplished in Paris last week in connection with the extension of the Paris "Tube." Between 6 o'clock and 3 o'clock a bridge 130ft. long, which spans the Seine at Passy, was moved a distance of nearly 80ft. The preparatory work for this difficult operation took about 10 weeks, and when everything was ready the huge mass was moved over wooden rollers by a windlass worked by hand for safety. The operation was completely successful.

Holywell.—The Urban Council have considered an application requesting the Council's support to a Bill to be promoted in the ensuing parliamentary session for power to construct an electric tramway, to run from Sandycroft along the shore to Bagillt, thence to Holywell, Mold, Buckley, and Hawarden. In the discussion which followed the reading of the letter nothing but approval of the scheme was expressed, and a resolution to support the Bill was carried unanimously.

Burton and Ashby Light Railway.—On Monday the Burton and Ashby light railway order, promoted by the Midland Railway Company, for the construction of 11¼ miles of tramways between Burton and Ashby, came before Sir Herbert Jekyll at the Board of Trade for the consideration of objections of the Swadlincote Urban District Council, the Leicestershire Council, and the Burton Corporation. The two latter, however, did not appear. The order as amended will be confirmed later on.

Cape Town.—Further information is to hand in regard to the opposition of the inhabitants of Sea Point and Green Point suburbs as to the proposals of the Cape Town Tramway Company, whose lines run through these places, to electrify the at present disused Sea Point tramway. It appears that the company's service is not considered satisfactory, and the feeling of the ratepayers is that it is undesirable that the possibility of competition should be extinguished, and that the Government should run the line itself.

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Electric Automobile.—The City and Suburban Electric Carriage Company have built for the town use of the Prince of Wales a four-seated brougham, the body of which hangs specially low on springs of a design which gives great ease and luxury to the passengers. The battery boxes in this carriage are not to be seen, as the batteries are skilfully concealed within the lines of an ordinary horse-drawn carriage. The driver's seat is low, so that the occupants of the carriage have a good view through the glass panel at the front.

Bath.—In connection with the electric tramways which are being laid down in the town, the local authority have passed the following resolution: "That the question of the rebuilding of the Midland Bridge be referred to a joint committee of the Electric Traction and Streets Improvements Committee for further consideration, with instructions to report upon the probable cost of improving the bridge and its approaches, and also for the purpose of furnishing the Council with further information as to the proposed improvements on the tramway routes."

South London.—The traffic returns of the London County Council tramways (including the electrified portion) show that for the week ending July 18 the receipts were £10,674. 19s. 11½d., as against £9,218. 0s. 1d. during the corresponding week of last year. This shows an increase of £1,456. 19s. 10½d. The number of passengers carried was 2,715,905, over a mileage of 397, against a mileage of 265 last year. Counting a period of 109 days, the receipts were £154,870. 1s. 1d., against £134,277. 15s. 10d. last year. This gives an increase of £20,592. 5s. 3d.

Wolverhampton.—It is stated that negotiations are still in progress between a committee of the Corporation and the Lorain Tramways Company. Nothing definite has been decided on as yet. The Lorain Company claim the payment of a large sum if the contract is to be determined, and on the other hand less than half the amount asked for has been offered. The proceedings may be of a prolonged nature, and, failing agreement, the last resource will be arbitration, which, it is feared, will be very expensive. Both sides, however, appear anxious to come to an amicable arrangement.

Burton.—The construction of the Burton electric tram system is now all but complete, and a very satisfactory trial run was made during the early hours of Friday. Later in the morning a special meeting of the Town Council was held to consider certain details in relation thereto, including the settling of the fares and the question of Sunday running. It was decided only to run the cars during the afternoon and evenings of Sunday. The official inspection, on behalf of the Board of Trade, of the tramways was made by Major Pringle and Mr. Trotter on Wednesday. The length of route is nearly six miles.

Additional Traffic Returns.—Anglo-Argentine, £1,371 increase; Barcelona Ensanche y Gracia, £213 increase; Barcelona, £201 decrease; Brisbane, £53 decrease (month of June, £9,575, decrease £612); British Columbia Electric (month of March), gross earnings £10,352, net income £2,658; Buenos Ayres and Belgrano Electric, £23 increase (month of April, £12,995, increase £1,123); Calcutta, £597 increase; Cape Town (month of April), receipts £16,003, expenditure £8,313; Isle of Thanet Electric, £61 increase; Mexico Electric (month of June), recepts £46,270; Perth Electric, £109 increase; Port Elizabeth (month of April), receipts £4,292, expenditure £2,281.

Hull.—Having inspected the sample top covers erected on two of the cars of the Corporation, the Tramways Committee have decided to have the Magrini covers fixed to 13 cars to be supplied under the Westinghouse contract. The city engineer has been authorised to lay the tramway lines in Lowgate, from the town hall to Silver-street, and repave the widened street with hardwood blocks. An unopposed Bill to empower the Corporation to make certain street improvements, to construct additional tramways, etc., came on Tuesday before Lord Morley, chairman of committees, and after proof of preamble had been given by the town clerk, it was sent for third reading.

Greenwich.—The much-vexed question of a tramway from Deptford Bridge to Shooter's-hill *viâ* Blackheath was again before the Council at their last meeting, and it was decided to enquire from the London County Council whether the alternative route from Westcombe-hill to Shooter's-hill *via* Old Dover-road had been under their consideration. The deputation representing the Special Tramways Committee of the Borough Council waited upon the Highways Committee of the London County Council to confer upon the subject of tramways in the borough. We understand that a compromise was suggested in the matter of the borough's contribution to the cost of the widenings which would be necessary for the carrying out of the County Council's schemes.

Middlesex.—At the last meeting of the County Council the Parliamentary Committee reported that the promoters of the Watford and Edgware Railway Bill, had signed an undertaking not to oppose any application made by the County Council within three years for powers to construct a light railway or tramway along the main Edgware-road to Watford-road through Stanmore, unless at the time at which the County Council made the application the company should have provided the capital and commenced the construction of the railway authorised by the Bill. The Light Railways and Tramways Committee of the County Council are considering whether it is desirable to make applications to the Light Railway Commissioners for an order to authorise the construction of a number of light railway extensions in the county.

Barrow.—At the last meeting of the Town Council the delay in commencing the new electric tramways was strongly commented upon, and Alderman Lee suggested that a telegram should be sent to the British Electric Traction Company informing them that the Corporation were greatly dissatisfied with the delay, and asking them to make a start at once. Mr. Dawson said a letter had been received from the British Electric Traction Company stating that 500 tons of the rails which are being made in Belgium had been condemned, but that 300 tons would be shipped very soon. In further discussion it was stated that according to the agreement the company should have commenced operations within three months. The agreement was signed 12 months ago. A proposal was carried that the Council consider in committee whether a mandatory injunction should be applied for to compel the company to begin the work at once.

Aberdeen.—The traffic returns of the Corporation tramways for last week show a decrease of revenue amounting to £349. 2s. 7d., and an increase in expenditure of £127. 3s. 11d. For the past seven weeks there has been an increase in revenue of £912. 7s. 3d., and an increase in expenditure of £991. 19s. 3d. As explaining this unsatisfactory state of affairs a local paper states that the committee are face to face with the whole question of early and late cars and the double shift of men. The early cars, except probably on the Woodside route, are a failure, and the late cars in the evening are run at a distinct loss. Moreover, the double shift of men has added greatly to the expenditure, and the position of matters, as brought out in the returns for the past week, is of such a nature that the whole question of early and late cars and of a double shift of men must be reconsidered if the undertaking is not to show a very serious deficit at the end of the year.

South Africa.—According to *South African Exports*, the scheme of the Lourens River and Estate Company, Limited, to erect and run a system of electric trams from the G.S. Railway Station to Somerset Strand is receiving strong support from the ratepayers. It is stated in Kimberley that the De Beers Company are negotiating with Messrs. Gibson Bros. with regard to the purchase of the Victoria Tramway, in order to secure a service of electric trams throughout the town and to the suburbs. The Sydenham Electric Tram and Lighting Bill has been introduced into the Cape Parliament. The construction of the electric tramways at Lourenço Marques is being rapidly pushed on with, and it is hoped to have the cars running by Christmas. The haulage at De Beers mines at Kimberley is to be replaced by electric traction, and the British Westinghouse Electric and Manufacturing Company have received an order for the supply of a dozen mining locomotives.

New Zealand.—A correspondent says that "the New Zealand Government intends to make use of a powerful waterfall called the Huka Falls, in North Island, for the purpose of obtaining electricity. A Swiss engineer named Alloa, of Berne, has been engaged by the Colonial Government to construct an electric station on the falls, and has already left this country for New Zealand. It is estimated that the electric force which will be obtained will be sufficient to light the principal centres in the North Island and to supply power for the tramway systems. The Swiss engineer is a well-known authority on the question, and has built some of the most important electric installations in this country. It will take a year to complete the new works." The above is practically a repetition of what we were able to state some weeks back, but we believe we are right in saying that the New Zealand Government has not decided upon any particular scheme. A sort of general enquiry is being made on the subject.

Birmingham Tramways Bill.—That portion of the tramway scheme as was left in the Bill by the committee of the House of Lords came on Thursday last week before a committee of the House of Commons. Mr. Fitzgerald, in opening the case for the promoters, said the object of the Bill was to authorise the extension of the existing Yardley tramways from Sparkhill to Olton on the one hand, and from College-road to Shirley on the other hand, for the purpose of meeting the wants of a great and growing population of clerks and artisans who had to go to their businesses and works in Birmingham every day. The two local authorities of Yardley and Solihull were strong supporters of the tramways; in fact, the Yardley District Council were actually promoters of the Bill. The County Councils of Warwickshire and Worcestershire, as the road authorities, both assented to the Bill, and there was not a single landowner or frontager opposing; in fact, the City of Birmingham Company, in promoting these tramways, which when constructed would be a very great convenience to the inhabitants, had at their back the whole public feeling of the district.

Batley.—On Tuesday Major Druitt made an inspection of the electric tramways at Batley, and also of the Hightown (Spen Valley) and Ravensthorpe sections of the Heavy Woollen District lines. Two cars were sent from Liversedge to Batley to meet the inspector and the local officials, but in descending Purlwell-lane, Batley, a rather steep hill, the brake attached to the second car failed to act, and the car ran into the leading car. The driver of the latter sustained injuries to his head. Both cars were damaged, and had to be taken away. Until fresh cars were procured the inspector was kept waiting at Batley, and Mr. O. J. Kirby, the borough surveyor, was standing in the crowd that assembled, when a Bradford man drove up Bradford-road at a quick pace and ran Mr. Kirby down. He was badly shaken and his clothes were torn, but he was able to accompany Major Druitt over the lines. The inspector found the whole of the Batley and Hightown sections satisfactory, and the latter section will be opened at once. The cars ordered for Batley have not yet been delivered, but it is probable that the lines will be opened with cars from the Spen Valley depôt.

Reading.—The electric tramway system which, as noted last week, was opened for traffic on the 22nd inst., has been laid down by the municipality. Altogether 7½ miles of route have been equipped on the overhead trolley system, and over five miles are double track. The permanent way is partly in granite setts and partly in wood blocks. Centre poles with double arms and painted white and green have been erected in the principal thoroughfares, and bracket arms from side poles painted in two shades of green carry the wires on the remaining parts of the route. The cars, 30 in number, are very handsome in appearance and will accommodate 48 passengers, 22 inside and 26 on the top. The generating station stands in Mill-lane. The

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boilers, of which there are three, with space left for a fourth, are of the Babcock and Wilcox type. A Green's economiser with condensing and oil extracting apparatus have been installed, as well as feeding and condenser pumps. The generators, of which there are four, are each of 100 kw., with an average voltage of 500 volts. The car-shed contains 10 beds for three cars each, and has a hollow floor throughout. The cars are fitted with both hand and electric brakes.

Private Bills.—In the House of Lords on the 23rd inst. the Croydon and District Electric Tramways Bill was read a second time, and the Blackheath and Greenwich District Electric Light, the Watford and Edgware Railway, the London United Tramways, the London, Tilbury, and Southend Railway, the Great Northern, Piccadilly, and Brompton Railway (Various Powers), the Beckenham Urban DistrictCouncil, and the Harrow-road and Paddington Tramways Bills a third time. In the Commons on the 22nd inst. the Tynemouth and District Tramways Bill was read a third time. In the Lords on Tuesday the Baker-street and Waterloo Railway (Extension of Time) Bill was read a third time and passed. In the Commons the following Bills were read a third time: Birmingham District Tramways Bill, Dewsbury, Batley, and Birstal Tramways Bill, Manchester Southern Tramways Bill, and Worthing Corporation Tramways Bill. A number of Tramway Bills, authorising the construction of of tramways in several provincial towns, including Burton-on Trent, Huddersfield, Leeds, Keighley, Horsforth, and Barrow-in-Furness, passed Mr. J. W. Lowther's Unopposed Committee, and were reported for third reading. They have already passed the Lords.

Light Railways Bill.—In the House of Lords, last Friday, Lord Wolverton, in moving the second reading of this Bill, said that when Parliament passed the Light Railways Act of 1896 it treated that measure more or less as of an experimental description, and confined its operations to the period of five years. Since the expiration of that period Parliament had renewed the Act year by year, and the object of the present Bill was to make it permanent, as the Board of Trade considered that it had been a success. This was the effect of Clause 1. Clauses 2 and 3 reformed the procedure. Under the existing Act if the Board of Trade thought a light railway scheme to be of such importance that it ought to be submitted to Parliament, the preliminary work on the order was wasted, and the promoters had to begin *de novo*. Clauses 2 and 3 remedied that state of things. The Earl of Morley thought that the measure was a very useful one, but remarked that there was no doubt that the existing legislation in regard to light railways and tramways was not in a very satisfactory condition, and appealed to the Board of Trade to consider before another session whether they should not introduce a more comprehensive measure which should bring some order into the law. The Bill was read a second time, and on Monday the committee stage was completed.

Blackburn.—Reporting on the working of the tramways department during the past 12 months, Mr. Alfred S. Giles, the borough electrical engineer submits the following statement, showing the revenue and expenditure and the application of the balance in a condensed form: traffic receipts, £40,963. 18s. 4d.; other receipts, £1,215. 5s. 5d.; total revenue, £42,179. 3s. 9d.; working expenses, £25,702. 12s. 1d.; gross profit, £16,476. 11s. 8d. This balance has been applied as follows: interest on loans, £8,914. 13s. 2d.; sinking fund, £11,636. 16s. 7d.—total, £20,551. 9s. 9d.; balance from revenue account, £16,476. 11s. 8d.; financial result (deficit), £4,074. 18s. 1d. The total length of the tramways now owned by the Corporation is the equivalent of 21 miles of single track. The total mileage run during the year was 826,558, and the passengers carried were 7,234,106. The receipts average 11·89d. per car mile. The capital expenditure of the department was £275,651 at the commencement of the year, of which £96,577. 11s. 8d. represents the purchase price paid to the late tramway company. The report concludes by expressing regret at the loss on the year's working, but the engineer is hopeful that, should the revenue increase next year in proportion to the progress achieved during 1902-3, the department at the end of the following year will be in a position to meet all charges.

Leeds.—A comprehensive scheme of ½d. fares on the trams is about to be put into operation. The revision of the hours and wages of the Leeds tramway workers, which the committee governing the municipal system have undertaken, on the application of a couple of trade societies representing every section of the men, is proving a more contentious matter than was at first anticipated. A few weeks ago the Tramways Committee appointed a special sub-committee to revise the general conditions of the men, and the result of their deliberations have been laid before the full committee in the form of a report, recommending briefly a small increase of the men's wages, reduced and regular hours of labour, and generally improved working conditions. These proposals do not find favour with the men, as the following resolution passed at a mass meeting shows: "That this mass meeting of tramwaymen, after considering in detail the programme drawn up by the committee appointed, considers the same in its present form unsatisfactory. The men consider the period of probation from the minimum to the maximum too long. The offer to shedmen and washers is inadequate, and we desire also the deletion of the condition recommended as regards shedmen. We strenuously oppose the bonus system in relation to drivers, and request its deletion, and that a defined wage, irrespective of privileges, be substituted." Matters are assuming a serious aspect, and a general strike is regarded locally as a not unlikely contingency.

Brighton Railway.—Speaking at the half-yearly general meeting of the London, Brighton, and South Coast Railway Company on Wednesday, the Right Hon. Lord Cottesloe (the chairman) said the Board was actively pursuing its enquiry into the subject of electric traction, and a committee of directors had been appointed for its special consideration. The problem was a very difficult one so far as this railway was concerned, by reason of the complication of lines and the intermixing of main and local, or fast and slow, traffic, and it would be obviously wrong to revolutionise the present system of working by the introduction of a new method of locomotion until it was made absolutely clear that advantage, both in greater rapidity of of transit and greater economy and ease of working, would result. Regard must be had also to the competition of other means of transport, and it was necessary for the Board to be assured that electrical traction would be a success from its commercial as well as its mechanical aspect. It was, therefore, advisable to proceed with caution, and, having every desire to arrive at a true conclusion, this was what the directors were going. In conjunction with the London and South-Western Company, they were trying an interesting experiment with a self-contained steam motorcar on the branch line between Fratton and Southsea, and it was hoped that the result would be a saving in working expenses; and the advisability of establishing similar working, either by steam or electricity, on other parts of the company's system was engaging the attention of the Board.

Darwen.—The borough accountant's annual statement includes the following: "The revenue account of the tramways (Darwen section) shows a gross profit of £2,482. 5s. 8d. The charges for interest on loans, instalments of principal repaid Public Works Loan Commissioners, and sinking fund instalments, less bank interest received, amount to £3,591. 10s. 10d., leaving the net loss for the Darwen section at £1,109 5s. 2d. It should be pointed out that this loss includes the sum of £900 debited to revenue account for depreciation. The traffic receipts for the year on this section have been £10,743. 8s. 4d., as against £10,411. 11s 11½d. for the year ended March 31, 1902, showing a gain in receipts of £331. 16s. 4½d. for the year. These increased receipts are accountable to some extent to the increased traffic in consequence of the "Peace" and "Coronation" celebrations of June last year. The revenue account for the Hoddlesden section shows, after debiting to revenue account the sum of £150 for depreciation, a loss of £71. 5s. 10d., to which must be added for interest on loans and sinking fund instalment, less bank interest received, the sum of £740. 10s. 10d., showing a net loss of £811. 14s. 8d. This loss, however, is reduced by the guarantees for the year, amounting to £370, leaving the net loss to be carried to balance sheet at £441. 14s. 8d.. The total amount standing to debit of tramways net revenue account at March 31, 1902, was £262. 12s. 5d., to which the losses for the past year have to be added, leaving a total amount standing to the debit of net revenue account of £1,813. 12s. 3d. The total number of miles run and the average traffic receipts per mile are as follows: Darwen section: 222,329 miles; traffic receipts, 11·5973d. per mile run. Hoddlesden section: 31,951 miles; traffic receipts, 11·6174d. per mile run."

Newcastle.—The extension of the tramways from the present terminus in Tynemouth-road to Wallsend will be opened for traffic to day. This extension will form a connecting link between the Newcastle Corporation tramways and the Tyneside tramways, thus making it possible to travel direct from the city by car to the Tyneside by changing cars where the systems meet. The professional auditor for the Corporation has issued his annual report on the electric tramways undertaking. The amount of loans raised was on March 25, 1902. after deducting £6,771. 19s. 9d. repaid, £683,228. 0s. 3d.; borrowed or transferred during the year, less instalments repaid and accrued, £90,397. 5s. 9d.; and outstanding loans up to March 25, 1903, amounted to £773,625. During the year, capital expenditure amounting to £230,256 has been incurred in connection with the tramways. The revenue account of the tramways shows that the expenditure for the year has been £153,822. 1s. 8d., as against the previous year of £21,171. 4s. 1d. The traffic receipts amounted to £150,334. 5s. 8d. The income derived from public lighting in connection with the tramwas was £3,100; from rents, advertising, and sundries, £387. 16s.; and the balance available for depreciation and interest and redemption of capital is £69,452. 10s. 1d. The amount for interest on and redemption of loans during the period covered by the working of the system is £52,407. 10s. 6d. Deducting this from the surplus, there remains a balance to the credit of revenue account of £17,044. 19s. 8d. available as the nucleus of a depreciation and reserve fund, the further annual provision for which will depend upon the basis decided upon by the Council. The balance to the credit of the sinking fund account, representing loans repaid, amounts to £33,710. 14s., the amount due to the city fund (for advances made during the construction period) after deducting £3,000 repaid is £13,819. 10s. 6d., exclusive of interest, which is in dispute. Included in the assets there appears an item, under the heading of "Interest on and redemption of loans during construction," of £20,098. 2s. 5d., which is to be written off out of revenue, as no power exists to capitalise, as is generally the case in the construction of large undertakings.

Manchester.—On Tuesday the report of the tramways department for the year ended March 31 last was issued. It appears that during the year the Victoria Park, Hyde-road, and Stockport-road, and the southern routes have been opened—over 57 miles, and bringing the total up to 77 miles and 1,611 yards. In the matter of finance, the report states that the total revenue was £317,960. 9s. 2d., against £111,307. 12s. 7d. for the year preceding. Working and other expenses came to £193,989. 11s. 9d., against £64,688. 16s. 5d. The balance, being gross profit, came to £123,970. 17s. 5d.—a leap in 12 months from £46,618. 16s. 2d. With bank and other interest added, the sum available was £126,566. 16s. 5d. Out of this sum £39,968 went in interest on mortgage debt, etc., £8,545 in rent of lines leased by the Corporation, £30,000 was given in relief of the rates, and £39,551 went to reserve, renewals, and depreciation account. Figures are also supplied which show that the operation expenses per car mile are being reduced. In 1901-2 the total spent under this head per car mile was 8·10d., whereas it was only 6·95d. in the year under consideration. The expenses for electrical energy rose from 1·45d. per car mile in 1901-2 to 1·94d. in 1902-3. Traffic expenses have, however, fallen. The cost of salaries under this head has slightly declined. The total traffic expenses per car mile have

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declined from 4·24d. to 3·53d. Management expenses have also fallen from 1·80d. per car mile to ·75d. Salaries, wages, stationery, and miscellaneous office expenses under this head show the largest reduction, standing at ·81d. in 1902 and at ·28d. in 1903. Repairs and maintenance have cost the committee slightly more this year than last. In 1902 the car mile charges for repairs and maintenance were ·61d.; in 1903 the total was ·73d., the largest item of increase being registered under the head of permanent way. A total car mileage of 6,382,036 was run between April 1, 1902, and March 31, 1903; the number of passengers carried during the year was 66,849,457; the receipts amounted to £306,249. 15s. 8d.; while the average receipts per car mile were 11·52d. The committee have had under consideration the fares on all the routes, and, guided by the experience they have gained, they have decided to make some important alterations. The main principle is to introduce between the 1d. and the present 2d. stages a 1½d. fare, between the 2d. and 3d. stages 2½d. fares, and so on according to the length of the routes. The 1½d. fare will really supersede the present 2d. fare. In addition to the 1½d. fare the committee will introduce 1d. fares for from the middle of the first stage to the 1½d. stage. All the revised fares will, it is expected, come into operation on Oct. 1.

London County Council.—At the meeting of the above body on Tuesday, the Highways Committee expressed their regret that they had to report that there had been several cases lately of persons maliciously inserting pieces of metal and wire in the conduits on the Westminster-to-Tooting tramways, the result of which had been to create short-circuits, the tramway traffic being in consequence seriously interfered with. This malicious interference with the conduit, in addition to hindering the smooth working of the tramways, and causing numberless delays, is likely to endanger the safety of the passengers on the tramcars; and the committee have therefore arranged for the issue of a notice offering a reward of £25 to any person who may supply such information as will lead to the conviction of the offenders, and they hope that this course will effectually stop so dangerous a practice. Another report presented by the committee recorded the fact that the District Railway Company intend to lay electric mains between the Lot's-road power station at Chelsea, along Fulham-road, King's-road, and Unerdale-road, to their railway. The only powers vested in the County Council under the company's Act are in regard to works affecting their sewers. The Highways Committee have therefore seized upon this opportunity to object to the plans submitted by the company on the ground that they do not indicate the extent to which the sewers would be affected by the company's works. The Improvements Committee submitted a report on the subject of tramways subways. Their recommendations were as follows: "(*a*) That, in the event of the Works Committee being prepared to undertake, at the amount of engineer's estimate, the construction of the tramway subway and the subway for pipes and wires, and also the execution of the paving, etc., works between Great Queen-street and Holborn, and between Eagle-street and Vernon-place, such works be carried out by the Council without the intervention of a contractor, and that the working drawings, specification, bills of quantities, and estimate be referred to the Works Committee for that purpose; but that in the event of the Works Committee not being prepared to accept the work at the amount of the engineer's estimate, tenders be invited by advertisement. (*b*) That in the event of tenders being invited by advertisement, the operation of the standing order which requires that all tenders in respect of works estimated to cost £500 shall be opened in the Council by the chairman, be suspended so far as may be necessary to enable the chairmen of the Highways and Improvements Committees to open during the ensuing recess the tenders referred to in the foregoing recommendation, and to accept on behalf of the Council the lowest satisfactory tender, subject to any action taken in the matter being fully reported to the Council at the first meeting after the recess (*c*) That the employment of a resident engineer and of a clerk of works be sanctioned in connection with the above-mentioned works at a total cost not exceeding £550." The Highways Committee presented a report in which they recommended that, under the provisions of the contracts with Messrs. Walter Scott, Limited, for the supply of rails, etc., required in connection with the reconstruction, for electrical traction, of the Tooting, etc., sections of the London County Council tramways, the sum of £455 be retained by the Council, out of the moneys for materials supplied under the contracts, as liquidated damages in respect of the delay of seven weeks, caused by the failure of Messrs. Scott to comply with the terms of their contracts, in the commencement of the roadwork and platelaying; and that the balance, £4,120, of amounts which have been deducted as liquidated damages in respect of other delays in the supply of material under the contracts, be now paid to Messrs. Walter Scott, Limited. Owing to the resignation of Mr. Alfred Baker, consequent on his appointment as tramways manager to the Birmingham Corporation, the County Council have decided to advertise for a successor.

LIGHTING AND GENERAL.

Fife.—The Fife Electric Power Bill has been read a third time in the House of Commons.

Sunderland.—The Corporation have decided to lay electric cables to the east side of the Hudson Dock.

Melksham.—A company proposes applying for a provisional order for supplying electricity in the urban district.

Nuneaton.—The Local Government Board have sanctioned a loan of £1,200 required for electric light purposes.

Bath.—The question of supplying the district with electricity is to be further considered by the District Council.

Accrington.—The Electricity Committee recommend a reduction in the price of electricity for both illumination and power.

Change of Address.—Mr. L. Gaston, consulting electrical engineer, has removed to 32, Victoria-street, Westminster, S.W.

Cannock.—A scheme for supplying electric light and power in the district has been submitted to the District Council by a company.

Newark.—The electric light agreement between the Corporation and the Notts and Derbyshire Power Company has been completed.

Valley.—The Rural Council have agreed to join the Holyhead Urban District Council in the guarantee for the new telephone service.

Ripon.—The Empire Electric Light and Power Company intend to apply for a provisional order for electric lighting purposes in the city.

Holyhead.—The Local Government Board have sanctioned the borrowing of £16,000 towards the electric lighting and refuse destructor scheme.

Gravesend.—The Town Council have obtained sanction to loans of £9,580 and £2,000 for their electric lighting undertaking and refuse destructor.

Dublin.—The Corporation have retained Mr. R. Hammond to advise them on their electric lighting scheme, which is estimated to cost about £300,000.

Trunk Telephones.—The Post Office Department has decided to seek Treasury authority for the provision of a direct Liverpool-Bristol trunk telephone circuit.

Plymouth.—The Electricity Committee report having reduced the charge for the supply of electric current to the Tramways Committee from 2½d. to 2d. per unit.

South Stoneham.—The Inland Waterways, Limited, have given notice of their intention to apply for a provisional order to supply electricity in the district.

Tewkesbury.—The Southern District Electricity Corporation have given notice of their intention to apply for a provisional order to supply electricity within the area.

Swindon.—The new infirmary at the workhouse, which has just been erected at a cost of £15,000, is equipped in the latest style, and is fitted throughout with electric light.

Boston.—The Town Council have decided to light their new municipal buildings by electricity. The installation will be carried out by Messrs. Beavan and Co., of Scarborough.

Dorchester.—The Empire Electric Lighting Company have given the Town Council notice of their intention to apply for an Act of Parliament to light the town by electricity.

Serrated Oilcans.—Messrs. Joseph Kaye and Sons, Limited, of Leeds, inform us that they have received an order from H.M. Navy for 7,500 of their patented serrated oilcans.

Bermondsey.—The Electric Light Committee have engaged Messrs. Kincaid, Waller, and Manville to report upon the possibility of extending the present electric lighting station.

Nelson.—Whitefield School is to be lighted by electricity, and the electrical engineer is to submit to the committee an estimate and specification for the necessary work and fittings.

Calne.—Notice has been received from the Southern District Electricity Supply Corporation of their intention to apply for a provisional order to supply electricity within the urban area.

Hanwell.—The proposal to establish a telephone exchange at Hanwell has been revived, and the Hanwell Urban District Council have promised the company to become subscribers.

Aberdeen.—A recommendation will come before the Town Council to apply for additional borrowing powers in connection with the electric lighting department to the extent of £65,000.

Norwich.—An agreement is being negotiated between the Norwich Mutual Telephone Company and a firm of contractors to equip a telephone exchange suitable for the requirements of the city.

New Australian Cable.—Reuter's Melbourne correspondent telegraphs that the Commonwealth House of Representatives has ratified the agreement with the Eastern Exension Telegraph Company.

Normanton.—The National Telephone Company having secured the necessary number of subscribers for an exchange, their offer to supply the Corporation with an installation has been accepted.

Pontypool.—The area at present lighted by gas is proposed to be lighted by electricity, and the electric lighting company have been asked to state their terms for an extension of the public lighting.

Falkirk.—An agreement which it is calculated will hasten the progress of the Bill in Parliament has been arrived at between the Town Council and the promotors of the Scottish Central electric power scheme.

Bastian Mercury Vapour Lamp.—A private demonstration has been given at the works of the Bastian Meter Company, Kentish Town, of a new mercury vapour lamp invented by Messrs. Bastian and Salisbury.

Westminster Electric Supply Corporation.—The directors have declared an interim dividend for the half-year ending June 30 last at the rate of 13 per cent. per annum, less income tax, payable on Sept. 1, 1903.

South London Electric Supply Co.—The South London Electric Supply Corporation's accounts for the half-year ended June 30 show a net profit of £5,210, against £2,548 for the corresponding six months of last year.

Bury.—It was reported at the Electricity Committee's meeting last week that the receipts for current supplied for motive power during last month showed an increase equal to 100 per cent. on the corresponding period last year.

Holland.—At the last meeting of the County Council the recommendation of the Asylums Committee to expend £3,920 in lighting

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the asylum by electricity was considered. The question was referred back for further information.

Bookenham.—The following extensions of cables are proposed: Whitmore-road, estimated cost, £30; Westmoreland-road, £70; Hayes-road, £26. An application for an extension of cable in Wickham-road has been deferred.

Hollingbourne.—A conference is being arranged between the Rural District Council and the Kent Electric Power Company with reference to the latter's decision to apply for parliamentary powers to supply electrical energy in the district.

Aberystwyth.—Instructions have been given to the town clerk and the borough surveyor to make enquiries of other boroughs in regard to their existing arrangements for public lighting, the use of gas and electric light, and the cost of each system.

Blairgowrie.—We learn that satisfactory progress is being made with the electric light question. From what we can gather, it is proposed to utilise the water power of the river for generating, and surveys are now being made in this direction.

Metropolitan Electric Co.—The directors of the Metropolitan Electric Supply Company, Limited, have declared an interim dividend for the half-year ended June 30 last at the rate of 8 per cent. per annum, as compared with 7 per cent. last year.

Keighley.—The report on the electricity department states that the electricity sold from July 1, 1902, to June 30, 1903, was 137,721 units, as compared with 90,737 units sold during the corresponding period of 1901-2, being an increase of 46,984 units, or 51·8 per cent.

August Holidays.—We have received notice from the Robertson Incandescent Electric Lamp Company and the Hart Accumulator Company that in both cases their works will be closed during the week commencing Monday, Aug. 3, reopening on Monday, Aug. 10.

Hackney.—The Borough Council have decided to reduce the price charged for electrical energy for power purposes from the flat rate of 2d. per unit to the following: for the first 1,000 units per quarter at any one premises, 2d. per unit; any further consumption at 1½d. per unit.

Chester-le-Street.—Notice has been received by the District Council of an intention to apply to the Board of Trade for a provisional order authorising the supply of electrical energy and power in this and surrounding districts. It was agreed to oppose the application.

Morecambe.—A draft agreement has been approved between Messrs. Ledward and Co. and the Corporation for the supply of condensing plant. The engineer has been instructed to prepare a report as to the best means of dealing with the smoke nuisance at the electric light works.

Penzance.—The Visiting Committee of the Guardians have been asked to bring up a report to the next meeting of the Board as to the desirability of having telephonic communication at the asylum, to be connected with the general telephonic arrangements in the town, together with the cost.

German Telegraph Cables.—Germany possesses 73 cable lines, with a total length of over 10,000 miles. This does not include the second cable now being laid across the Atlantic. One-third of the cables belong to the Government. Of the entire cable system of the world, Great Britain owns nearly two-thirds and Germany one twenty-fourth.

Hoylake and West Kirby.—The District Council propose to make application for sanction to borrow £324 for the erection of a water-softening plant at the electric supply works. The Local Government Board have directed an enquiry to be held respecting the Council's application to borrow £5,435 for electric lighting purposes.

Dunstable.—At the last meeting of the Town Council a communication was read from the Empire Electric Light and Power Company, Limited, intimating their intention of applying for a provisional order to supply electric light and power in the Dunstable area. The Council decided to write to the company and ascertain their precise intentions in the matter.

Shropshire and Worcestershire Power Bill.—The Worcestershire County Council, having withdrawn their opposition to the Shropshire, Worcestershire, and East Denbighshire Electric Power Bill, it has been withdrawn from the consideration of the committee of the House of Commons and referred to Mr. J. W. Lowther, chairman of the Committee of Ways and Means, as an uncontested scheme.

Erith.—With reference to the proposed further loan of £20,000 for electric lighting, the Local Government Board have promised to sanction the borrowing of the money. A transformer station is proposed to be erected at Belvedere. The committee have instructed the electrical engineer to have the connection of the remaining public lamps to the electric lighting mains and the fitting of the lamps for electric lighting forthwith completed.

Electrical Machinery List.—Under the title of "Electrical and Autocar Supplement" of "Philips's Monthly Machinery Register," Mr. Charles D. Phillips has issued a list of new and second-hand electrical machinery, also motorcars and motor bicycles, illustrated throughout. The "Register" is now in its twenty-ninth year of publication, and serves the purpose of a medium for the purchase, sale, or hire of plant of every description.

Underground Telegraphs to the North.—The continuation of the underground telegraph cable is progressing satisfactorily, and the pipes are now being laid in Penrith. It is expected that by the end of the year the pipelaying will be completed as far north as Carlisle. After this is done the cable will be drawn in, and the result expected is that there will be less interruption of telegraphic communication between the Metropolis and the North.

Sunbury.—Edmundsons' Electricity Corporation are about to apply for a provisional order to supply Sunbury with electric light. The proposed charges are 7d. per unit for the first hour and 3d. per unit afterwards, whilst for public street-lighting the company propose to supply at a price not exceeding 2½d. per unit. The company have a large generating station at Twickenham, and wish to take in Sunbury on the way through to Staines and possibly Weybridge.

Eton.—As the result of the recent fire at Eton College, the Urban District Council have decided to obtain a steam fire-engine and the latest electric alarms. A deputation, having visited Liverpool and Blackpool, have presented their report, and, as the consequence, all the houses in each college will be put into electrical communication with the fire station. The governing body of the college are financially supporting the Council in these precautionary efforts.

County of London and Brush Co.—The directors of the County of London and Brush Provincial Electric Lighting Company, Limited, have declared an interim dividend for the half-year ended June 30, 1903, on the ordinary shares, at the rate of 4 per cent. per annum. The amount of electricity sold in the Company's London districts during the half-year is estimated to realise £49,824, which compares with £43,725 for the corresponding period of last year.

Portsmouth Telephones.—The Telephone Committee report that they are constantly receiving new applications for instruments, and before very long an application will probably be made to the Local Government Board for an additional loan. In the meantime the committee are preparing to meet the requirements of the public, and have accepted tenders for a further supply of 250 wall and 50 Edison-Bell table instruments, at a little less cost than those previously supplied.

Hull.—An assistant assistant engineer is to be advertised for at £200 per annum. The committee have adopted a revised scale of meter rents, which, it is explained, will place all consumers of the same size of installation at the same rate, independent of the initial cost of the meter, but which at the present price of meters will recoup the committee to the extent of 10 per cent. per annum on the initial outlay. The present revenue is expected to be reduced by £290 per annum.

North-Western Electricity and Power Gas Bill.—Details of this proposed measure were given in our last issue. On Friday a committee of the House of Commons found the preamble proved, but confined the proposed area of supply to parts of Staffordshire, Denbighshire, Flintshire, and Derbyshire, and excluded the whole of Cheshire. The committee were of opinion that the proposed capital of a million and a half was insufficient for the whole area as proposed by the promoters, and therefore limited the scheme to the districts named.

Stourbridge.—The question of the electric lighting order came before the Council at their last meeting, when the Gas Committee presented a special report requesting the Council to relieve them of the responsibility of carrying out the order, believing that a separate committee would be better able to deal with it. The Gas Committee's report was carried, but not unanimously, and afterwards it was carried by a majority of two that the working of the electric lighting order be placed in the hands of the Railway and Destructor Committee.

Reading.—Trials are being conducted in the Oxford-road with four electric arc lamps erected by the Reading Electric Supply Company, who are in communication with the Corporation with reference to the terms of supply for lighting certain of the tramway routes. Simultaneously experiments are being conducted with incandescent gas burners. The borough engineer (Mr. John Bowen), who is superintending these experiments, will shortly make detailed comparative reports to the Highways and Lighting Committees of the Corporation.

Hythe (Kent).—The Folkestone Electricity Supply Company have offered to become entirely responsible for the whole of the public lighting of Hythe, the hours to be from dusk to midnight, the light of the lamps to be not less than that previously produced by the gas-light, the charge for such lighting to be £560 annually, payable in quarterly instalments. These terms have been accepted by the Council. The Mayor spoke strongly in favour of the proposed scheme, and mentioned that it would effect a saving, as for one year their gas bill totalled £715.

Shildon.—A letter was read from the Northern Counties Electric Supply Company at the last meeting of the Urban District Council stating their experience was that two years was too short a time in which to develop the demand for electricity sufficient to justify the erection of a refuse destructor, and that they thought the Council should be satisfied with the installation of a dust destructor as soon as the electric lighting demand was equivalent to 10,000 8-c.p. lamps. It was decided to write the company asking them to at once make arrangements for the supply of electric light.

Southampton.—Mr. W. Bone, a former mayor, on Monday laid the foundation stone of the new electricity works for the county borough. The original works were purchased by the Corporation from a private company, and the demand for electricity has so increased that it became necessary to provide entirely new works which will be of a very extensive character and are to be completed early in October. As an illustration of the growth of the department it is stated that in 1896-7 the output was 134,843 units, in 1901-2 1,430,222 units, and in 1902-3, 1,732,013 units.

Darwen.—The revenue account of the electricity department for the past year shows a gross profit of £2,924. 16s. 6d., and a net profit, after deducting interest and repayment of principal and sinking fund instalments, of £104. 11s. 9d. No depreciation has been debited to the revenue account beyond the statutory requirements for repayment of principal to the Public Works Loan Commissioners and sinking fund instalments. The amount standing to debit of net revenue account has been reduced by the above profit from £1,630. 0s. 11d. at March 31, 1902, to £1,525. 9s. 2d. at March 31, 1903.

Swansea Telephones.—A meeting of the Telephones Committee of the Corporation was held on Thursday last week, when the manager reported that 98 lines were now fitted with instruments, and can be

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fitted to switchboards when the contractors hand over the cables. Three hundred and seventy-six subscribers had applied for the limited service, 62 for the message rate, and 18 for the private service, making a total of 456 in all. Orders are coming in satisfactorily, and it is expected that many more would come in when the National Telephone Company's contracts expired and the Corporation telephones had had a fair test.

Ealing.—At the last meeting of the Town Council the Electric Lighting Committee reported that 930 lamps had been applied for since the last meeting. They have resolved to revise the scale of meter rents at present in force. The present charge is 1s. 6d. per quarter up to 25 lights applied for, 3s. up to 50, 4s. 6d. up to 75, and 6s. per quarter for any number over 75. The new scale is: not exceeding 10 8-c.p. lamps, 1s. 3d.; above 10, but not exceeding 25, 1s. 6d.; above 25, but not exceeding 45, 2s.; above 45, but not exceeding 65, 2s. 6d.; above 50, but not exceeding 75, 4s. 6d.; above 65 for any number, 3s.; above 75, 6s.

Maidenhead.—Mr. C. O. Milton, the resident electrical engineer, in his latest report on the electric lighting undertaking, states that the meter readings for the June quarter are very satisfactory. Thirty new connections have been made during the quarter and 9,829 units have been sold to private consumers, this number being less than 3,000 smaller than that for the winter quarter. This of course, is due to the increase in the number of consumers. The revenue amounts to £373 odd, and as the ensuing quarter will earn more than the estimated deficit for the half-year ending September will be on the right side.

Macclesfield.—The recent canvas for probable customers to the proposed electricity undertaking has shown that there are about 120 applications for current, aggregating over 3,000 lamps and over 100 h.p. for motive purposes. Of the applications, two-thirds are from residents within the compulsory area laid down in the Corporation's provisional order, and most of the others from the immediate neighbourhood. The figures far exceed the anticipations of the committee, who have decided to send the results to the three firms who have been asked to tender for the work so that they may form a basis as to the size of the installation.

Floods.—Considerable damage was done to the newspaper presses on the south side of Fleet-street by the heavy rains at the beginning of the week owing to the inadequacy of the existing storm-sewer arrangements. The City of London Electric Lighting Company inform us that they have made special arrangements to place their staff, men, and appliances at the service of any of their customers during such times of emergency. The company have placed a suggestion before the London County Council to provide them with a suitable pumping station, driven by motors supplied with their current, at a trifling cost, which would prevent the recurrence of the recent disaster.

Bristol.—At Wednesday's meeting of the City Council, a debate took place on the question of the inclusion of Bristol in the Somerset and District Electric Power Bill, which, as noted last week, has been passed by the Parliamentary Committees. Mr. Witty declared that this was a blow to municipal trading which should not be minimised by the advocates of that system. Mr. Hughes believed that the city was greatly disappointed, and felt that they had had too much of the sword of justice and not enough of the evenly-balanced scales. Mr. Lloyd held that the result would be that the committee would meet the competition successfully, and eventually the matter dropped.

Halifax Telephones.—An important meeting of the Corporation Finance Committee has been held, at which Mr. Bennett, acting on behalf of a prospective company, presented a scheme for the establishment of a system of telephones in Halifax. In their last parliamentary Bill the Corporation secure powers for municipal telephones, but apparently there is a disinclination on the part of the public to favour for the time being any extension of municipal enterprise. The proposal before the Finance Committee is to the effect that a company should be permitted to operate under the necessary license, and give telephonic accommodation at greatly reduced rates compared with those of the National Telephone Company. The committee intend to consider the proposal made by Mr. Bennett.

Stock Exchange.—The Stock Exchange Committee has appointed Thursday, Aug. 6, a special settling day for Callender (George M.) and Co., Limited, 25,000 preference shares of £1 each, fully paid, Nos. 50,001 to 75,000. Applications have been made to the Stock Exchange Committee to appoint a special settling day in and to grant a quotation to the British Westinghouse Electric and Manufacturing Company, Limited, further issue of 100,000 6 per cent. preference shares of £5 each, fully paid; Metropolitan Electric Supply Company, Limited, 71,083 4½ per cent. cumulative preference shares of £5 each, fully and partly paid; Underground Electric Railways Company of London, Limited, fully and partly paid provisional certificates for £7,000,000 5 per cent. profit-sharing secured notes.

Ipswich.—The electric light and tramway scheme is progressing towards completion, and a reminder of this fact is that the local contractors, Messrs. Reavell and Co., have just completed the official tests on the last of the six engines which they have been constructing. The two largest engines, which are of 400 h.p., have already been completed and delivered at the electric lighting station, these sets being intended principally for providing the electric energy for the tramcars. Two small steam-engines of 80 h.p., with their dynamos, have also been tested and delivered, these engines being intended for the lighting load only. In addition there are two sets of medium size, of 200 h.p., which will be principally used for providing electrical energy for lighting purposes. The tests which were carried out were all successful.

Hammersmith.—At this week's meeting of the Borough Council the Electric Lighting Committee reported that 17 additional consumers had been connected, representing a maximum of 436 8-c.p. lamps, that 14 consumers had been disconnected, and that the total number of consumers now taking current from the mains was 1,271. The committee have approved the plan submitted by the London United Tramways, Limited, showing the positions of the standards to which arc lamps will be affixed in Glenthorne-road, Dalling-road, Paddenswick-road, and Askew-road. The committee have made an arrangement with the Imperial Tobacco Company to supply their factory at Fulham Palace-road with exhaust steam at 3s. 4d. for 100lb. for a period of three years. The company already take electricity from the Corporation department for lighting and power in large quantities.

Gosport.—Plans and estimates are in course of preparation for installing the electric light in the Clarence Victualling Yard, Priddy's Hard, and Forton Barracks. The money necessary to proceed with the work will be included in the naval estimates next year. The scheme is as yet only in the initial stage. It is proposed to erect a generating station in Clarence Yard, with sufficient accommodation for later adding two more boilers and dynamos. Priddy's Hard will be connected by cables carried across the creek under the water. From that establishment the wires will be carried to the Marine battery and then recross the creek to Forton Barracks. The divisional schools and the hospital standing in the field opposite the barracks will be included in the installation. The scheme provides for a large number of arc lights at each of the three establishments in addition to the ordinary connections.

London Electrical Contractors' Association.—At the annual general meeting of the above, held at Frascati's Restaurant on the 27th inst., the president, Mr. Rashleigh Phipps, in the chair, the annual report and balance-sheet was submitted and adopted, and the following officers appointed for the ensuing year: president—Mr. E. L. Berry; vice-presidents—Mr. W. Duncan, Mr. W. W. Strode, Mr. C. L Troup; council—Messrs. Gillard, Joseph, Lund, Marryat, Mossop, Tate, Ratcliff, Tomlinson, Tricket; hon. treasurer—Mr. W. R. Rawlings; hon. secretary—Mr. E. J. Hogan. Among other business, it was decided to hold a series of monthly general meetings for the discussion of subjects of interest to the contracting trade. Any contractors in London and district who have not yet joined the association are requested to communicate with the hon. secretary, E. J. Hogan, 141, Fenchurch street, E.C.

Electrical Manufacturers and Contractors.—At a final conference between the committees of the National Electrical Manufacturers' Association and the National Electrical Contractors' Association recently held, a basis of agreement was finally agreed upon between the two associations. The result of these negotiations has taken some time to arrive at owing to the many difficulties in the way. It is believed, however, that the basis of agreement now come to will prove of a very satisfactory nature to members of both associations. The recommendations of the joint committees were on the same day submitted to the Central Board of the National Electrical Contractors' Association and approved by them. Simultaneously the National Electrical Manufacturers held a general meeting of its members, who also approved of what their committee had done on their behalf. Parties interested on either side can get full information from the secretaries of either association.

Wrexham.—From a statement presented by the borough accountant it appears that the number of units sold during the quarter for private lighting shows an increase of 45 per cent. The charges amounted to £258, an increase of 30 per cent.; the number of consumers was 127, against 87, an increase of 46 per cent.; and the average price obtained per unit was 5·28d., a decrease of 3·5d. For tramways 33,890 units were sold (minimum number charged, 37,000 at 2d.), and the charges amounted to £312. For public lighting the cost was £183, against £178. The total revenue amounted to £755, against £375. The electrical engineer's report, presented at the last meeting of the Town Council, showed that the units generated during June were 29,094, compared with 8,164 last year; 12,755 units were used by the trams and 16,339 for lighting, etc. After a long discussion it was agreed that current for motors be supplied at 2½d. per unit within the regulation area, and that the minimum be reduced from £10 to 30s. It was decided to allow Mr. Sillery, electrical engineer, to conduct an electricity class at the art school.

South Africa.—We learn from *South African Exports* that a scheme of electric lighting for Wellington is being discussed. A number of electric lighting cable extensions have been authorised at Ladysmith, and when these are completed the entire residential quarters of the town will be served. There is considerable interest being manifested by the ratepayers of Potchefstroom in regard to the lighting of the town, offers to do this having been received from Johannesburg firms, but the matter was adjourned *sine die*. The ratepayers, however, have expressed themselves as dissatisfied with this, and several prominent traders have ordered complete plants of their own. The Health Board have, as a result, brought up the matter again, and will consider the advisability of granting a concession for lighting the whole town and military cantonment. The question of public lighting has been agitating the township of Beaconsfield for some time. The De Beers Company have now, at the request of the Beaconsfield Council, resolved to undertake to a certain extent to light the streets of Beaconsfield free with electric light, also to instal electric light in the town hall, and to supply current for municipal purposes only, free of charge. The company will erect 20 arc lamps in the streets, and lay cables sufficient to light private houses along the route, but the current cannot be supplied until the new power station now being erected in the vicinity is completed. The current supplied to the town hall for other than municipal purposes will be charged at 6d. per unit. No responsibility will be accepted by the company for any failure of supply. The Natal Government, being dissatisfied with the Durban municipal telephone service, have installed a system of their own, connecting the eight or ten local departments with the central exchange on the main wharf. The new system covers the whole of the harbour, including cargo sheds, etc. Greater expedition at the port is anticipated.

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Leicester.—The Finance Committee report that the Gas and Electric Lighting Committee have submitted to them a proposal to seek power from the Local Government Board to borrow £100,000 to cover the amount already overspent on the electric lighting capital account, and for future extensions of distributing plant. The committee have no comment to make on the proposal. The Electric Lighting Committee report that their engineer, Mr. Alfred Colson, M.I.C.E., has brought under their notice the increase in the demand for current, the capabilities of the present cables and transformers, and the probable demand for current in the near future. The engineer advises that, in order to meet the anticipated requirements of the town as regards the supply of electricity during the next few years, a considerable extension of the distributing plant, etc., will be needed, necessitating an expenditure on machinery of £3,623; for mains and services, £50,550; for transformers, £7,350; for meters (1,500), £7,500; instruments, say, £200—making a total of £69,223.

Mechanical Ventilation Specialities.—Messrs. John Gibbs and Son, of Liverpool, have sent us a copy of their new catalogue of mechanical ventilation specialities, which has been got up in a distinctly attractive style and fully illustrated. The first illustration shows us three of the eight Gibbs fans, each 8ft. diameter, erected by the firm at the Bradford Corporation electricity works, and which are doing very successful work. Glancing through the catalogue, our attention is arrested by an illustration of a 48in. electric fan, dust-proof type, which, we are informed, is approved and adopted as their standard type by leading insurance companies. The fan is made in eight different sizes, the diameter of the blade varying from 15in. to 48in., and the price from £13. 10s. to £57. 10s. The 15in. blade is estimated to remove 1,500 to 1,800 cubic feet of air per minute, the 24in. blade 4,000 to 6,000 cubic feet, the 36in. blade 10,000 to 15,000 cubic feet, and the 48in. blade 25,000 to 40,000 cubic feet. The revolutions per minute range from 1,000 to 1,200 in the case of the 15in. fan to 400 to 550 in the case of the 48in. blade. The machines are stocked wound for 110 and 230 volts continuous current.

St. Marylebone.—The crisis has been reached in the electric lighting trouble at St. Marylebone. The present situation would afford excellent matter for comedy were it not for the serious position in which the Borough Council find themselves placed. Unable to get the consent of the County Council to raise the loan for purchasing the undertaking of the Metropolitan Electric Supply Company, they are now threatened with an application by the "Marylebone Electric Supply Company" to the Board of Trade for powers to authorise this company to supply electricity in the borough. Naturally, the Council will oppose this application tooth and nail, but we think it has a good chance of succeeding with the Board of Trade in view of the present state of affairs. As stated in another column, the Borough Council as a last resource propose to apply for a special license from the Board of Trade which would remove the legal difficulties in the way of the County Council sanctioning the proposed loan, but from what we hear there is a decided disinclination on the part of the Board of Trade to grant these licenses, and it is possible that it will prefer to sanction the application of the St. Marylebone Company to undertake the supply of electricity in the borough.

Camberwell.—As recently noted in these columns, the Camberwell Borough Council have circulated among the London local authorities the documents in connection with the refusal of the Board of Trade to grant to the London Electric Supply Corporation an order under the Electric Lighting Acts in respect of the southern portion of the borough. The matter has come to the notice of the London County Council, who have sent the Borough Council a communication, pointing out that, as regards applications for orders under these Acts, the Council have always been in favour of two companies being allowed to compete in the same area, but they have always considered that any application by a company for an order in respect of an area for which the local authority have been granted an order should be refused. It appears to the County Council that the action of the Board of Trade in the present instance is to some extent a departure from the attitude generally taken up by it in the past. The County Council are in sympathy with the Borough Council in the matter, but it does not appear that the Council have any power to render assistance with regard thereto, as under Section 4 of the Electric Lighting Act, 1882, the Board has a discretionary power to grant a provisional order authorising any local authority, company, or person to supply electricity for public or private purposes within any area, and there is no appeal against the decision of the Board.

Wandsworth.—Dealing with the question of electric light in the borough, it was stated at the last meeting of the Council that the special sub-committee appointed to go into the matter had come to the conclusion that the only remedy for the present evil of high rates was competition. The committee recommended that Mr. Adams, electrical expert, should be empowered, at a cost of £105, to draw up a complete scheme for the supply of electric current generated by power obtained from the Tooting dust destructor, and the recommendation was confirmed. It was reported that the London Electric Supply Corporation had written stating that they would be prepared, if they obtained the provisional order which they sought, to supply consumers in the borough with electric current at 6d. per unit for the first 4,000 units in each year, and 4d. per unit in excess of 4,000, with reductions for large orders. The committee recommended that the company should be informed that the Council could not support their application for the proposed order unless they undertook to supply electricity for lighting purposes at a flat rate of 4½d. per unit to private consumers and 2d. per unit for power. This was agreed to. The General Purposes Committee reported that when the matter of lighting the town hall by electricity was under consideration it was not present to the minds of the committee that the tenders were received by invitation and not by public advertisement. The tender of the City of London, etc., Electric Lighting Company having been accepted by the Coun[illegible] the committee were of opinion that the contract should be proceeded with, and that Mr. A. T. Snell, who prepared the specification, should be retained to superintend the work.

Southwark.—At the last meeting of the Borough Council the General Purposes and Finance Joint Committee reported that the district auditor had disallowed certain charges, thereby leaving the whole deficiency of £3,945. 6s. on the electric light undertaking as a charge upon the rates of the parish of Newington, because no part of the expense incurred under the Act relating to the supply of electricity in the parish of Newington, which extended only to a part of the borough, could lawfully be charged upon the general funds of the whole borough, and because, by Section 10, Sub-Section 4, of the London Government Act, 1899, it was provided that such expenses should be borne by the area to which the adoptive local or other Act in point extended, and because no scheme under the London Government Act had provided otherwise. The committee were of opinion that considerable difficulty would arise hereafter if the undertaking were treated as a parish and not a borough concern, and would materially tend to retard the future unification of the borough. The committee, therefore, recommended that an appeal be made to the Local Government Board against the disallowances of the auditor, and that in the event of the appeal failing, application be then made to the London Government Act Commissioners to issue a scheme under the London Government Act, 1879, making the expenses of the undertaking chargeable to the whole borough. The recommendation was adopted.

Dewsbury.—The annual report of Mr. R. H. Campion, borough electrical engineer, to the Electricity Committee on the working of the undertaking during the past 12 months has been issued, and it is with pleasure we record a successful year in regard to the running of the station and the financial result. The gross receipts by sale of current are £5,469. 18s. 7½d. Discounts have taken £296. 18s. 5d., leaving the net amount £5,173. The total revenue is £5,434. 3s. 10½d. The total costs are £2,778. 9s. 2d. (£107 less than last year), leaving a gross profit of £2,655. 14s. 8½d. This is sufficient to pay the interest and sinking fund charges for the year and leave a surplus of £286, which has gone to help to pay off the deficit of £378 left over from last year. Practically the undertaking is £664 better than last year. Thirty-four consumers have been connected during the year, several of them being millowners, who should run for longer hours than most motor consumers. The capital expenditure during the year has been £3,235, which has taken £92 extra for interest and sinking fund. In his general remarks the engineer states that there is an equivalent of 21,207 lamps of 8 c.p. connected to the mains, an increase of 2,822 over last year. During the year applications were received for supply of 10 additional motors, which now total 38. The number of units sold for the year is 282,340 for lighting, which is an increase of 19,264. Four thousand four hundred and forty units were sold to the tramway company at 4d. per unit for trial runs, and from Feb. 18 to March 31 they used 28,352 at 1½d., so that the total number of units sold is 315,132. The highest load reached for lighting was 263 kw. on Dec. 19 and for traction 200 kw. on March 21.

York.—A quarterly meeting of the City Council was held last week, at which Mr. H. V. Scott, chairman of the Electricity Committee, gave some most interesting details of the working of the electric light undertaking during the past year, supplementing the information given in the annual report, which we published last week. He said there had been a most substantial increase in the business done. There had been a steady increase in the units sold—220,000 in the first year, 423,000 in the second year, and 652,000 in the third year. The cost per unit of providing the light had steadily decreased. In the first year it was 2·428, in the second year 1·960, and in the last year 1·896. The total revenue for the year had been £7,454. 17s., which was a steady increase on former revenues, and the total costs of the concern had been £5,243. Of the latter sum, however, £553 would, if they were a trading concern, be charged to capital and not to revenue, which would leave the profit £2,764, which was exactly 5 per cent. upon the capital expended at the commencement of the year. He thought that was an extremely satisfactory result for a concern only in the third year of its working. With regard to the position of the concern, they were authorised to borrow £90,000, and there was a further sum of £10,850 which they would no doubt receive leave to borrow, making the total borrowed capital of the concern £100,000, or rather over. Replying to criticisms which had been passed upon the concern, he said that the average percentage on the capital of the whole of the public companies of the country set aside for depreciation was 1·1, the average of the municipalities was 2·2, the amount for York was 2 per cent. The average cost of production of all the companies had been 2·35d. per unit, of all the municipalities 2·18d., of York 1·77d. The average price of the public companies to their consumers for lighting was 4·96d., for all the municipalities 4·52d., and for York 3·60d. The average price of public companies for public lighting was 2·64d., of all the municipalities 2·48d., and of York 1·74d., so that in every respect the municipalities beat the companies, and York practically, in every respect, beat the municipalities hollow.

Blackburn.—In his report on the working of the electricity department, Jubilee-street, during the past 12 months, Mr. Alfred S. Giles, the borough electrical engineer, states that the receipts and expenditure, shown in a condensed form, are as follows: receipts, £25,750. 7s. 10d.; working expenditure, £14,208. 3s. 7d.; gross profit, £11,542. 4s. 3d. The interest and sinking fund charges and the above balance is shown as follows: interest, £4,527. 6s. 7d.; sinking fund, £5,180 12s. 6d.—total, £9,707. 19s. 1d. The net profit amounts to £1,834. 5s. 2d. The output from the generating station for the year is 2,503,639 units sold. The works cost has been reduced from 1·09d. last year to 0·79d. per unit. The total costs, including management and distribution to the consumers, has been reduced from 1·48d. to 1·20d. per unit. There is the equivalent of 106,866 lamps of 8 c.p. connected to mains, being an increase of 24,757 over last year. The number of consumers taking the supply of electric energy for lighting and power purposes now number 890, an increase of 107

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over last year. The total capacity of the works is now 3,720 h.p. The maximum load at any one time was 1,638 kw., on Dec. 17. The average price obtained per unit sold for lighting purposes is 3·83d., a figure which will compare favourably with other towns of the same output. The average for power purposes is 1·59d., and for tramway traction 1·5d. per unit. During the year two more Lancashire boilers have been put down, and the new chimney completed, doing away with black smoke troubles due to working the old chimney beyond its capacity. The buildings in connection with the extension of the works are nearly completed, and one of the new engines has been erected. The contractors are proceeding with the erection of the other plant on order, and this will be all completed during the summer and be in working condition for next winter. Last winter proved a most anxious time for the staff in charge of the generating station, for they were working at times without an adequate proportion of spare plant, but they were able to get through the winter load with but few troubles affecting the general supply for more than a few minutes. The cost of generating has been largely reduced during the year. A large proportion of the economy achieved is due to their being able to use the town's water for condensing purposes, and to being able to contract for a cheaper fuel than that they used last year, owing to having installed additional boilers.

London County Council.—At Tuesday's meeting of the London County Council the Finance Committee brought up a report on the subject of the St. Marylebone electric lighting. The question considered, and upon which the opinion of Mr. Haldane, K.C., had been taken, was whether, if a license be obtained by the Borough Council from the Board of Trade, the Borough Council will obtain such legal power to borrow as will justify the County Council in sanctioning the loan. The committee state that in this event the legal difficulty in the way of granting the loan will be removed, but in the first instance the period authorised by the sanction of the County Council, if given, for the repayment of the money will be limited to the period of the license—*i.e.*, seven years. Such period, however, will be open to consideration after purchase. Upon the recommendation of the Finance Committee, it was agreed to lend the Poplar Borough Council £3,345 for electric lighting, and the Hampstead Borough Council £1,273 for street-lighting. The Bridges Committee reported on the resolution of the Council to accept the offer of the London Electric Supply Corporation to supply electric current for lighting and working the lifts at Greenwich Tunnel at the rates of 2d. and 1½d. per unit respectively. An expenditure of £1,900 for electric plant to enable the supply to be taken has already been sanctioned. The committee have been in communication with the corporation as to the amount to be paid to it for plant under the proposed agreement, and have arranged that this shall not exceed £1,650, made up as follows: two motor-generators and switchboards complete, erected and set to work, £1,470; high-tension feeder through tunnel, £125; contingencies, £55. Other work, such as the foundations and covering for the generators, will be undertaken by the Council. In connection with the price to be paid for current for lighting purposes, the committee have considered an offer of the corporation to reduce the charge from 2d. to 1·8d. on condition that the Council will not work the lifts on Sundays. This offer, if accepted, will effect a considerable economy on lighting, and in addition the cost of power for working the lift on Sundays will be saved. There will be no business use for the lifts on those days, and the 24 hours' break would be very useful for the purpose of overhauling the machinery should this be necessary. Under the circumstances the committee have decided to accept the offer. Notices were received from the following companies of intention to lay electric mains subject to certain conditions: Charing Cross and Strand Electricity Supply Corporation, City of London Electric Lighting Company, County of London and Brush Provincial Electric Lighting Company, and Notting Hill Electric Lighting Company.

Croydon.—Mr. J. Gray Scott, borough electrical engineer of Croydon, has presented to his committee a report on the past year's working of the electricity undertaking. He states that the returns for the period under review are gratifying, showing, as they do, an all-round improvement on the previous year, and representing the most successful year of working in the history of the undertaking. The capital expenditure has increased from £212,389 to £231,353, the expenditure during the year amounting to £18,964. The total receipts for the year amount to £40,154, as compared with £27,483 for the previous year; the total expenditure amounts to £21,875, as compared with £14,582 in the previous year, leaving a balance of gross profit to be carried to the net revenue account of £18,200 as against £12,850 last year. The net profit for the year, after payment of interest and sinking fund, amounts to £4,654. 17s. 8d. The return on the average capital outlay therefore represents 8·54 per cent. The capacity of the plant in kilowatts amounts to 3,215, and the maximum load reached was 2,127 kw. This represents an increase in load on the station of 444 kw. The number of consumers during the year has increased from 1,043 to 1,378, an actual increase of 335, or 32 per cent. The number of 8-c.p. lamps connected at March 25, 1903, was 96,479, as compared with 78,386 for the corresponding period of last year, representing an increase in lamps connected of 18,093. The average price obtained for private supply was 4·34d. per unit, as compared with 4·39d. per unit for the previous year. With regard to the analysis of costs: the cost of generation and distribution, which includes coal, oil, and other stores, wages, repairs, and maintenance, amounts to 1·26d. per unit sold, as compared with 1·34d. per unit for the previous year. Adding to these figures the items of rents, rates, taxes, etc., and management, the total cost per unit sold during the past year amounts to 1·58d., as compared with 1·82d. for the previous year. Dealing with the output of the works, it will be seen from the statement of electricity generated, sold, etc., that the number of units generated during the past year amounts to 3,889,794, as compared with 2,310,876 for the previous year. This represents an increase of 68 per cent. After deducting the units used for station lighting, testing, and driving auxiliary plant, also allowing for the losses in distribution, the actual number of units sold for private lighting, public lighting, and tramways amounted to 3,131,841, as against 1,810,387, an increase of 73 per cent. The percentage of units sold to units generated is 80, as compared with 76 the previous year, and it will be his endeavour to still further increase this efficiency of distribution by reducing the proportion of losses incurred. The engineer goes on to refer to the fact that during the past year they have been severely handicapped in the work of the department by several circumstances beyond their control. The supply was entirely disorganised by the fire which occurred at the end of October, and since that date until very recently the works have been run with temporary mains on the engine-room floor, and other similar arrangements of a temporary nature. It has been necessary to gradually carry out the work of permanent reinstatement, but at the same time always maintain an efficient supply. Their position with regard to stand-by plant has been an undesirable one, and he points out how very serious a responsibility rests upon his assistants and himself when they are confronted with the fact that for a certain period of the year, at any rate, the supply throughout the borough for tramways or lighting is entirely dependent upon certain portions of plant, a breakdown of which would involve serious inconvenience and loss, not only to his department, but to the borough generally. There is a further disadvantage in running a station to its full capacity, and that is, that in the event of machinery or plant of any kind to be supplied under contract proving unsatisfactory, it is impossible to reject the plant in the event of serious defects, while in the event of minor defects arising, which might easily be located by the contractor, were he provided with ample opportunity for doing so, it is sometimes difficult to make the necessary provision under the above circumstances. The subject of further extensions of plant in the station will be dealt with in a separate report, but he impressed upon the committee the desirability of anticipating a continually increasing demand for a supply of electricity, having in view the progress of the station since the commencement of the undertaking, and the rapid strides in its development which are at present being made. The report then goes into detail, giving particulars of the plant installed, mains, sub-stations, etc. In conclusion, Mr. Scott expresses his appreciation of the loyalty and hearty co-operation of his assistants and the members of the staff.

PROVISIONAL PATENTS, 1903.

JULY 20.

15968. Improvements in electric batteries. Alfred Blackman and Charles Ernest Warren, 115, Cannon-street, London.

15970. Improvements in and connected with electric tramcars. James Albert Lycett and George John Conaty, 128, Colmore-row, Birmingham.

15972. Improvements in switches and rheostats for starting and controlling electric motors. Frederic Osmund Hunt, 21, Mount-vale, York.

15975. An improved suspender for carrying balance weights used as electric lighting accessories. Richard Thomas Grocott, Whitehall Works, Longport, Stoke-on-Trent.

15979. An improved switch lampholder for electric lighting. George Casperson, 11, Upper Mill-hill, Boar-lane, Leeds.

15980. Indicating attachment on electric fuseways. James Wilson, 90, Boston-street, Hulme, Manchester.

15992. Electromagnetic brake for electrically-propelled cars of tramways and street railways. Heinrich Seggel, 78, Fleet-street, London. (Complete specification.)

15995. Improvements in charge indicators for secondary batteries. Hiram Percy Maxim, Westinghouse-building, Norfolk-street, Strand, London. (Date applied for under Patents Act, 1901, Aug. 4, 1902, being date of application in United States.) (Complete specification.)

16014. Improvements in casings for electric conductors. Warner Valentine Smith, 18, Southampton-buildings, Chancery-lane, London.

16033. Improvements in apparatus for regulating the supply of current in electric mains. Herbert William Butler, 47, Lincoln's-inn-fields, London.

JULY 21.

16078. Improvements in and relating to electricity motor meters. William Hamilton, 18, Southampton-buildings, Chancery-lane, London.

16100. Improvements in circuit-controlling devices chiefly designed for use with electric flash signs. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (Automatic Time Switch Company, United States.) (Complete specification.)

16113. Improved means and apparatus for producing and detecting Hertzian oscillations. John Nevil Maskelyne, jun., 6, Bream's-buildings, Chancery-lane, London.

16114. Improvements in interrupters for use with induction coils and other electrical apparatus. John Nevil Maskelyne, jun., 6, Bream's-buildings, Chancery-lane, London.

16132. Improvements in and relating to rectifying polyphase alternating currents by means of unipolar cells. William Edward Evans, 27, Chancery-lane, London. (Allgemeine Elektricitäts-Gesellschaft, Germany.) (Complete specification.)

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16115. Improvements in electric system of fire-alarm and signalling apparatus. Frank Hubber and William George Higgs, 6, Bream's-buildings, Chancery-lane, London.

16133. Improvements in electrical signalling systems for railways. Charles Willard Mills and William Walter Piddington, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

JULY 22.

16142. Improved switch hook for telephones. Robert Frederick Hall and Thomas Linforth Jones, Cheston-road, Aston, Birmingham.

16148. An improved fuseboard for any number of ways. Albert Reame, 48, George-street, Hull.

16159. Improvements in or connected with electric measuring. Arthur Thomas Cooper, 15, Water-street, Liverpool.

16190. Improvements relating to tension-limiting devices for electrical apparatus. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (Compagnie de l'Industrie Electrique et Mecanique, Switzerland.) (Complete specification.)

16191. Improvements relating to the deposition of metals or metallic compounds. Sherard Cowper-Coles and Co., Limited, and Sherard Cowper-Coles, 45, Southampton-buildings, Chancery-lane, London.

16208. Improvements in and relating to nozzles for elastic fluid turbines. The British Thomson-Houston Company, 83, Cannon-street, London. (Charles Gordon Curtis, United States.)

16209. Improvements in apparatus for governing elastic fluid turbines. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Charles Gordon Curtis, United States.)

16210. Improvements in and relating to elastic fluid turbines. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Charles Gordon Curtis, United States.)

16211. Improvements in elastic fluid turbines. The British-Thomson-Houston Company, Limited, 83, Cannon-street, London. (Charles Gordon Curtis, United States.)

16212. Improvements in elastic fluid turbines. The British Thomson-Houston Company, Limited) 83, Cannon-street, London. (Charles Gordon Curtis, United States.)

16213. Improvements in elastic fluid turbines. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Charles Gordon Curtis, United States.)

16214. Improvements in elastic fluid turbines. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Charles Gordon Curtis, United States.)

16215. Improvement in elastic fluid turbines. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Charles Gordon Curtis, United States.)

COMPLETE SPECIFICATIONS ACCEPTED.

To be published August 13, 1903.

1902.

15842. Electric switches applicable for electrically-driven hoists or other machines. Etchells.

16241. Prevention of formation of deleterious vapours by electric discharges in air. Viertel und Gebrüder Siemens und Co.

16706. Galvanic cells. Strickland.

16711. Electrical conductors. Siemens Bros. and Co., Limited, and Dieselhorst.

16776. Electrically-operated safety clutch for hoists. Horsfall and Crowther.

16839. Polyphase induction motors. Siemens Bros. and Co., Limited, and Lydall.

18317. Electric arc lamps. British Thomson-Houston Company, Limited. (Wood.)

18327. Starting devices for electric motors. British Thomson-Houston Company, Limited. (Read.)

19089. Carbon-feeding mechanism of electric arc lamps. Veritys, Limited, and Ridings.

19442. Electrical switches. Macfarlane.

20445. Terminals for electric wires. Wolseley Tool and Motor-car Company, Limited, and Austin.

20482. Electric safety fuses. Peard and Dew.

20643. Safety appliances for controlling the action of winding engines. Siemens Bros. and Co., Limited. (Siemens und Halske Aktiengesellschaft.)

20646. Safety appliances for winding engines. Siemens Bros. and Co., Limited. (Siemens und Halske Aktiengesellschaft.)

20663. Means or apparatus for attaching electric sconces and the like to walls, ceilings, and other places. Van Hooydonk.

22017. Construction of underground conduits more especially intended for use in systems of underground electric traction. Devonshire.

22184. Electrical signalling and controlling apparatus, chiefly designed for artillery purposes. Lewis and Kirke. (Secret document under Sec. 44, Patents, etc., Act, 1883.)

23323. Sparking plugs for use in connection with the electric ignition systems of internal-combustion engines. Foley.

1903.

1606. Trolley arms used on electric tramcars and like vehicles. Wilkinson.

2239. Electric wiring for lighting and other installations. Bayliss and Browne.

4410. Method of producing storage battery plates. Fairweather. (General Storage Battery Company.)

8524. Electric signalling apparatus for railways. Oesterreicher and Nemelka.

8600. Telephone transmitters. Fahnestock.

11426. Vibrators for sound telegraph apparatus. Lind.

12203. Electric burglar alarms. Schubert.

12865. Electric burglar alarms for vaults, safes, and the like. Miller.

12982. Conduits, conductors, and contact devices or collectors for electric railway and tramway systems. Kuchinka.

13109. Feed wheels for automatic telegraph perforators and transmitters and for chronographs and like instruments. Gell.

13281. Device to be used in connection with telephone receivers. Capell.

13305. Brush boxes of dynamos and motors. W. H. Allen, Son, and Co., Limited, and Hawkins.

13570. Electromagnets for magnetic ore extractors. Haddan. (Bergmann-Electricitatswerke Aktiengesellschaft.)

14021. Galvanic batteries. Brandt.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.	Last price
Commercial and Industrial.—	£	£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1 ..	½-¾
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1 ..	¾-1
British Insulated and Helsby Cables, Ord., 1-100,000	5 ..	6¾-7¼
—— 6 per cent. Cum. Pref., 1-100,000	5 ..	5¼-6
—— 4½ per cent. Mortgage Debentures	100 ..	102-106
British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red.	100 ..	104-106
British Westinghouse Elec. and Manuf., 6 per cent. Pref., 275,001-375,000	5 ..	5¾-6
—— 4 per cent. Mortgage Debenture Stock	100 ..	100-102
Brush Electrical Engineering, Ordinary, Nos. 1-105,731	2 ..	¾-1¼
— Non. Cum., 6 per cent. Pref.	2 ..	1¼-1⅝
—— 4½ per cent. 1st Debenture Stock	100 ..	99-102
—— 4½ per cent. 2nd Debenture Stock	100 ..	87-92 xd
Callender's Cable, Debentures	100 ..	106-110
—— Ordinary	5 ..	11¼-12½
—— 5 per cent. Pref.	5 ..	5¼-5⅜
Crompton and Co.	3 ..	2-2¼
—— 5 per cent. Debentures	100 ..	101-105
Edison and Swan United, "A" Shares, 1-99,261	5 ..	¼
—— "A" Shares, 01-017,139	5 ..	1¼-2¼
—— 5 per cent. Debentures	100 ..	75-80
—— 4 per cent. Deb. Stock, Red.	100 ..	71-75
Electric Construction, Limited, Nos. 1 to 112,100	2 ..	1⅝-1⅞ xd
—— 7 per cent. Cumulative Pref.	2 ..	2½-3
—— 4 per cent. Perp. 1st Mort. Deb.	100 ..	99-102
Ferranti Limited, 5 per cent. 1st Mort. Deb. Stock, Red.	100 ..	90-95 xd
General Electric Company (1900), 5 per cent. Cum. Pref.	10 ..	9½-10
—— 4 per cent. 1st Mort. Deb. Stock	100 ..	99-102
W. T. Henley's Telegraph Works, Ordinary	5 ..	14-15
—— 4½ per cent. Preference	5 ..	5-5¼
—— 4½ per cent. Debentures	100 ..	108-112
India Rubber, Gutta Percha, and Telegraph Works	10 ..	18¼-19½
—— 4 per cent. Debentures	100 ..	100-103
Parker, Thos., Limited, Ordinary	10 ..	14½-15¼
Telegraph Construction and Maintenance	12 ..	32-35 xd
—— 5 per cent. Bonds	100 ..	100-103
Electric Lighting and Supply.—		
Blackheath & Greenwich District Ordinary 1,201-101,200	1 ..	⅝-¾
—— 4½ per cent. Deb. Stk. Certs., Red. and Conv.	100 ..	118-121
Bournemouth and Poole, Ordinary	10 ..	12½-13½
—— 4½ per cent. Cum. Pref., 7,501-15,000	10 ..	10-11
—— 6 per cent. Cum. Second Pref., 15,001-22,500	10 ..	10¾-11¼
—— 4½ per cent. Debenture Stock, Red.	100 ..	102-105
Bromley (Kent) Electric Light and Power Co., 4½ per cent. 1st Debenture Stock, Red.	100 ..	102-105
Brompton and Kensington, Ordinary	5 ..	10¼-11
—— 7 per cent. Preference	5 ..	10¼-10½
Calcutta Electric Supply Corp., Ordinary, Nos. 1-40,000	5 ..	6¼-7⅛
—— Nos. 20,001-30,000	5 ..	7-8⅛
Cambridge Electric Supply Company, Ltd., £10 Ord.	8 ..	14¼
—— ,, ,, £10 Ord.	6 ..	10¼
Central Electric Supply, Ld., 4 per cent. Guar Deb. Stock	100 ..	106-109
Charing Cross and Strand, Nos. 1-70,000	5 ..	9-9½
—— 4½ per cent. Cum. Pref.	5 ..	5¼-6
—— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000	5 ..	4⅜-5
—— 4 per cent. Debenture Stock, Red. (Prov. Certs.)	100 ..	104-106
Chelsea Electricity Supply	5 ..	6-6¼
—— 4½ per cent. Debentures	100 ..	107-110
City of London, Ordinary	10 ..	11-11½
—— 6 per cent. Cumulative Pref.	10 ..	13-14
—— 5 per cent. Debenture Stock	100 ..	121-126
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100 ..	102-105
County of London and Brush Provincial, Ordinary	10 ..	8-9
—— 6 per cent. Cum. Pref.	10 ..	11¼-12¼
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	100 ..	109-112
Edmundsons' Electricity Corporation, Ordinary, 1-50,000	5 ..	6¼-7
—— 6 per cent. Cum. Pref.	5 ..	6-6¼
—— 4½ per cent. First Mort. Deb.	100 ..	106-109
Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-30,000	5 ..	3¼-4¼
—— 5 per cent. Debenture Stock, Red.	100 ..	96-98
Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000	5 ..	6-6¼
—— 4½ per cent. First Deb. Stock, Red.	100 ..	102-106
Hove Electric Lighting, Limited, Ord., 1-13,000	5 ..	8-9
Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000	5 ..	11-12
—— 4 per cent. Debenture Stock Red	100 ..	103-106

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Name.	Amount paid.	Last price.
	£	£
Kensington and Knightsbridge and Notting Hill	100 ..	103-106
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10 ..	9½-10½
London Electric, Ordinary	3 ..	2-2½
—— 6 per cent. Pref.	5 ..	5½-6
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100 ..	100-102
Metropolitan, Ordinary	10 ..	17½-18½
—— 4½ per cent. First Mortgage Debenture Stock	100 ..	108-112
—— 4½ per cent. Mortgage Debenture, Red.	100 ..	97-100
Newcastle-upon-Tyne Electric Supply, Ordinary	5 ..	100-103
—— Preference	4 ..	102-105
Notting Hill Electric Lighting	10 ..	13-14
—— 4 per cent. First Mort. Debs., Nos. 1-500 (Reg.)	100 ..	99-102
Oxford Electric, Ordinary, 1-96 and 407-14,310	5 ..	5-6
—— 4 per cent. Debenture Stock	100 ..	98-101
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100 ..	100-102
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5 ..	3-3½
—— 4 per cent. Debenture Stock	100 ..	88-93
South London, Ordinary	5 ..	3½-4
St. James's and Pall Mall, Ordinary, 101-20,080	5 ..	15½-16½
—— 7 per cent. Pref.	5 ..	8-9
—— 3½ per cent. Deb.	100 ..	98-101
Urban Electric Supply Co., Ordinary, 8-30,007	5 ..	5-5½
—— 5 per cent. Cumulative Preference, 50,001-80,000	5 ..	5-5⅛
Westminster, Ordinary	5 ..	12-13
—— 5 per cent. Cum. Pref., 110,101-138,251	5 ..	6½-6⅝
Electric Railways.—		
Central London, Ordinary	100 ..	104-107
—— 4 per cent. Pref.	100 ..	101-104
—— ,, ,, deferred	100 ..	107-110
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100 ..	115-118
City and South London, Consolidated Ordinary	100 ..	65-67
—— 4 per cent. Debenture Stock	100 ..	116-119
—— 5 per cent. Pref. Stock '91	100 ..	130-133
—— ,, ,, ,, '96	100 ..	129-132
—— ,, ,, ,, '01	100 ..	128-131
Liverpool Overhead, 5 per cent. Pref.	— ..	13-13½
—— Ordinary, 1-50,000	— ..	7½-8
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	— ..	103-104
Waterloo and City, Ordinary	100 ..	97-100
Electric Tramways.—		
Anglo-Argentine, 1-260,007	5 ..	4½-4⅝
—— Permanent 6 per cent. Debenture Stock, 1888	100 ..	125-130
Blackpool and Fleetwood Tramroad	10 ..	13½-14½
Brisbane Tramway Invest., Lim., Ord., 1-75,000	5 ..	2⅞-3½
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5 ..	4½-4⅝
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100 ..	100-103
British Columbia Electric Railway Co., Ord., Nos. 1-20,000	100 ..	69-72
—— Non-Cum. 5 per cent. Pref., Nos. 25,001-38,600	100 ..	92-96
—— 4½ per cent. 1st Mt. Debs., Nos. 1-6,250, of £40 each	40 ..	104-106 p.c

Name.	Amount paid.	Last price
	£	£
British Electric Traction, Ord., 1-300,000 & 60,001-90,000	10 ..	11⅝-12⅛
—— 6 per cent. Cm. Pf., 30,001-60,000	10 ..	11⅝-12⅛
—— 5 per cent. Perpetual Debenture Stock	100 ..	124-126
Buenos Ayres and Belgrano Tram., Ord., 1-100,000	5 ..	2⅜-2½
—— "A" 6 per cent. Cm. Pf., 1-40,000	5 ..	5⅛-5⅜
—— "B" 6 per cent. Cm. Pf., 1-27,500	5 ..	4⅞-5⅛
—— 5 per cent. Deb. Stock, Red.	100 ..	105-108
—— Prov. Cert., all paid	100 ..	97-100
Cape Electric Tramways, Nos. 1-480,000	1 ..	2¼-2⅜ xd
City of Birmingham Tramways, 5 per cent. Cum. Pref.	10 ..	5-5⅛
—— 4 per cent. 1st Mortgage Deb., 1-3,000 (1917)	100 ..	99-102
Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red.	100 ..	103-105
Cork Electric Tramways and Lighting Co., Ordinary	10 ..	13-14
—— 5 per cent. Cum. Pref.	10 ..	11-12
—— Debentures	100 ..	96-99
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10 ..	13-14
—— 6 per cent. Pref., Nos. within 1-60,000	10 ..	15-16
—— 3½ per cent. Mort. Debs., 1-3,000, Red.	100 ..	96-97
Imperial Tramways, Ordinary	all ..	82-83½
—— 6 per cent. Cum. Pref.	all ..	144-151
—— 4½ per cent. Deb. Stock	100 ..	112-114
Isle of Thanet Electric Tramways and Lighting, 5 per cent. Cum. Pref., Nos. 30,001-60,000	5 ..	4-4½
—— 4 per cent. Debenture Stock	100 ..	92-95
Kidderminster and District Lighting and Traction, Pref.	5 ..	3½-4
London United Trys. (1901), 5 per cent. Cum. Pref.	10 ..	11⅝-12⅛
—— 4 per cent. 1st Mt. Db. Stock, Red.	100 ..	105-107
Metropolitan Electric Trams., Deferred, 1,000.001-1,314,016	1 ..	3-16-5/16
—— 5 per cent. Cum. Pref., 500,001-814,016	1 ..	1-1⅛
New General Traction, Ordinary	5 ..	1-1⅛
—— 6 per cent. Cum. Pref.	5 ..	2-3
—— 5 per cent. Mortgage Debentures, 1-1,713 (Regd.)	100 ..	88-93
Oldham, Aston, and Hyde Tramway, Ordinary	10 ..	10½-10⅝
—— 5 per cent. Cum. Pref.	10 ..	11⅝-12⅛
Perth Elec. Tramways (W.A.) 5 per cent. 1 Mort. Deb. Stk.	100 ..	98-102
Potteries Electric Traction, Ordinary, 20,001-40,000	10 ..	8½-9⅜
—— 5 per cent. Cum. Pref., 1-20,000	10 ..	9⅞-10⅛
—— 4½ per cent. Debenture Stock	100 ..	103-105
South Lancashire Electric Traction and Power Company—		
—— £250,000 Ordinary	1 ..	1
—— £101,132 6 per cent. Preference	1 ..	1
—— £528 093 4½ per cent. Debenture Stock	100 p.c.	100 p.c.
Telephones.—		
National Telephone, Preferred	100 ..	102-104
—— Deferred Stock	100 ..	82-84
—— 6 per cent. Cum. First Pref.	10 ..	13-14
—— 6 per cent. Cum. Second Pref.	10 ..	12½-13½
—— 5 per cent. Non. Cum. Third Pref.	5 ..	5⅛-5⅜
—— 3½ per cent. Deb. Stock, Red.	100 ..	96-98
—— 4 per cent. Deb. Stock, Red.	100 ..	101-103
Oriental Telephone and Electric Company	1 ..	13/16-15/16

TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line	Traffic Returns for week			Increase or decrease.		Miles of single track open.		Accounts for past year.						Cost per car mile.
	Ending	1903.	1902.	Week.	Current year.	1903.	1902.	Ending	Total receipts	Passengers carried.	Car miles run.	Receipts per Pass'nger	Receipts per Car mile.	Receipts per Mile of track.	
		£	£	£	£				£			d.	d.	£	d.
Aberdeen Corporation	July 25	1,625	1,113	+ 511	+10,440	19¼	17¼	May 31	37,931	9,099,715	794,641	0·98	13·02	1,970	6·14
Ayr Corporation	—	—	—	—	—	8	6	Sept. 25	12,503	2,979,276	290,099	1·00	10·34	1,560	4·7
Birmingham Tramways	,, 25	5,239	4,834	+ 405	+ 7,038	6¼	6¼	—	—	—	—	—	—	—	—
Blackburn Corporation	June 26	909	1,193	− 236	+ 674	24	24	March 25*g*	40,964	7,234,106	826,558	1·36	11·87	1,705	7·44
Blackpool Corporation	July 9	1,078	936	+ 102	+ 1 254	17½	16½	,, 31	211,168	6,169,121	784,443	1·52	10·8	—	—
Blackpool-Fleetwood Tramways	,, 25	1,391	1,209	+ 182	+ 277	16½	16½	Dec. 31	30,923	2,049,677	584,989	3·62	12·68	1,932	6·99
Bolton Corporation	,, 26	2 048	1,563	+ 484	+ 4,627	25	25	March 31	85,704	17,761,605	1,896,247	1·15	10·75	3,430	5·87
Bournemouth Corporation	,, 22	1,022	—	—	—	10½	—	—	—	—	—	—	—	—	—
Bradford Corporation	,, 26	4,165	3,135	+1,030	+ 7,323	39	—	—	—	—	—	—	—	—	—
Brighton Corporation	,, 26	960	869	+ 91	+ 5,382	6½	—	,, 31	—	10,432,508	1,031,928	1·00	10·10	—	—
Bristol Tramways Company	,, 24	5,581	4,721	+ 850	—	51½	51½	Dec. 31	223,480	41,192,899	5,724,114	1·30	9·38	4,348	—
Burnley Corporation	,, 25	889	615	+ 274	—	—	—	—	—	—	—	—	—	—	—
Cardiff Corporation	,, 25	2,136	1,542	+ 593	+11,747	—	—	—	—	—	—	—	—	—	—
Carlisle Tramways Company	—	—	—	—	—	—	—	,, 31	—	2,216,583	320,129*h*	—	—	—	—
Central London Railway	,, 25	6,402	6,218	+ 184	+ 714	6	—	,, 31	367,225	45,305,110	1,276,971*a*	1·87	66·6 *a*	59,076	35·6 *a*
City and South London Railway	,, 25	2,545	2,715	− 170	− 928	6⅜	—	,, 31	165,003*a*	19,069,319*a*	—	—	—	—	—
Cork E. T. and L. Company	,, 23	645	985	− 340	− 477	—	—	—	—	—	—	—	—	—	—
Darwen Corporation	,, 10	220	243	− 23	− 113	7·23	—	March 31*g*	12,341	2,360,735	254,279	1·25	11·65	1,707	9·36
Dover Corporation	,, 25	271	256	+ 15	+ 137	3	—	—	—	—	—	—	—	—	—
Dublin & Lucan Electric Railway	,, 26	542	495	+ 47	— *h*	—	—	Dec. 31	5,796	364,796	102,087	3·81	13·62	859	7·68
Dublin U. T., electric cars	,, 24	4,471	3,987	} +4888	+ 5,260	46	46	March 31	126,121	24,553,133	3,429,356	1·23	8·82	2,741	5·06*h*
Dublin S. District, Electric	,, 24	2,543	1,138												
Dundee City Tramways	,, 15	834	718	+ 116	—	22	22	May 15	35,874	9,084,522	752,814	0·93	11·276	1,630	—
East Ham Corporation	,, 25	700	451	—	+ 3,680	10·75	7·52	March 31	25,341	9,971,337	650,224	0·61	9·35	2,357	—
Farnworth U.D.C.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Glasgow Corporation	,, 25	11,471	9,252	—	—	124	101	May 3	653,200	177,179,549	14,008,750	—	—	—	—
Halifax Corporation	—	—	—	—	—	30¼	27¾	—	—	—	—	—	—	—	—
Huddersfield Corporation	,, 6	1,406	1,045	+ 361	—	34	35	March 31	55,631*h*	9,738,213	1,218,539	1·4	11·14	1,618	6·38
Hull Corporation, E. S.	,, 25	1,911	1,693	+ 218	+ 1,956	19	19	,, 31	87,707*h*	21,065,999	2,218,696	1·00	9·49	5,004	5·07
Ilkeston Corporation	,, 23	191	—	—	—	—	—	—	—	—	—	—	—	—	—
Kirkcaldy Corporation	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Leeds Corporation	,, 25	5,958	5,034	+ 924	+ 6,627	77	—	March 25	262,656	57,239,779	5,773,651	1·11	10·91	3,283	—
Liverpool Corporation	,, 18	10,700	10,748	− 48	+10,509	101	95	Dec. 31	504,304	108,906,472	11,705,425	1·11	10·34	5,000	6·88
Liverpool Overhead Railway	,, 26	1,710	1,561	+ 149	+ 469	15½	15½	June 30	79,252	10,466,726	986,185*a*	1·82	19·30*a*	5,110	— *a*
Newcastle-on-Tyne Corporation	,, 25	3,509	2,872	+ 637	—	36	36	Dec. 15	127,852	28,411,899	2,767,444	1·08	11·09	3,551	—
Portsmouth Corporation	—	—	—	—	—	29	29	Sept. 30	47,651	9,168,137	868,157	1·24	13·17	1,643	—
Rochdale Corporation	,, 20	157	164	− 7	—	4½	—	March 31	5,416	925,281	127,456	1·38	10·27	—	7·66
Salford Corporation	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Sheffield Corporation	,, 25	4,767	—	—	—	53½	46¼	Mar. 25*g*	216,709	56,812,049	4,926,083	0·904	10·428	7,510	7·03*f*
Southampton Corporation	,, 23	1,115	995	+ 119	—	11	11	,, 31	35,874	9,084,522	752,814	0·946	11·436	3,760	—
Sunderland Corporation	,, 23	1,426	1,204	+ 222	+ 669	18·48	17·18	,, 31	59,930	13,987,121	1,270,957	1·03	11·3	3,243	6·43
Wallasey U.D.C.	,, 25	844	718	+ 126	+ 1,656	10·5	10·5	,, 31*g*	31,307	5,690,378	654,550	1·32	11·47	2,981	6·97

* Includes maintenance of permanent way and proportion of profits paid to the tramway companies for term of unexpired lease. *a* Train mile.
h Half-year's figures. *e* Include rail and tram. *f* Including one section of horse traction. *g* 1903.

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NOTES.

Edison's Storage Battery.—If we are to believe a report which comes from New York, Mr. Edison's storage battery for motorcars has now reached the practical stage, and will be put on the market before the end of the year. A 5,000-mile running test concluded recently is claimed to have proved the excellent durability of the battery, but with regard to the length of run on one charge, the correspondent is ominously silent.

Sir Wm. Preece.—It is with sincere regret that we hear of the serious illness of Sir Wm. Preece, K.C.B. The eminent electrician has been confined to bed for over a week suffering from pneumonia and pericarditis, and his condition is stated to be grave. Latest bulletins fail to show any permanent improvement in the patient's condition, but we are sure our readers will join with us in wishing Sir William a speedy recovery and return to his professional duties.

Enclosed Electric Fuses.—Mr. Jos. Sachs has been awarded the John Scott legacy premium and medal of the Franklin Institute for an invention relating to electric fuses. The principle and details of the invention are covered by patents. It appears that the improvement Mr. Sachs has made consists in the introduction of a solvent flux in the interior of the chamber and surrounding the fuse. The function of this flux is to dissolve and remove from the surface of the fuse the coating of oxide which is formed, and which tends to retain the metal of the fuse wire in the circuit after it is melted, thus preventing an immediate rupture of the circuit.

Electrical Combine in India.—Combinations of electrical engineering concerns are not confined to these shores, nor to America or Germany. We hear of one in India which is making good progress under the title of Marshall-Crompton. Indeed, the combine is already at work with a view to securing concessions for electric lighting in different States. Chief among the concessions sought is one from the Bombay Government to supply electrical energy within the municipal area of Karachi and the North-Western Railway. Another application has been made to the Central Provinces Government with respect to Nagpur, and similar enterprise is being shown in other districts.

Ether Waves and Interference.—We are interested to learn from a New York correspondent that Mr. Nikola Tesla has succeeded in immunising his system of wireless telegraphy from external interference by adopting the principle of tuning. Many another inventor of wireless telegraph systems have made similar claims, not excepting Mr. Marconi, but it is a point that requires more than mere assertion to be properly accredited. Some success has undoubtedly been achieved in this direction, but the possibility of external interference still remains one of the chief obstacles in the way of a successful wireless telegraph service for commercial purposes. Another New York correspondent says that Prof. Stone, of the Massachusetts Institute of Technology, claims to have discovered a selective system of wireless telegraphy which enables the tall masts to be dispensed with. Details are wanting.

Wireless Fire-Alarms.—Electric fire-alarms have been exploited by many inventors, and in certain towns they are a wonderful help to the fire brigade in preventing damage by giving timely warning. We refer particularly to automatic alarms in which the rise of temperature in a building calls the brigade directly. The most recent development of such an alarm is one patented by Mr. Guarini for doing without communicating wires. Experiments in Brussels have shown that the system will work, but we are not hopeful of any system which depends on the Hertzian wave for giving such an alarm. Quite apart from the difficulty of getting good distinctive signals from a large number of subscribers, there is the interference question, which is even more serious in a fire-alarm system than in ordinary telegraphy. Up to the present we know of no experiments which give that secrecy and freedom from interference with wireless telegraphy which can be obtained easily and cheaply when wires are employed.

The Telautograph.—Dr. Karl Gruhn, of Dresden, is probably the latest inventor to adopt a form of the telautograph, which is an instrument for reproducing handwriting or simple line drawings telegraphically at a distance. Instead of using a stylus at the receiving end, Dr. Gruhn employs a moving beam of light, which writes the message transmitted on a strip of sensitised photographic paper. The principle is not unlike that of the Pollak-Virag method of telegraphic writing, which was explained in these columns a few weeks back. The electrical resistance is varied by the sending pen through sliding contacts. These influence two electromagnets in the receiving station. By these electromagnets a small mirror is made to move a beam of light, and this moving beam of light acts as the recording pencil. The beam of light falls on a strip of bromide paper unwound from a roll. After being acted on, the moving strip passes through a developing bath and a pair of drying rollers, and emerges as a photograph of the writing dispatched.

"Science Abstracts."—The Council of the Institution of Electrical Engineers has now, with the approval of the Physical Society, undertaken the publication of *Science Abstracts* as an Institution publication. In connection with this work Mr. Louis H. Walter, M.A., A.M.I E.E., has been appointed editorial assistant to the secretary, and will take up his duties in the autumn. It is not difficult to read between the lines of the above announcement which we have received from the secretary of the Institution. The conclusion is that all the time the members and associates received these abstracts without extra charge they were pleased with the same, but that a sufficient number would not undertake to pay the small extra sum required for them when they were an independent publication. We think the Institution has done quite the right thing to take the matter up, and we trust that they will revert to the old plan of sending these abstracts to every member and associate. If this be done, the members are encouraged to have on their shelves these useful abstracts, and in this way they will learn the value of the production.

Junior Institution of Engineers.—The summer meeting of this institution, of which Colonel E. Raban, C.B., director of works of the navy, is president, is to be held at Sheffield. The proceedings will be opened by the Lord Mayor (the Right Hon. J. Wycliffe Wilson, J.P.) on the 17th inst., who will receive the members at the town hall. Messrs. Davy Bros.' works will then be visited, and afterwards those of Messrs. Hadfield's Steelfoundry Company at Tinsley. On Tuesday there will be an excursion to Haddon Hall and Chatsworth. Messrs. Charles Cammell and Co.'s works will be visited on Wednesday morning, and in the afternoon those of Messrs. J. Dixon and Sons. Thursday will be occupied by an excursion to Castleton, and on Friday are to be seen the Toledo Steelworks of Messrs. J. H. Andrew and Co. and the Suffolk Works of Messrs. T. Turner and Sons. The summer dinner takes place in the evening at the Royal Victoria Hotel, Sheffield. Mr. Ernest King, of Messrs. Mellowes and Co., Corporation-street, Sheffield, is acting as hon. local secretary. The.

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programme includes various hospitable invitations arranged for the entertainment of the members during the week.

The Motorcar Bill.—During a discussion on the Motorcar Bill in the House of Commons on Tuesday, Mr. Walter Long, on behalf of the Government, was led to make promises to amend what are practically the two most important provisions of the Bill. In the first place, he agreed that some test of efficiency should be imposed before a driver of a motorcar was licensed; and, what is more important still, he promised, secondly, to consider the imposition of a speed limit in rural districts. For towns and congested districts this has already been fixed at 10 miles an hour, and in the House of Lords the Government stedfastly refused to apply any limitation to the speed of motors in the country, preferring to place the responsibility on the motorist not to drive to the public danger. Mr. Long has now promised to reconsider the matter, but it is not expected that the Government will propose to fix the limit at anything under 30 or 35 miles an hour. This, it is anticipated, would meet with favour among motorists generally, whereas the proposal of a lower speed limit would probably arouse so much opposition as to endanger the safe passage of the Bill through Parliament.

Cable Rates to Australia.—Sir Edward Sassoon having asked in what proportions the rate of 3s. per word charged for a telegram from London to Sydney, *viâ* the Pacific Cable, is divided up, Mr. Austen Chamberlain states that the sum is divided as follows: Atlantic Cable Company, 8d.; land lines in North America, 4d.; Pacific Cable Board, 1s. 7d.; Australian Government, 5d. Out of the sum of 8d. accruing to the Atlantic cable companies the Post Office is paid the ordinary inland rate in respect of such telegrams as are dealt with at postal telegraph offices. In respect of telegrams dealt with entirely by the companies, no payment is made to the Post Office beyond the rent which the companies pay for the use of their special wires. Under normal circumstances the transit of the Pacific Cable telegrams is effected only over Canadian territory. The Atlantic cable companies at present charge 1s. for the transmission in the service instructions of the date of a telegram and time of handing in—that is, one-fifteenth of the cost of a five-word telegram. All unrouted telegrams from this country to Australia handed in at postal telegraph offices are divided between the Anglo-American and Direct United States Cable Companies and the Commercial Cable Company.

King's College Engineering Course—In a letter to the *Times* of a recent date, Dr. Arthur C. Headlam, principal of King's College, writes on the subject of the scheme the college proposes to adopt as an experiment for alternating the college course for engineers with training in the workshops. The proposal is making considerable advancement. Arrangements have been made with firms for receiving candidates, and the matter has been brought before the Technical Education Board of the London County Council, who have shown the greatest sympathy towards the experiment, and have voted a sum of £500 for extension of laboratories and equipment, on condition that it is met by a sum of at least an equal amount for the necessary increase in maintenance expenses. The full amount required for making the experiment is £1,000 for laboratory outfit and £1,000 a year for increased annual expenditure, although the new system of training will be started at once. There is a strong evidence of opinion that in the present stage of engineering education in the country the practical value of this method of training should be thoroughly tested, and Dr. Headlam appeals for assistance to all those who feel how important it is that our technical training should be as good as possible.

Electrolysis of Alkali Sulphides.—A paper under this title by Messrs. A. Brochet and Georges Ranson is abstracted in the current number of the *Journal* of the Chemical Society. In the course of their experiments these gentlemen found that Durkee's statement, that solutions of alkali sulphides when electrolysed yield first thiosulphates and eventually sulphates, is confirmed for dilute solutions. When concentrated solutions are employed at temperatures of from 50deg. to 70deg., sulphur is produced at the anode and dissolves in the electrolyte, forming polysulphides, whilst at the cathode sodium is formed, and hydrogen or hydrogen sulphide evolved. The use of a diaphragm does not alter the course of the reaction, but in this case hydrogen sulphide alone is evolved. With dilute solutions of alkali sulphides the anode must be constructed of platinum; when concentrated solutions containing sodium chloride are used the anode may be of platinum, lead, or carbon, whilst in the absence of sodium chloride iron or nickel may also be employed. Copper in all circumstances behaves as a soluble electrode. During the experiments the needles of the voltmeter and ampere-meter oscillated regularly and in opposite senses, due to the continuous deposition of sulphur and its immediate solution from the anode.

Engineering Colleges in India.—Our contemporary, the *Indian and Eastern Engineer*, has in its last two or three issues been giving illustrated descriptions of the engineering colleges of India, and the Thomason Civil Engineering College at Roorkee has come in for special attention. The equipment of this college in its several sections is apparently as efficient and up-to-date as could be desired. There are mechanical, electrical, physical, and chemical laboratories, in which tests are carried out in connection with engineering and other industries. In these investigations the testing of all types of electrical measuring instruments takes a large part, and also of lightning conductors, while researches into Rontgen-ray emanations are at present being made with much success. The workshops are thoroughly modern in design and equipment. They include a carpenters' shop, foundry, smithy, machinery and fitting shop, engine-room, boiler-room, electrical test and switch room, and a mechanical shop. The power for working the machinery is distributed by electricity. This was one of the first workshops in India to be run by this method, and it has been found to work extremely conveniently and satisfactorily. Electrical driving is employed in the foundry in connection with a crane, and also for other purposes. In other sections the equipment appears to be equally satisfactory, and is fully kept up to modern requirements.

Municipal Accounts.—The Joint Parliamentary Committee on Municipal Trading have issued their first report, having commenced their enquiry on June 15. The committee's deliberations so far have been confined to an enquiry into the question of municipal accounts, and the evidence taken has been directed particularly to the form in which these accounts are prepared, the systems under which they are audited, and the right of access to them possessed by the ratepayers. The committee make a number of important recommendations, with which we hope to deal more fully in a future issue. Briefly, however, it is recommended, in the first place, that a conference shall take place between the various institutions in the country representing the interests of accountants and auditors, to consider the question of prescribing a standard form of keeping accounts; and secondly, it is proposed to abolish the existing systems of audit applicable to corporations, county councils, and urban district councils in England and Wales, and that the auditors shall be appointed by

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these three classes of local authorities themselves. An auditor so appointed would hold office for five years, his appointment being subject to the approval of the Local Government Board. In the case of Scotland the present system of statutory audit of accounts will probably hold good, with the exception of the five large cities, which will be treated in a like manner to that proposed for England and Wales.

Trunk Telephone Communication.—The Postmaster-General has sent an important communication to Mr. M'Arthur, M.P., in reply to the latter's representations regarding frequent and serious delays in the trunk telephone communication between Liverpool and Manchester and other commercial centres in Lancashire and Yorkshire. Mr. Chamberlain states that these services will be greatly improved in the near future by the opening of additional circuits between Liverpool and Wigan, Accrington, Bolton, Burnley, Bury, Oldham, Rochdale, St. Helens, and Huddersfield. The completion of the whole of these circuits depends on that of a new underground line between Liverpool and St. Helens, which it is expected will be finished early next month. Besides the above circuits, five additional circuits are being provided between Liverpool and Manchester. These will be carried by means of a new underground line through Warrington, which is being pushed forward as rapidly as possible, but some little time must elapse before the circuits can be brought into use. Most of the additional circuits were authorised a considerable time since, and the delay in completing them is due solely to the necessity for the new underground routes and the existing lines being practically filled with wires. Mr. Chamberlain further promises an enquiry into the alleged interference of the traffic between Liverpool and Manchester by somewhat numerous interruptions of the wires, and holding out a hope that it will be possible to improve the working.

Central Technical College.—The diploma of associate of the City and Guilds Institute has been awarded to the following matriculated third-year students of the Central Technical College who have completed a full course of instruction as prescribed by the council: civil and mechanical engineering—J. D. Griffin, R. C. Munro (Siemens Medal), H. H. Baxter, H. F. Bayley, W. E. G. Bender, G. W. M. Borns, C. E. Capito, J. R. Fox, E. A. Gatehouse, C. J. Guttmann, V. B. Harley-Mason, W. H. Hingston, E. W. Lace, E. Latham, E. De Lautour, R. E. Lehuraux, F. E. Maynard, J. E M. McGregor, H. W. Nicholson, T. C. Ormiston-Chant, D. A. S. Porteus, L. F. Rampal, M. K. Rice-Oxley, F. J. Salberg, E. A. Salt, C. F. Satow, A. E. Scoones, J. H. Segrave, C. G. Smith, V. C. Smith, C. E. Thomson, T. W. Wallace; electrical engineering—A. A. Gomme (Siemens Medal and Premium), J. M. De Artola, W. A. Burton, W. G. H. Cam, F. Creedy, R. S. Dahl, A. G. Ellis, E. P. Elwin, S. F. W. Finnis, A. L. Glegg, C. E. Greenslade, G. R. Griffin, P. H. Harding, M. S. Kennedy, A. H. Knight, T. F. Lee, L. Lehuraux, H. M. Lyons, F. Neuhaus, C. Petersen, H. S. Plymen, R. H. Turrall, L. D. Wainwright; chemistry—E. F. Armstrong, R. J. Caldwell, J. V. J. Hayman, C. D. McCourt, F. J. Salmon. In addition to the above, certificates have been awarded to 26 matriculated third-year students who have completed a full course of instruction at the Central Technical College, and to 55 students who have completed a full course of instruction at the Technical College, Finsbury.

Guernsey Telephones.—We have received a statement of accounts of the States of Guernsey telephone system for the year 1902, and, as usual, they contain some noteworthy points as to the success of an undertaking of this description. To begin with, there were 1,073 lines working on Dec. 31 last, exclusive of junction lines. The population of the island is 40,300, which is thus equal to one telephone to every 37·5 souls, and it is justly claimed that Guernsey is the best telephoned area in the United Kingdom. The total capital expenditure on telephone construction stands at £18,849, and in addition to this £2,241 has been expended on the purchase of land and erection of buildings, as the interest on money so invested is considerably less than the annual rent cost of similar buildings taken on lease. The cost per line comes out at the low figure of £17 odd. Last year the total revenue amounted to £3,483, or £3. 4s. 11d. per line per year. A little over £2,717 has been set aside out of this sum for capital sinking fund and depreciation, after paying interest, Post Office royalty, and all working expenses, and another sum of £195 has been placed to the special contingency fund out of revenue. Notwithstanding these heavy charges, a net profit has been realised of £157, a result which Mr. A. R. Bennett, the consulting engineer, and the permanent staff can afford to congratulate themselves on. Good headway is being made with the extension of the system. At the end of last year, in addition to the 1,073 working lines, there were several hundred spare partially-completed lines. If the value of these were deducted from the cost of construction, the cost of the working lines would be even less than is stated above.

Electric Cables for High-Voltage Service.—In a paper under this title read before the recent Niagara meeting of the American Institute of Electrical Engineers, Mr. Henry W. Fisher gave some interesting notes on the manufacture of cables. Since paper-insulated cables have been improved some engineers prefer paper to rubber, the life of paper cables being assumed to be longer than that of rubber cables. On the other hand, the ability of a rubber-insulated cable to withstand high voltages depends upon the ingredients entering into the composition of the rubber compound. The dielectric strength to resist electric pressure becomes greater within certain limits with increased percentages of pure Para or other high-grade rubber, and there is good reason for believing that when lead-covered cables are employed, the life of rubber-insulated cables is lengthened with increased percentages of such rubber. In the manufacture of paper-insulated cables for high voltages great care has to be exercised in selecting the right kind and quality of material, and also in the methods of construction and impregnation of the paper with the insulating compound. Cables saturated with oily compound can better be handled without injury to the dielectric, and also resist better high voltages. The use of oily compound is, however, accompanied with lower insulation resistance, and consequently many engineers who think they are adopting the best practice by specifying several hundred megohms per mile are in reality inviting bids on an undesirable type of cable. The carrying capacity of cables as frequently recommended is entirely too great when many cables are in the same duct system. In this case the middle and top one, although carrying normal currents, are apt to become very warm. Under no circumstances should the temperature of the conductor be allowed to reach 90deg. C.

Electric Shock.—In a paper read before the Verein Deutscher Revisionsingenieure, Dr. Kath treated of the conditions for the safety of the men driving electrical plant. Direct current, he pointed out, will, as a rule, become really dangerous only in the case of several unlucky circumstances being present at the same time, as its tension seldom exceeds 500 volts. Direct-current machines should be enclosed tightly, so that sparking, liable to endanger

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the surrounding medium, is prevented. As regards the properties of the human body, the author draws attention to the fact that an electric shock will essentially act on the nervous system, as the nervous substance is a conductor of electricity surrounded by less conductive fat and muscle substance. The paths most frequently followed by the current in the case of accidents will afford an evidence as to which nerve strings are most likely to be struck, which functions most liable to be paralysed, as being controlled by these nerves. In the case of the shock entering by a hand or the head and leaving by the other hand or a foot, the nerve descending from the neck and leading to the lungs and heart—the so-called *nervus vagus*—will be struck, and as the latter regulates both the respiration and the action of the heart, respiration will first be stopped, and the action of the heart will eventually cease in the graver cases. A shock entering by the points of the fingers and leaving by the upper arm, however, will, as a rule, not be attended by fatal results, the above nerve not lying on its way. The best assistance in the case of an accident will be rendered in the way of producing artificial respiration, enforcing the heart action and diminishing the pressure of blood, the latter being obtained by injecting one to three drops of amyl nitrate. The dangers of electric currents will, moreover, vary to a high degree according to personal predisposition, persons subject to alcoholism, as well as those easily frightened, suffering much more from the effect of electric shock than normal people. The limit of danger is considered as coinciding with 0·1 ampere.

Pacific Cable Finances.—It was not to be expected that the "all-red" Pacific Cable would return a profit or even meet expenses during the first few years of operation, so the fact that there is likely to be a loss of over £200,000 in two years does not come as a surprise to anyone. The expenditure in the year 1902-3, when the line was in course of construction, was £120,000, and under agreement this will be met by proportional contributions from the Colonies. In the estimates for the present financial year there is an item of £77,540 for interest, including instalment repayment of principal, which, of course, is included in the total annual expenditure. The revenue is estimated to amount to £73,400, and the total expenditure to £165,500, showing an estimated deficit of £92,100. But when the large amount of £77,000 odd for interest, etc., is put on one side, and the working expenses only balanced against the revenue, it is seen that the loss on the first year of operation is quite within a reasonable limit—a matter of some £15,000. It is interesting to consider some of the principal items of expenditure in an undertaking such as the Pacific Cable. In the first year the expenditure of £120,000 was made up of interest on capital, salaries, station expenses, repairing ship, and renewals for cable, but in that year the line was not in operation. In the current year, besides the interest payments, the principal items of expenditure are estimated as follows: Board salaries and expenses, £4,400; cable stations, salaries, and expenses, £26,300; repairing ship, £19,500; renewals and depreciation, £35,500; and miscellaneous, £2,250—a total of £165,500. The total estimated loss on March 31, 1904, is estimated at £212,100, and as Australia has to provide one-third of this deficit, about £70,000 will have to be provided by the Commonwealth Parliament within the next eight or nine months. It will be noticed that these large deficits are more apparent than real, as in the case of a company no interest or repayment of capital is made during the early years of working.

Street-Lighting at Westminster.—Mr. J. W. Bradley, city engineer of Westminster, is rendering electricity an important service by issuing quarterly reports of the comparative merits from an economical point of view of gas and electric lamps for street-lighting. Once again, and in his latest report, Mr. Bradley gives authoritative figures to show that the electric arc lighting of Westminster costs the ratepayers a comparatively insignificant figure as against the gas lamps. Supply is taken from three electric light companies for the arcs in different parts of the city, and, with one exception, the total cost per candle-power per hour comes out at half, a third, and in one case a fourth of the gas lamps. Witness the following figures representing the total cost per candle-power per hour in every case: For the electric arcs supplied by the Charing Cross and Strand Company the cost is ·0031d.; those supplied by the St. James and Pall Mall Company, ·00575d.; and those supplied by the Westminster Company, ·00234d. In the case of the gas lamps, the refuge lanterns, four incandescent mantles in Victoria-street cost ·00845d., Sugg's high-pressure lamps, incandescent mantles, ·00358d.; ordinary single burners, incandescent mantles, ·00627d.; ordinary flat-flame, ·00947d.; and ordinary flat-flame burners in Chandos-street, ·01307d. Thus it is seen that while the lowest total cost per candle-power per hour of the electric arcs is ·00234d., or 8·57d. per candle-power per annum, the lowest figures for gas lighting are ·00358d. or 14·1d. respectively. Similarly, the highest total cost per candle-power per hour for the electric arcs is given at ·00575d., or 14·9d. per candle-power per annum, as compared with ·01307d., or 47·65d., in the case of the gas lamps. These figures must come as a revelation to advocates of incandescent gas lighting, whose claims, on account of alleged lower cost, are to-day so often pressed upon local authorities charged with the responsibility of lighting the public highways. The figures are the more valuable because they include capital charges and extend over a considerable period of time.

Post Office Mains.—Lord Kinnaird in the House of Lords on Tuesday put an important question to the Government with reference to the laying of Post Office telegraph and telephone mains in the streets. The noble lord wanted to know whether, in view of the danger and inconvenience to the public stated to have been occasioned by the laying of Post Office mains under the public streets without due regard to existing pipes and drains, the Postmaster-General would, before commencing work in any street, cause notice to be served upon owners of existing pipes and mains of the intention of the Post Office to lay mains therein, and would conform with such reasonable requirements as might from time to time be made by the owners of such pipes and mains for the purpose of protecting them from injury; and whether the Postmaster-General would accept responsibility for the damage he might cause, in the same manner as companies having parliamentary powers to open up thoroughfares. Lord Balfour of Burleigh, in reply, said it was true that electric lighting companies had to give notice to local bodies before they opened the streets. As to the Post Office, it was under statutory restrictions, and the Postmaster-General would, if any specific case of damage was brought to his notice, give it his attention. Every procedure on the part of the Post Office in these matters was regulated by statute. There were three distinct requirements. First, the Postmaster-General was obliged to get the consent of the local authority, and he had to come to an agreement with that authority as to the method of carrying out the work. He had further, when it was resolved to open a street, to give notice so that the local authorities might have an opportunity of supervising the work. Then he had to give notice to any water or

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gas company of any alteration which was intended in their pipes. It would be undesirable that any further restrictions should be placed on the Post Office in carrying out works for the public service. Many of the bodies who had put down wires and pipes had no legal right to do so; many of them were, in fact, trespassers. He must refer the noble lord for further information to the Telegraph Act of 1863.

Wireless Telegraphy Conference.—At the initiative of the German Emperor, the long-talked-of conference on wireless telegraphy has been opened in Berlin. On Tuesday representatives of Germany, Great Britain, France, Russia, Austria-Hungary, Italy, Spain, and the United States, assembled in the German capital, began proceedings within closed doors. The chief object of the conference is to arrive at an international agreement for the regulation of etheric telegraphy, with a view to harmonising the various competing systems. The subject is one which concerns the various wireless telegraphy companies no less closely than it does the Governments of the countries represented, but the conference will be strictly confined to the State delegates, and no representatives of companies operating certain systems or of inventors will have an opportunity of urging the claims of their respective systems. We take it that the decisions of the conference will be made public at some future date, and we await with interest its opinion as to the possibility of adopting an international and uniform system of telegraphy by etheric waves. Although the Marconi Company cannot take part in the conclave, it has endeavoured to make its voice heard through the correspondence columns of the *Times*. In Saturday's issue a long letter is published from Mr. H. Cuthbert Hall, managing director of the company, and the position he takes up may be fairly gauged from this remark: "It may be said generally, however, that the art of wireless telegraphy has not yet reached such a stage of development as to be ripe for the imposition of special rules and regulations for its working applicable to all systems; and that if rules and regulations are now laid down, with which the majority of persons working wireless telegraph systems can comply, the utility of the most advanced system will be enormously reduced." Mr. Hall's view of the whole affair is that the aim of the conference is to secure for a German company advantages which it has failed to obtain in fair business competition. The German Emperor recently urged the founders of the new German company to "exert all their influence to overthrow the monopoly which the Marconi Company is creating," from which may be understood the hostile attitude the latter has assumed towards the Kaiser's move. A great part of Mr. Hall's letter is a eulogy of the Marconi Company and the work it and its subsidiary companies has done during the past two years in organising a system of shore stations throughout the world for communicating with ships at sea. For this the company deserves all praise, and its success in such work is very widely recognised. At the same time the matters which have to be discussed by the conference are of an international character, wherein the interests of private individuals may not enter. Apart from the technical question, the Marconi Company contends that it would be a "commercial injustice" to compel it to put its organisation at the disposal of every ship carrying other wireless telegraph apparatus, and some scathing remarks are made by Mr. Hall about the "inferior apparatus" of companies which have not even "an elementary knowledge" of the business with which they are attempting to deal. The Marconi Company, naturally enough, perhaps, wants a monopoly of wireless telegraphy, and this is pretty freely indicated by Mr. Hall's rabid attack on the "so-called" systems of other companies, and everything else not labelled Marconi. Mr. Hall concludes by calling upon the representatives of the British Government at the conference "to resist any proposals which, whatever their purpose, tend artificially to deprive a British company of the advantages which it has fairly secured in open competition." There is little fear, however, that the English representatives will do their duty, and will not allow the interests of private individuals to supersede those of the country as a whole.

Electrolytic Estimation of Arsenic.—There is published in the issue of the *Journal* of the Chemical Society for the current month a long communication by Mr. T. E. Thorpe, C.B., F.R.S., on the electrolytic estimation of minute quantities of arsenic, more especially in brewing materials. The paper is evidently suggested by the report of a committee appointed as a result of a recommendation of the Royal Commission on Arsenical Poisoning. In their report the committee stated that of the various methods for the detection and estimation of the relatively small quantities of arsenic which may be present in beer, they were of opinion that those methods which depend on the conversion of the arsenic into hydrogen arsenide, and the subsequent deposition of the arsenic in the elementary form by heating the gas, are, on the whole, to be preferred. The hydrogen arsenide may be formed in practice by the action of so-called "nascent" hydrogen on the arsenic present. The hydrogen may be evolved either electrolytically or through the agency of dilute hydrochloric acid on zinc admixed with or containing such an amount of copper or other suitable metal as to give rise to a sufficiently rapid evolution of the gas. The amount of arsenic deposited by heating the hydrogen arsenide so formed is then determined by comparison to deposits obtained in precisely the same manner from wort, beer, malt extracts, sugar solutions, etc., containing known quantities of arsenic. The author describes an electrolytic method in detail, and arrives at a number of conclusions in which he sets out the advantages of adopting electrolytic means of detecting arsenic. In the first place it obviates the use of zinc. Simple in execution, it is under perfect control, and may be carried out under such conditions that the results obtained by different operations are strictly comparable, inasmuch as with a current strength of fair regularity the evolution of the gas is practically constant and uniform. The whole of the solution to be tested may be added to the apparatus at once, so that during the whole time of testing the arsenic is under the influence of the "nascent" hydrogen. It has been established that such amounts of arsenic as are present in beer or its ingredients are evolved as hydrogen arsenide during the 30 minutes occupied by the tests. The nature of the material associated with the arsenic is found to exercise no inhibiting effect on the formation and evolution of the hydrogen arsenide. Aqueous extracts of malts and worts may be added directly to the electrolytic apparatus without previous destruction of the organic matter as required by the zinc and acid process. Another advantage of the electrolytic method is that the deposits obtained are more uniform in character than those furnished by the zinc and acid method, and admit, therefore, of more accurate quantitative comparison. Lastly, the process allows of the simultaneous execution of a number of estimations of arsenic, depending on the arrangement of the rheostat. There are two disadvantages of the method, which the author gives as follows: first, the initial cost of the apparatus as compared with that employed in the zinc and acid method, and, second, that it can only be applied when an electric current of sufficient intensity is available.

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THE DESIGN OF EXTRA HIGH TENSION SWITCHGEARS.

BY W. E. WARRILOW.

(Continued from page 111.)

A similar type of switch for two-way purposes is illustrated in section by Fig. 12, and in this instance the tanks

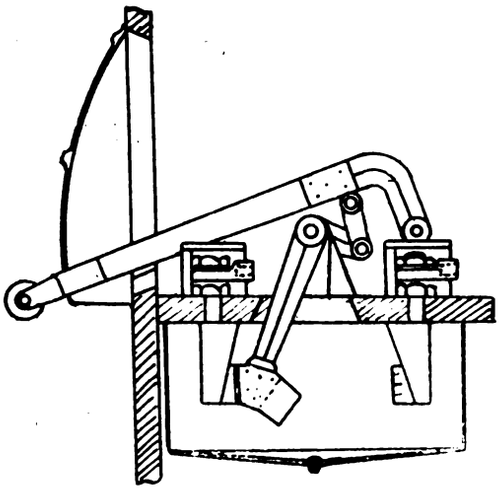
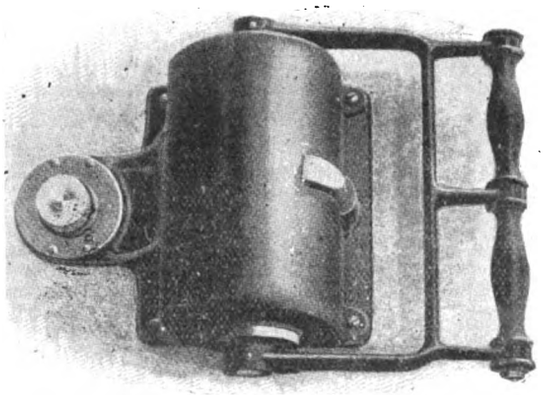


FIG. 12.—Stanley Double-Throw Switch.

are arranged in tandem, the operating being still carried out from one main lever. These switches are made for



Front View of Switch, showing handle and time-limit screw.

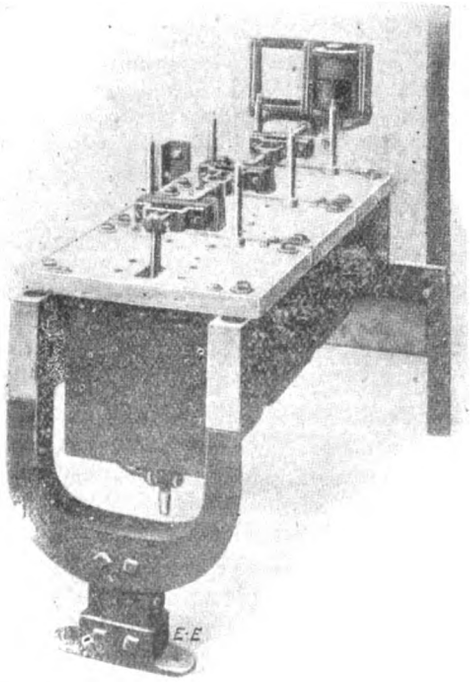


FIG. 13.—Stanley Three-Phase Switch mounted behind panel, showing tripping solenoids.

capacities of from 100 to 1,000 amperes, and for pressures varying between 4,000 and 15,000 volts. The oil tanks are porcelain lined in each case, and the placing of each pole in a separate tank prevents leakage between the conductors through the oil. When it is required to open

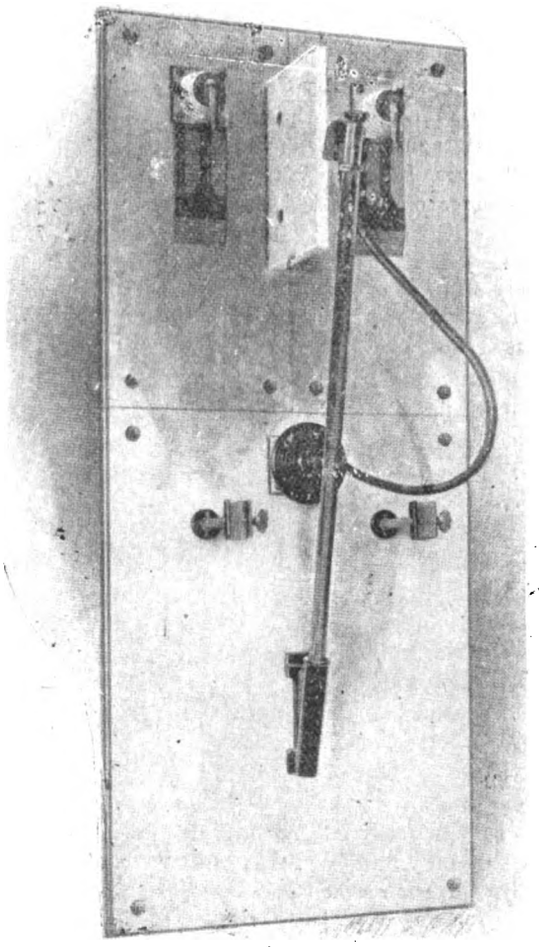


FIG. 14.—E.H.T. Flare Switch (Stanley Company).

the circuit automatically, a tripping solenoid is fitted to the mechanism, this taking the form of a small coil mounted on the back of the front marble slab, as shown

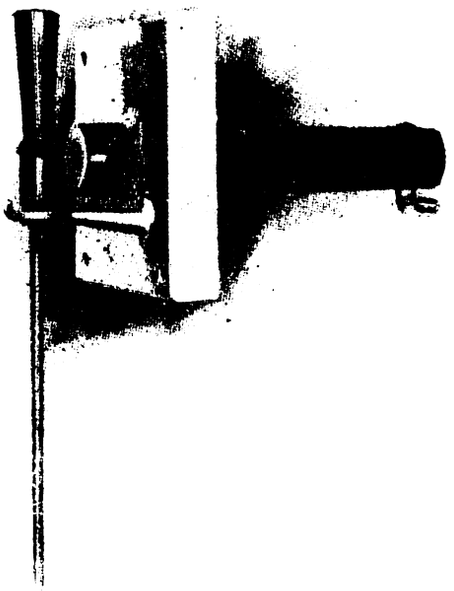


FIG. 15.—E.H.T. Plug Switch (Stanley Company).

in Fig. 13. The general assembly of this switch can be well seen from this figure, the small pillars standing up from the marble bases being the terminals. The operating

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handle of this type of apparatus is fitted with a time-limit device, and the small milled head to be seen under the handle permits the adjustment of this within a certain range.

For extra high voltages and small currents the Stanley Company make a plug switch, which is simplicity itself,

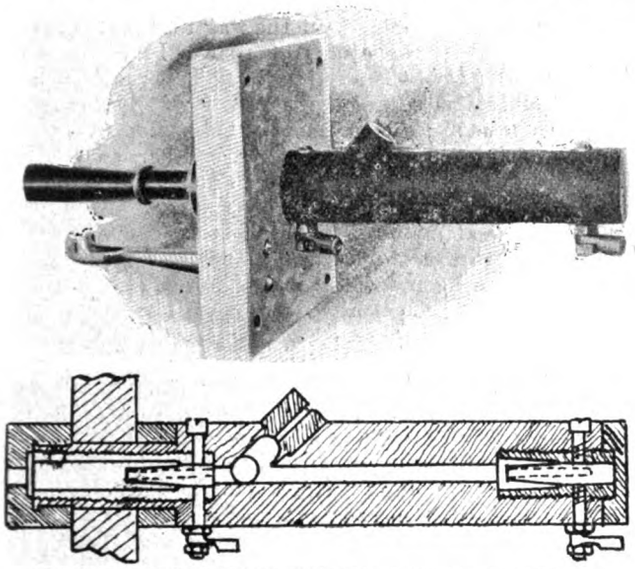


FIG. 16.—Stanley Stab Switch.—Side View of Plug Switch and Section through same.

and is said to be reliable in action. The circuit is broken in air, and provision is made for the drawing out of a long flaring arc, which is increased until it can no longer be maintained across the gap. Fig. 14 is a photograph of a double-throw switch of this design, the contacts and operating rod being mounted, as in the foregoing examples, on marble slabs, behind which all connections are made. One contact of the switch is mounted high up on the slab, and well insulated from it by porcelain, and the other is connected to a length of flexible cable, terminating in a contact fixed at the end of a long rod. This contact is designed to hook over the fitting at the top of the gear, and in both instances the terminals are tipped with zinc. Where the lower end of the flexible is fastened to the board a receptacle is provided, which allows of the entire handle and connection being removed when required, so that the circuit can not be again made until the plugging end of the cord is inserted. A locking device is also fitted, which prevents the circuit being broken at the fixed end of the flexible. When breaking the circuit, the handle, which is clipped in a holder when the switch is in, is unfastened, and when firmly grasped in both hands is lowered quickly from the top terminal, and the arc which is at once formed is drawn out to considerable length by swinging the rod back over the shoulder. The attendant then moves away from the board until the circuit is ruptured. When not in use the handle is dropped into a socket on the lower slab.

A small switch for light capacities up to 7,000 volts is illustrated by Fig. 15, which shows a front view of the device with the handle in its holder. The switch comprises two terminals fixed at each end of a fibre tube, these contacts being joined together by the rod when it is required to close the circuit. The connecting rod, in its passage down the tube, raises a small marble ball into a pocket, and upon the withdrawal of the rod this ball falls into the tube and smothers the arc which is drawn out between the rod and the contact at the end of the tube. This design of switch is very effective for small currents, but it would only be really safe when used for closing a circuit one side of which was "dead," otherwise, if both contacts were "alive," the rod would become charged directly it was inserted in the forward contact, and should the attendant's hand slip over the guard washer—a very likely occurrence—disaster would probably result. A back view of the device and a section through the same are shown in Fig. 16, and the above point is clearly exemplified from examination of these.

When controlling large powers at extra high voltages the switches are mounted some little distance from the operating face of the board, and are also pitched farther apart to ensure absolute safety in operation. Air break switches and fuses may answer the purpose for circuits of low power, but when the output is increased and the apparatus in the line is likely to set up varying potential stresses, reliance can no longer be placed on the air as a breaking medium, and recourse must be had to oil, both for switches and fuses. Fig. 17 illustrates a complete switchgear for controlling the high and extra high voltage sides of a transformer supplying a rotary converter, the direct-current gear being also included on the same frame-

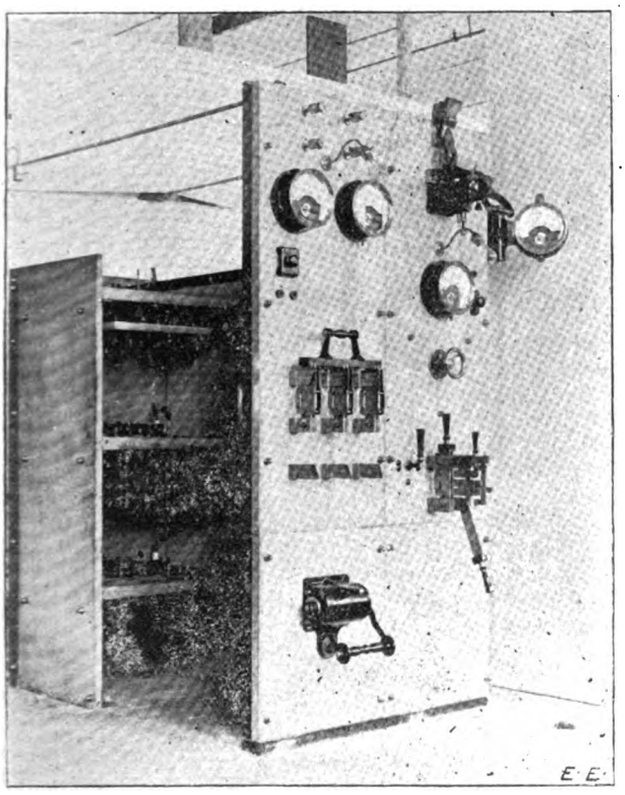
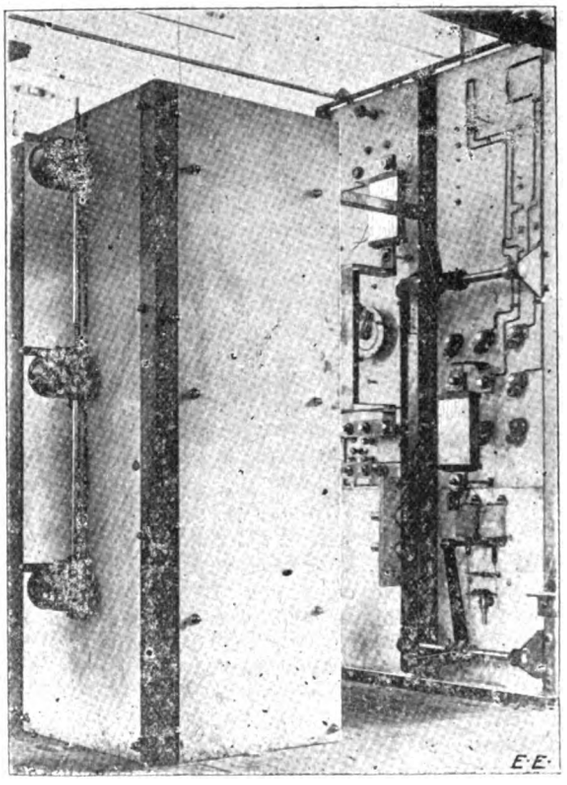


FIG. 17.—Lever Control Gear, with switches mounted behind (Stanley Co.)



Back View of Lever Control Gear.

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work. The extra high tension switches are fitted in a cubicle formed of marble slabs, each switch being complete in itself and secured to a marble shelf arranged horizontally in the frame. The moving contacts are operated from one handle placed low down on the face of the board, and each switch has a horizontal rod which transmits the motion to the switch proper, turning the contact arm in a circular manner. Fig. 17 is a back view of the same set of panels, from which the connections of the working face can be discerned, also the cubicle and the rods for actuating the switches. The tripping solenoid connected to the secondary of a transformer is bolted to the lower right-hand slab above the fulcrum of the large switch lever. The terminals and contacts for the secondary leads from the converter feeding the rotary are fitted above the section containing the extra high tension switch handle, while to the extreme left are to be noticed the couplings of the direct-current side of the rotary. The complete arrangement is designed for the supplying of rotaries from long-distance transmission lines, each machine having its own set of gear, which provides for the running up of the converter from the low-tension alternating side of the transformer, this having tappings brought out for the purpose to get half speed. The normal voltage is then applied by changing over the starting switch to a position in which all the windings of the secondary are made use of. The arrangement permits of steady running on the part of the rotary, but the absence of 'bus bars make it essential that the plant be always in good working order, as interchange of current is impossible.

(To be continued.)

RADIUM AND OTHER RADIOACTIVE SUBSTANCES WITH A CONSIDERATION OF PHOSPHORESCENT AND FLUORESCENT SUBSTANCES. THE PROPERTIES AND APPLICATIONS OF SELENIUM AND THE TREATMENT OF DISEASE BY THE ULTRA-VIOLET LIGHT.*

BY WILLIAM J. HAMMER.

(Continued from page 52.)

Within the past month great interest has been attracted by the statement made by Profs. Curie and Laborde that radium maintains its own temperature at 1·5deg. C. above its surroundings, this being equivalent to stating that ½lb. of radium salt would evolve in one hour sufficient heat to equal that caused by the burning of one-third of a cubic foot of hydrogen gas; and that the heat evolved from pure radium salt is sufficient to melt more than its own weight of ice every hour. This evolution of heat, it is claimed, is going on constantly for indefinite periods and leaving the radium at the end of months of activity as potent as it was at the beginning. The problem, therefore, confronts the world of solving how radium can constantly throw off heat without combustion or without chemical change, as Prof. Curie says it does. Messrs. Curie and Laborde employed a thermo-electric couple of iron and constantin, one of whose junctions is surrounded by radioactive barium chloride and the other by pure barium chloride. They used two small bulbs of the same dimensions, one containing 1 grm. of radiferous barium chloride containing about one-sixth of its weight in radium chloride and the other bulb containing 1 grm. of pure barium chloride. The junctions of the thermo-electric couple are respectively placed in the centre of each bulb, surrounded by the substances. The bulbs are isolated in air within the centre of two small identical enclosures, surrounded in turn by a third, which is thermally insulated, and maintains itself at a practically uniform temperature, and under these conditions variations in the surrounding temperature are felt in the same manner at both junctions, and do not affect the indications of the couple. Messrs. Curie and Laborde both thus observed a difference of temperature of 1·5deg. C. between the radiferous barium chloride and the pure barium chloride, the former having the higher temperature. (*Comptes Rendus*, March 16, 1903.)

In a letter recently received by the author from Prof Curie bearing upon the question of heat given off by radium, Prof. Curie writes as follows: "Since the time I had the honour to see you at our School of Physics and Chemistry I have continued to investigate into the radio-activity induced by radium and the way that radioactivity is disappearing in the course of time. In a study of another kind (in collaboration with M. Laborde) I found that the radium is setting off heat continually and in a very large amount; each gramme of the radium is setting off in each hour 100 small calories, or, in other words, it is setting off heat enough to melt in each hour its own weight in ice. Where is the source of this energy? Both Mme. Curie and myself are not able to go beyond some hypotheses. One of these consists in supposing the atoms of radium evolving and transforming into another simple body, and, despite the extreme slowness of that transformation, which cannot be located during a year, the amount of energy involved in that transformation is tremendous. The second hypothesis consists in the supposition that radium is capable of capturing and utilising some radiations of unknown nature which cross the space without our knowledge." Profs. J. J. Thomson and Rutherford advance the theory that there is a succession of chemical changes going on causing the spontaneous projection of larger masses of material at enormous velocities, and that while certain portions are constantly dying out and becoming inert, other portions are constantly increasing in strength and power. Someone has remarked that for years we have been extracting uranium oxides, and pouring down the waste-pipes and into the dustbins the more interesting and precious radioactive substances.

Although radium, polonium, and actinium have been termed new elements, in the case of polonium and actinium they have not yet been found in sufficiently pure state and in sufficient quantity to give a spectrum, and to prove conclusively that they are new elements. Prof. Curie has, however, stated emphatically that there is now no doubt of radium being a new element. The tiny brown bulb which I hold in my hand is the duplicate of the one which Prof. Curie showed me at his laboratory last fall, which contained the only sample of chemically pure radium in the world, this being between two and three one-hundredths of a gramme; and it was the spectrum of that sample, showing only the lines characteristic of radium, as tested by Demarcay, which demonstrated it to be a new element. And with this sample, also, the atomic weight for radium of 225 was determined. The atomic weight of the barium heretofore always associated with radium, but which in this sample had been eliminated, is but 157. In answer to my enquiry as to its value, Prof. Curie said that 100,000fr. (20,000dol.) could not purchase this tiny sample. I was enabled through the courtesy of Prof. Curie to secure from the Société Centrale des Produits Chimique of Paris some nine different preparations of radium and two of polonium, which I have here for your consideration. I was unable to secure any actinium; in fact, but a trace of this substance has thus far been secured. If the lights are extinguished, and you will sit for a few moments in the dark, I will pass these tubes about the room that you may observe the bright light given off by certain of them. These samples which I have range from 40 times the radioactivity of uranium (which is taken as a standard) up to 7,000. The laboratory where these substances are prepared is under the control of Prof. Curie, and up to recent date all radium of higher radioactivity than 7,000 has been retained for the experiments of M. and Mme. Curie and their associates, but I received a letter recently from Director P. Boulay, of the Société Centrale, in which I was informed that they will shortly put upon the market a preparation of radium, chemically pure, or nearly so, at a cost of 30,000fr. (6,000dol.) per gramme, or about 2,771,555·90dol. per pound.

Radium, while it has been spoken of as a metal, has never been secured in a metallic form, the usual form being as a chloride or bromide. Prof. Curie told the writer that

*A lecture delivered at a meeting of the American Institute of Electrical Engineers and the American Electrochemical Society, New York, April 17, 1903.

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the result of all the work done in Germany and France in the past three years had only resulted in the securing of about 1lb. of radium, this including all grades or qualities. Prof. J. J. Thomson says there is far more gold in sea-water than there is radium, polonium, or actinium in pitch-blende. Prof. Curie took this ring which I have on my hand, which contains a small diamond, into his dark room, and holding near it a small pill-box containing about a gramme of radium, caused the stone to phosphoresce most beautifully. It was as if a lightened candle had been brought near to it. Prof. Curie remarked that this showed that the stone was a genuine diamond, and if it had been paste there would have been no effect produced, and that radium, therefore, constituted an excellent means for testing the genuineness of diamonds. According to M. and Mme. Curie, radium rays act in many ways like light. They reduce silver salts, peroxide of iron, and bichromate of potash in presence of organic substances; they also colour glass, porcelain, and white paper, and they transform greenish-yellow platino-cyanide of barium into a brown variety. Giesel had prepared platino-cyanide of barium with a trace of radium. This spontaneously became brown, and it then polarised light like tourmaline. He also found that this coloured rock salt just as cathode rays do, or the vapours of alkaline metals, and furthermore showed that radium salts brought near the temples or to the closed eyes produced a sensation of light.

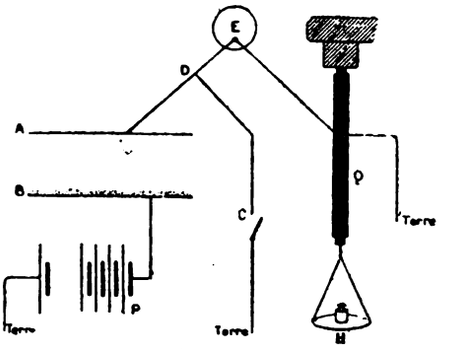

FIG. 4.—Apparatus employed by M. and Mme. Curie in the study of radio-activity.

M. Becquerel, referring to the chemical action of radium rays, says that radium and uranium rays act upon silver gelatino-bromide, but produce no effect upon Daguerre plates, or upon photographic papers, and says that colorations of glass, porcelain, paper, and certain crystals, as well as the painful physiological effects, also belong to this class of phenomena. He also calls attention to the transformation of white into red phosphorus in 24 hours, the reduction of mercuric chloride in the presence of oxalic acid with the precipitation of calomel, and finally the destruction of the germination power of seeds after long exposure. Becquerel also shows that radium rays possess the same power as the electric spark, or the prolonged action of violet or ultra-violet rays, of restoring the phosphorescent properties under exposure to heat of a body deprived of them by overheating. Practically all the radium which has thus far reached this country, with the exception of that in the possession of the author, has been the German radium, and Prof. Curie tells the writer that he had tested all of the German productions, and he has found none of them to exceed a radioactivity of 300. De Haen, of Seelze, near Hanover, Germany, and Giesel, of Brunswick, also have manufactured radium. De Haen recently informed the writer that the preparations he put on the market cost 10s. and 30s. per gramme. As indicative of the enormous difficulties to be encountered in procuring this wonderful substance, it is interesting to note that it takes 5,000 tons of uranium residues to produce a kilo (2·2lb.) of radium; and the cost of handling these residues is 2,000dol. per ton. To secure the chemically pure radium is enormously expensive, and it would be impossible to do this by chemical analysis; therefore, the far more sensitive electrical method is employed, and the Curies say that they can detect the presence of a radio-active substance by the means of such a minute quantity that it would require 5,000 times this amount to show at all in the spectroscope. And it is stated that this method of electrical analysis is thousands of times more sensitive than spectrum analysis and millions of times more sensitive than chemical analysis.

In Fig. 4 is shown the "electrometer" method with which the Curies have studied the radioactivity of different substances. It consists of two plates, A and B, on the latter of which is placed the radioactive substance to be tested. This makes the air a conductor of electricity between the two plates, and for measuring this degree of conductibility the plate B is brought to a high potential by connecting it to one side of the storage battery, P, the other side of which is connected to the ground. If the plate A is brought to the potential of the ground by the wire, C-D, an electric current begins to flow between the two plates, A and B. The potential of plate A is shown by the electrometer, E. If we cut this communication with the ground at C, the plate A becomes charged, causing the electrometer to deviate. The speed deviation is proportionate to the intensity of the current, and can serve for measuring it. But it is preferable to make this measurement by compensating the charge taken by plate A, so that the electrometer remains at zero. The charges, which are extremely feeble, can be compensated by means of a Piezo-electric quartz, Q, one armature of which is connected with the plate A, and the other armature grounded. The quartz plate is given a certain tension by weights placed on the plate H. This tension is gradually produced and gives a charge of a definite quantity of electricity which can be measured. The operation may be so regulated that there is a constant compensation between the quantity of electricity which passes through the condenser and that of the opposite sign furnished by the quartz. So we can measure in an absolute value the quantity of electricity passing through the condenser in a certain time. Doubtless some loss is caused by the rays which pass directly through the condenser plates

(To be continued.)

NOTES ON WHAT AND HOW TO LEARN IN AN ELECTRICAL ENGINEERING WORKS.

BY G. RALPH.

The following rough notes have been put together in the belief that they may be of assistance to apprentices going through the various departments of an electrical engineering works, by directing their attention to important points they should look out for in any department.

To become acquainted with any business, particularly in all branches of engineering, it is extremely important that an apprentice should learn the *reasons why* things are done in a certain manner, as well as learning how to actually *do* them. It may here be said that unless an apprentice shows a keen interest in the work which is going on in the department in which he is engaged, it is quite certain that the foreman will not interest himself in the apprentice, nor will he take the trouble to explain things. But if a proper interest be exhibited, everyone, from the manager and foremen downwards, will be found always ready and willing to impart information. Of course, a judicious time should be chosen in asking information from the foremen or men. It is *not* the right time to ask when one can see plainly that the party is engaged on something which is demanding his whole attention at the moment.

A most excellent little book dealing fully with what and how to learn in an engineering works was published by Messrs. E. and F. Spon, entitled "Workshop Manipulation," by Richards. This book ought to be in the hands of every engineering apprentice, but, being out of print, can probably only be obtained now through a second-hand bookseller. The following are a few of the more important points which the apprentice should notice and think about in the various departments.

Machine Shop.

1. The importance of marking out work on the marking table before machining operations are commenced.

2. The cutting speeds of various classes of tools, such as lathes, boring machines, planers, etc.; also the difference in speed for different materials operated upon.

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3. The special tools used for boring bearing brasses, etc.
4. The importance of the use of gauges for accurate work and interchangeability.
5. Think out the reasons which probably determine whether a certain piece of work shall be done on a particular class of machine, when it is possible to do it in several different ways.
6. The angles of the cutting edges of tools.

The Foundry.

1. The way moulds and cores are ventilated.
2. The importance of making that part of the casting which must be perfectly sound and free from dirt the bottom side of the mould.
3. See at which point the metal is run to a casting, and why it is better at one particular place than another.
4. The various qualities of brass and gunmetal best adapted for certain classes of castings.
5. The dressing of moulds to obtain a smooth, clean surface.

The Pattern Shop.

1. The amount of allowance for "machining" being left on various sizes and classes of castings.
2. The amount of taper to allow of patterns being easily withdrawn from the moulds.
3. The amount allowed for "shrinkage" or contraction for castings in various sorts of metals.
4. How core-boxes must be made to take to pieces easily to remove the loam cores.
5. How cores are to be supported and located by "prints."
6. Think how the casting will probably be moulded, which side down, and where the joint in the mould will be; the reasons will then be seen for coring out certain parts, or leaving bosses or other parts loose on the pattern, so that they be drawn out of the mould after the body of the pattern has been removed.

The Fitting and Erecting Shop.

1. The marking off of bed-plates for dynamos and motors.
2. The fitting of keys in armatures, couplings, etc.
3. The building of armature cores.
4. The saving of time which is effected when the various parts of a machine are made accurately enough to require very little fitting together.

The Brass-Finishing and Instrument Shop.

1. The various classes of switchboards and arrangement of switches and connections upon them.
2. The construction of switches and various means adopted to secure good contact between the jaws.
3. The construction of commutators and the care necessary in insulating them.
4. The connections and terminals of dynamos and motors.
5. The construction of projectors and arc lamps.
6. Fittings adapted for use at various classes of installations, ships, collieries, mills, etc.

Capstan-Lathe, and Milling Shop.

1. The form and arrangement of tools in the turret.
2. The enormous saving of time in making quantities of small parts on these machine tools over making them by hand in the ordinary brassfinisher's lathe.
3. The variety of work which can be performed on a universal milling machine.
4. The importance of doing repetition work by milling instead of by hand filing or grinding.
5. The speed used in milling different materials.

Tool Shop.

1. The degree of hardness to which tools are "tempered" for various purposes.
2. Methods of hardening, the heating, cooling, and tempering.
3. The angles to which tools are ground for turning, planing, and boring, etc.
4. Methods of grinding milling cutters, taps, reamers, etc.
5. Various forms of jigs and templates for repetition work on milling and drilling machines.

Steam Testing Shop.

1. The arrangement of steam-pipes and reducing valves, drain pipes, etc.
2. The arrangement for lubrication on various makes of engines.
3. Various forms of governors, how they act and within what limits they will govern.
4. Indicating and working out the horse-power of engines.

The Winding Shop.

1. The various classes of material used for insulation and the thickness of the same for various purposes.
2. The importance of leaving plenty of length of surface to prevent leakage to earth in armature cores and slots, commutators, etc.
3. The method of making drum armature bars, formed coils, etc.
4. The form of end "crossings" in drum armatures, and how connected up.
5. How wires or conductors are insulated from each other to withstand high voltage.
6. Think out which are the weakest places in the various forms of armatures.

The Test-Room.

1. The usual tests for dynamos, temperature, speed, compounding, or variation of pressure in shunt-wound machines.
2. The usual tests for motors, also brake tests for efficiency.
3. The testing of two identical machines for efficiency by the "Hopkinson" method.
4. The various classes of instruments used in making the tests, and the principles upon which they work.
5. Methods of calibrating instruments.
6. Methods of regulating the speed of motors.

Installation Work.

1. The difference in arrangement of lights for various classes of buildings, etc.; amount of light per square foot of ground area.
2. Various methods of running wires—in casing, iron pipes, steel conduit, lead-covered, etc.—and the classes of work to which each is specially applicable.
3. Methods of jointing small wires, large cables, etc.
4. In motor work, notice the various forms of gearing employed for reducing speed and applying the motor to drive machinery.
5 The special classes of work best adapted for (1) series motors, (2) shunt motors, (3) compound motors.
6. The amount of power required for driving various classes of machinery.
7. Notice the engine and boiler plant at various works, the arrangement of steam-pipes, pumps, feed-heating, etc.

The Drawing Office.

1. Pay particular attention to the importance of being able to make hand sketches, properly dimensioned, quickly from existing machinery.
2. The importance of dimensioning drawings in such a way that the dimensions can be easily found. Look at the matter from the workman's point of view, and give all dimensions necessary for a man to complete the job without having to add up or subtract several dimensions.
3. When designing anything new, endeavour to avoid unnecessarily small fractional parts of an inch. Make things to even dimensions, if possible, without resorting to $\frac{1}{16}$ths, $\frac{1}{32}$nds, and $\frac{1}{64}$ths.
4. There are generally several ways of making a thing. Aim at the most direct and simple from a manufacturing point of view.

In conclusion, part of the last chapter of Mr. Richard's book may very fitly be quoted:

"A mechanical engineer who has not been 'through the shops' can never expect to attain success, nor command the respect of even inferior workmen. Without a power of influencing and controlling others, he is neither fitted to direct construction, nor to manage details of any kind connected with engineering industry . . . No one can expect to prepare successful designs for machinery who does not understand the details of the construction . . .

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"Some hints will now be given relating to apprentice experience in a workshop.

"Upon entering a shop, the first thing to be done is to gain the confidence and respect of the manager or foreman who has charge of the work. . . . To command the confidence of a foreman one must be punctual, diligent, and intelligent. . . . The least word or act which will lead workmen to think that an apprentice is indifferent at once destroys interest in his success, and cuts off one of the main sources from which information may be derived.

"Punctuality costs nothing and buys a great deal: a learner who reaches the shop a quarter of an hour before starting time and spends that time in looking about manifests thereby an interest in the work, and avails himself of an important privilege—one of the most effectual in gaining shop knowledge. Ten minutes of his own time spent in walking about, noting the changes wrought in the work from day to day, furnishes constant material for thought, and acquaints a learner with much which would otherwise escape his attention. It requires, however, no little care and discrimination to avoid a kind of resentment which workmen feel in having their work examined . . . where such inspection is thought to be prompted by curiosity only. The better plan in such cases is to ask permission to examine work from the person concerned, and such an application will generally secure both consent and explanation.

"Politeness is as indispensable to a learner in the works as to a gentleman in society. The character of the courtesy may be modified to suit the circumstances and the person, but still is courtesy. . . . Without the art of questioning but slow progress will be made in learning shop manipulation. . . . The main point is to consider questions before they are asked, make them relevant to the work in hand and not too many. . . . It is important in asking questions to consider the mood and present occupation of the person addressed. . . . One question asked when a man is in a communicative humour is worth a dozen questions when he is engaged and not disposed to talk. It is a matter of courtesy in the usages of a shop, and one of expediency to the learner, to ask questions from those who are supposed to be best informed on the subject to which the questions relate. . . . There is not a more generous or kindly feeling in the world than that with which a skilled mechanic will share his knowledge with those who have gained his esteem, and who, he thinks, merit and desire the aid that he can give. . . .

"If asked for advice as to the most important object for an apprentice to aim at in the beginning of his course, nine out of ten experienced enginesrs will say, 'To do work well.' . . . Methodical exactness, reasoning, and persistence are the powers which lead to proficiency in engineering pursuits. There is, perhaps, no more fitting conclusion to these suggestions for apprentices than a word about health and strength. . . . One not accustomed to manual labour will, after commencing, find his limbs aching, his hands sore. He will feel exhausted both at the beginning and at the end of the day's work. These are not dangerous symptoms. He has only to wait until his system is built up so as to sustain this new draught upon its resources, and until Nature furnishes a power of endurance, which will in the end be a source of pride and add a score of years to life. Have plenty of sleep, plenty of plain substantial food, keep the skin clean and active, laugh at privations, and cultivate a spirit of self-sacrifice and pride in endurance that will court the hardest and longest efforts. An apprentice who has not the spirit and firmness to endure physical labour and adapt himself to the conditions of a workshop should select some pursuit of a nature less aggressive than mechanical engineering."

THE VERBAND DEUTSCHER ELEKTROTECHNIKER.

The Parallel Running of Alternators.

BY H. GÖRGES.

(Continued from page 172.)

We will now assume that the input of energy is not constant, but fluctuates uniformly in each cycle of the driving engine, however complicated this may appear. We can then represent the curve of driving energy by the sum of a series of sine curves, of which the first lasts through a complete cycle, the second being of half and the third of a third this duration, etc. The individual sine oscillations, therefore, bisect the zero point at different periods—that is to say, they have a definite relative phase distortion. We term the first oscillation the main one, and the rest the superimposed oscillations. The law of superposition serves for all the oscillations which we have to consider here—in other words, each oscillation behaves as if it existed alone, and we find the resultant oscillation by summing the values of the individual oscillations at each instant. This law applies equally to all the oscillations of the driving engine, as also for the natural oscillations set up in the armature, which follow a simple sine law. By means of this law our investigation will be greatly simplified, since we need take into consideration only one sine oscillation at a time.

The fluctuations in the output of the driving engine cause mechanical oscillations in the dynamo—that is to say, lead and lag. If only one dynamo is coupled to the 'bus bars, obviously these oscillations will observe the same cycle as the primary oscillations. In order to distinguish between the mechanical oscillations and those having their origin in the dynamo itself, we call the former forced oscillations. If a damping effect is provided by asynchronous motors, these oscillations will be checked in the rapidity of their succession and weakened, but never completely eliminated, as in the case of the natural oscillation of the machine.

Comparing the main oscillation with the superimposed ones, it is obvious that the influence of the former at equal strength must be the greater, because its swing is longer than those of the superimposed oscillations. Hence, for the same absolute amount the main oscillation will produce a greater variation of the speed than a superimposed oscillation, and will tend to a greater increase of the lead or lag. This explains the oft-proved fact that the curve which represents the periodic value of the lead and lag approximates very closely to a sine curve based on the period of the main oscillation. The main oscillation has, therefore, an important bearing on the whole phenomena. The greater its frequency the less will be the effect of the superimposed oscillation. Relative to the variations in speed, which must be considered in connection with the damping effect, the first superimposed oscillation has half and the second a third of the influence of the main oscillation; while relative to the lead and lag, which, apart from the damping, govern the output yielded, the influence of the superimposed oscillations sinks to the fourth and ninth part, and so on. As we have already seen, the speed must increase so long as there is an excess input. It will therefore be at its maximum if the acceleration has been positive and just reaches the zero value. In the sine curves of the cycle we see that the speed is retarded during a quarter of the whole period relative to the acceleration. The lead must also increase while the speed remains above the normal. The variation from the normal position suffers also a retardation for a quarter of the period relative to the speed, and therefore a retardation of one-half period relative to the acceleration. Hence the maximum input of energy from the driving engine corresponds to the greatest lag of the armature, and the minimum input to the greatest lead of same. This circumstance is of great importance in connection with parallel running, for, apart from the damping effect, the load is greatest for the maximum lead. Hence minimum input and maximum output coincide, and conversely. Consequently the oscillations which occur when a machine is running independently, must be aggravated when machines are run in parallel. But when we remember that the cause—*i.e.*, the variations in the input—are repeated in the same cycle, the oscillations to which they conduce must also be repeated in exactly the same order. In parallel running we, therefore, have forced oscillations, which, compared with those which occur in separate running, appear to be strengthened. This strengthening we term resonance. The resonance modulus depends very much upon the difference of the square of the forced snd the number of undamped oscillations pro-

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duced in the armature. It will be the greater in proportion as the difference between the two values for the oscillations is smaller, and will be indefinitely great if the values coincide. In the latter case we speak of complete resonance. It must be observed that the resonance is governed by the number of oscillations set up in the armature and remaining undamped, apart from whether damping really exists or not. We must prevent marked resonance, especially complete resonance, both in the case of the main oscillation and that of one of the superimposed oscillations. If the value for the natural period of oscillation be greater than that for the main oscillation of the driving engine, then resonance with it or with some of the harmonics is inevitable. Hence we get the practical rule that the value for the natural oscillations shall be less than that for the main oscillation. If the resonance with the latter is slight, it will be much more so with the superimposed oscillations. The number of oscillations can be best reduced by increasing the moment of inertia. Consequently resonance may be prevented with certainty by designing to get a sufficiently large moment of inertia.

The number of natural oscillations for a certain type of construction is practically independent of the output and speed of the dynamo. The value is approximately the same for each size, and lies between 2·5 and 1·5 oscillations per second. We will assume that all machines of a certain type of construction give 1 5 natural oscillations per second. A steam-engine running at 150 revolutions gives 2·5 main oscillations in the same time. In this case the resonance will be but slight. At 125 revolutions the number of oscillations will be 2·08d., making the resonance more appreciable, while at 100 revolutions the oscillations will be 1·67 per second. In the latter case the danger of resonance is very considerable. Complete resonance occurs at 90 revolutions—parallel running at this speed would, therefore, be quite impossible. We have assumed in making the above calculations that the steam-engine has no special flywheel. If such be provided or should the dynamo be of the flywheel type, then the number of natural oscillations will be less and the danger of resonance corresponds to a lower speed. This explains the fact that with the same degree of variation very good parallel running has been obtained in many cases with tandem machines, where, for instance, triple-expansion engines without special flywheels have given trouble. In any case it is sufficiently obvious that the difficulties increase rapidly with decreased speed.

Referring again to the law of the superposition of the oscillations, we may at once combine the different oscillations. The forced oscillations, more or less strengthened by resonance, combine with the natural oscillations to form a resultant curve which may assume a very complex character. Since we may assume that the numbers of oscillations are different—as otherwise the resonance would become infinitely great, thus causing the machines to fall out of step—the maximum values of the different oscillations will soon meet. As a result, lead and lag will be aggravated, and the maximum of the one oscillation will soon meet the minimum of the other, the resultant oscillation appearing small. We call this phenomenon interference of the oscillations. If the two kinds of oscillations are maintained permanently side by side, then strong and weak oscillations will be exchanged between them alternately at regular intervals. This give and take between the oscillations we term surging, and we can determine the ratio between the oscillations from the number of beats while surging is taking place. We have seen that the damping always eliminates the natural oscillations after a time. Hence, if they are not again excited by some cause or other, there will remain after a time only the forced oscillations, and the surging must cease.

We have also seen that by designing to obtain a sufficiently great moment of inertia, the danger of resonance may be avoided. But under certain circumstances this involves the provision of very heavy flywheels, so the question arises whether the danger cannot be eliminated by the provision of damping, whereby the oscillations are also reduced. As a matter of fact, the damping first of all eliminates the natural oscillations, whose length of swing is quickly reduced by the damping, or which are prevented from coming into being at all by strong damping. The damping also exerts an influence on the forced oscillations. We can reduce them at will by damping, even when complete resonance exists. Hence we are able to confine the lead and lag within any limits we please, and thereby maintain synchronism in any case. The question arises, however, if some sort of disadvantages are not connected with this remedy. We have seen that of the input, part is absorbed by the flywheel and the remaining part, deducting the loss in the dynamo, transferred to the 'bus bars in the form of electrical energy. The amount of energy which can be absorbed by the flywheel at any moment, depends upon its moment of inertia and the acceleration at a given mean speed. If, however, the flywheel yields up part of this energy to the 'bus bars directly a variation occurs in the speed, then considerable variations in speed, and consequently great accelerations, will be impossible. The flywheel is rendered more or less ineffective by the damping, and the fluctuations of the electrical energy yielded at the 'bus bars become more and more a reflection, so to speak, of the mechanical input. If means are available to render the lead and lag visible to the eye, we shall find that they are diminished by the damping. At the same time we shall observe that, corresponding to marked variations of the input, the oscillations indicated on the watt-meter and ampere-meter are increased. We must, therefore, distinguish between variations in the speed and variations in the output yielded. The latter may be considerably increased by the damping. But strong variations in the output and current, apart from the bad effect on the parallel running, entails the disadvantage of greater heating in the machine, and the voltage at the 'bus bars may be adversely affected also. This unpleasant property of the damping becomes more marked according as there is less resonance during parallel running—that is to say, the closer the resonance modulus approximates to 1. In the case of a gas-engine-driven dynamo, which requires an extra flywheel effect, a strong damping is not useful as a rule, but injurious in its effect. In connection with steam-driven dynamos, cases have also come to my notice where the damping had an adverse effect on parallel running. Having regard to the above, a slight damping appears to me to be always advantageous, because it eliminates the natural oscillations. A strong damping will prove useful as a substitute for a special flywheel only if the energy transmitted by the driving engine be fairly constant, but as a set-off against this there is the danger of resonance.

(To be continued.)

THE DANGER OF SHOCK TO FIREMEN THROUGH SQUIRTING HIGH-TENSION MAINS.*

The supply of electricity to villages and isolated houses is often carried out by means of overhead wires, which are usually uninsulated. The wires are carried on insulators either supported by posts or attached to the walls of houses, etc. The overhead trolley wires of electric tramways belong to the same category. Should a fire break out in a street containing such wires, it would not usually be possible to switch the wires out of circuit before the work of extinguishing the fire commenced. Also, it is hardly desirable to put the road in darkness just during the time of danger, especially as there is no fear of explosion from the lighting agent.

In such cases the danger of shock to the firemen through the stream of water from the hose coming into contact with the wires must be considered, and the following experiments were carried out at the Charzow power station for the purpose of obtaining some definite figures on the subject. A stream of water at a pressure of five atmospheres was taken from a hose pipe, A (Fig. 1), with a 12mm. diameter mouth, and was directed at the bare wire, C, carried on well insulated supports. The full section of the stream was allowed to hit the wire. The voltage of the

* Abstract of an article by F. Heinicke in the *Elektrotechnische Zeitschrift* of June 18, 1903.

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water, B, to earth was measured by means of a standard voltmeter, the copper mouth of the hose pipe being thoroughly insulated from earth.

The experiments were carried out with continuous and alternating currents and with various distances, L, between pipe and wire. As the quality of the water affects the results the tests were first carried out with the ordinary water from the town mains, which was rather hard and poorly conducting, and then with water containing ·5 per cent. of pure soda.

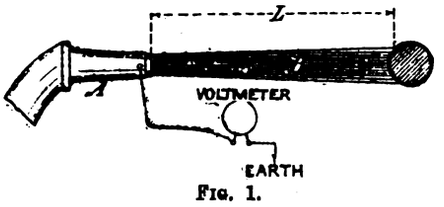

FIG. 1.

Experiments carried out by Prof. Weber in 1897 and Dr. Kath in 1899 (*E.T.Z.*, 1899, p. 601) show that a human being can just stand a current of ·03 ampere without fatal results. They also show that the resistance from hand to earth of a person standing on wet earth is at least 15,000 ohms. In order to determine the current which would pass through a human being holding the hose pipe, the method shown in Fig. 2 was employed; where e_1 = the E.M.F. measured by the voltmeter; i_1 and W_1 the corresponding current and resistance; i_2 and W_2 the current and resistance of the hose-pipe circuit; e_3 = the voltage between mouthpiece and wire; i_3 and W_3 the corresponding current and resistance; E = the whole voltage from wire to earth; J = current which would flow through a human being.

Then $i_3 = i_1 + i_2$, and $e_3 = i_3 \cdot W_3$;

$$W_3 = \frac{e_3}{i_3} = \frac{e_3}{i_1 + i_2} = \frac{e_3}{i_1 + \frac{e_1}{W_2}}.$$

The current in the hose circuit is given by $i_2 = \frac{e_1}{W_2}$, and $e_3 = E - e_1$, and by a separate measurement the resistance (W_2) of the hose circuit was found to be 5,000 ohms. The resistance of the water column is $W_3 = \frac{e_3}{i_3}$, and the combined resistance of the whole circuit, assuming a person with a resistance of 15,000 ohms to be holding the hose, is

$$W = W_3 + \frac{5{,}000 \times 15{,}000}{5{,}000 + 15{,}000} = W_3 + 3{,}750.$$

From this value and the total voltage, E, the value of i_3 is obtained, and then

$$J = \frac{i_3}{1 + \frac{W_1}{W_2}}.$$

So long as this value does not exceed ·03 ampere, the case may be considered safe.

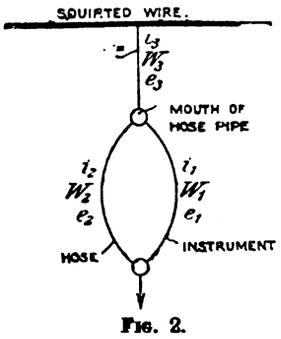

FIG. 2.

Experiment 1.—On a three-phase star-coupled circuit, with 6,000 volts between lines and the neutral earthed. The wires were bare and well cleaned. Each had a section of 95 square millimetres. The tests show that a distance, L, of 300mm. is sufficient for safety with pure water, whilst when ·5 per cent. of soda is added the distance, L, must be increased to about 1,000mm. before the current falls to 0·3 ampere. Though this removes the danger, an uncomfortable shock will certainly still be felt.

Experiment 2.—On a three-phase circuit with 125 volts between lines. In this case one of the mains, instead of the neutral, was earthed. Though the distance, L, was reduced as low as 30mm., the current never reached the limiting value, being only ·0024 ampere at 30mm. with pure water, and ·0073 ampere with ·5 per cent. of soda added.

Experiment 3.—On a continuous-current traction circuit supplied from accumulators at 550 volts with the negative pole earthed. With pure water the limit of ·03 ampere was not reached, even with a distance, L, of only 30mm., the actual current being only ·016 ampere. With ·5 per cent. soda in the water the limit was just reached at 30mm., and the current was ·026 ampere at a distance of 80mm.

Experiment 4.—With 240-volt continuous current the limiting value was not reached at all, though the distance, L, was reduced to 50mm., the current being only ·0076 with pure water and ·011 with ·5 per cent. soda solution.

From these figures it would seem that the danger from this source is not so great as is usually supposed, especially when it is remembered that such voltages as 6,000 are practically never carried on bare overhead wires.

PERMANENT-WAY CONSTRUCTION AND MAINTENANCE.

In our issue of July 17 last we referred to a report by Mr. John Young, general manager, Glasgow Corporation tramways, on "Permanent-Way Construction and Maintenance"; also to a summary of that report prepared by Mr. C. A. King, and read by the latter gentleman during the recent conference of the Municipal Tramways Association in Glasgow. Below we give a reprint of the summary in full:

PERMANENT-WAY CONSTRUCTION AND MAINTENANCE.

In Great Britain and Ireland the girder rail is the only rail in use on public streets. Note may be taken of the adoption by Hull of a girder rail with central groove. Several towns in America and on the Continent use the tee rail. Considerable diversity exists in the weight of rail used. For girder straight track rails the minimum recorded is 65lb. per yard and the maximum 105lb., but by far the greater number of systems adopt a rail weighing between 90lb. and 100lb. A large number of towns use a heavier rail on curves, in one instance the weight being 117lb. per yard. It is interesting to note that the lightest straight track section for tramway rails recommended by the Engineering Standards Committee is 90lb. per yard, and the heaviest 110lb. per yard.

Almost 50 per cent. of the systems have a rail 7in. deep, a considerable number having 6½in. and 6in. Except in America, where deeper rails are used, these limits are very rarely exceeded. It is of interest to find that out of every three tramway systems, two use rails with a flat head and one has the head coned.

The width of the groove on straight track rails varies on different British systems from 1in. to 1¼in., but only on seven systems is the groove wider than 1⅛in., this width and 1in. being by far the most common. In America 1⅜in. is in use on straight track. A large number of systems widen the groove on curves by about ⅛in. Norwich is unique in widening from 1in. on straight track to 1⅜in. on curves, and, what is worthy of note, state that they consider this too wide, and would prefer 1¼in. on curves.

About 35 per cent. of the tramways reporting use a specially high guard lip, on the curve of which the maximum height in this country seems to be ¾in. above the tread. Several systems use check rails on the sharper curves.

There has been some controversy as to the best length of rail to use. The returns show that at the present time 40 per cent. of the systems use 45ft. rails, the 60ft. rail coming a close second with 33 per cent. in its favour, the remaining 27 per cent. of the systems using shorter lengths than 45ft. Each length has its keen supporters, and the chief arguments in favour on each side are as follows.

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Those who support 45ft. lengths say: most convenient to handle and turn, most easily curved, less movement than longer rails; also that the longer rail causes more trouble with paving, more undulatory movement and hog-backing, and acquires a permanent set by sagging with its own weight. Those who favour the 60ft. rail put forward as their main argument: fewer joints, and therefore less maintenance and less electrical resistance, and maintain that the extra difficulty in handling is very slight, and that this long rail sits quite as securely on its bed as its shorter rivals.

There is considerable variation in the gauges adopted. The most common is the railway gauge of 4ft. 8½in., but several systems have a 4ft. gauge, and about 20 use 3ft. 6in. gauge One or two systems have gauges peculiar to themselves. That this is an inconvenience is apparent to everyone, and in the future, as lines extend and in many cases join, this will be more acutely felt.

The tests which engineers require the rails to satisfy vary considerably in severity, but the nature of the tests is very similar. A given weight falling from a fixed height on a given length of rail resting on rigid supports placed at a specified distance apart must not produce more than a given maximum of distortion or permanent bending. This is known as the drop test, and is almost universal. In many cases this is the only mechanical test applied, but it is often accompanied by the ordinary tensile test with a specified elongation and contraction. A few specifications require, in addition to the drop test, the bending of a small bar cold, without fracture, or the bending of the rail to a small radius without showing any signs of cracking or rupture. A complete statement of tests will be found in the detailed table supplied to you.

The chemical composition specified by the different systems shows that a considerable difference of opinion exists among tramway engineers as to what is required. With regard to the carbon, which is the main constituent, one specification is as low as from ·28 to ·40 per cent., while another is as high as from ·55 to ·66 per cent. The average carbon aimed at in the majority of cases seems to be about ·53 per cent. Regarding the rail in its capacity as an electrical conductor, the percentage of manganese is of importance. One specification asks for an average of 1·10 per cent., and another specifies no more than ·1 per cent., showing a very wide divergence of opinion. The average quantity of manganese wished for in most cases appears to be about ·90 per cent., which certainly does not err on the low side. In several cases a high silicon is specified with a very high carbon, which, if obtained, would necessitate a careful handling of the rails. It would be interesting to have some records of the analysis of the actual rail as compared with the composition specified. Generally, the tendency is to specify a higher carbon rail than was formerly used.

After the rail itself, there is no more important problem which presents itself to the engineer than the method to be adopted in joining these into a continuous smooth-running road.

Having only comparatively recently adopted electric traction on a large scale, we in this country are realising to the full the very exacting demands it makes on the permanent way as compared with horse traction. Nowhere is this more in evidence than at the joints. The number and diversity of the devices used, as shown in the replies, is evidence of this. There are at least a dozen separate methods, and many combinations of two or more of these.

Of the replies received 30 per cent. rely on fishplates unaided, 23 per cent. combine these with anchor plates, and 21 per cent. use sole plates in addition to fishplates. Of the remaining methods of jointing, the most interesting is perhaps the cast weld joint, large adopted on four systems, two of those in America.

That few of the above have proved entirely satisfactory is shown by the large number of systems on which trials are being made of other forms of joint than at present in use on these systems.

In this connection, mention must be made of the chemical welding material "Thermit," lately put in the market. At least eight towns are at present experimenting with this device. At Dresden, on the Continent, and Leeds, in this country, the trials have been extensive, and both towns have reported very favourably. In Glasgow we purpose making a trial of several hundred joints this summer. The returns for cast-weld joints are curiously at variance. Of nine towns reporting as having tried this method in America—two were favourable and two unfavourable; on the Continent one was favourable and one unfavourable; in this country one favourable and one unfavourable; one made no comment. Only one city reported having used electric welded joints—Boston, U.S.; the result is stated not to have been a success. It must, however, be noted that these welds were made in 1893, at which time it is now admitted, even by the contractors, that the methods were defective. The Lorain Steel Company, of Johnstown, who own the welding plant, claim that the present method is a great advance on the practice of 1893, and this form of jointing is making considerable progress in America. It has been arranged to make a number of these joints also in Glasgow in the autumn.

Before passing from the consideration of welded joints, it may be noted that the present practice regarding the bonding of these is to put no bonds with chemical and electrical welds. With cast welds about 50 per cent. seem to bond in addition.

Apart from the question of joints, but to a certain extent connected with it, is the fixing down of the rails to the bed, not only at the end, but at intervals in the length. The tendency seems to adopt this much more largely in the future. Taking into consideration the increasing length and height of the rails and the close butting of the ends, this is undoubtedly a step in the right direction. The rails are close-butted at the ends on over 75 per cent. of the tramway systems under consideration.

A question of considerable interest and importance, affecting not only the permanent way, but also the rolling-stock and the overhead trolley wires, is the placing of the rail joints. Of the total systems reporting, two out of every three have the joints placed opposite each other. Taking especially into consideration the rolling-stock and overhead work, the writer believes this to be the best practice. At the same time the longer experience of some of the earlier systems has led them to adopt "Staggeral" joints. On most systems squared joints are not insisted on at curves, but where the fishplate adopted is long, the writer is strongly of opinion that on sharp curves the joints should be squared or far enough apart to get at least one tiebar between them, otherwise a knee at the joint will result.

The most important feature in special work is, without doubt, the points, and more especially the tongues or switches. A defective tongue in a facing point may easily lead to serious accident. The returns show a variation in the lengths of tongue between 3ft. 6in. and 9ft. 6in. The tendency is clearly to go in for longer points and tongues than in the past. There can be no question that it is advisable to have the tongues at least 6in. longer than the length of the single-truck car wheel-base, to avoid the leading wheel throwing the tongue over before the rear wheel has entered. Other obvious benefits are derived from a long tongue, especially if curved on the branch-off side.

There is considerable diversity of opinion as to whether tongues should be placed on the inside or outside of curves, and as to the advantage of having two movable tongues instead of one tongue and a mate or dumb point. Also, on some systems, no tongue is used on trailing points. The writer hopes to hear these points fully discussed at this meeting.

The replies to question 23 regarding the "kicking" or rising vertically of the tongues of trailing points are of great interest to Glasgow, as this trouble has been considerable on this system. The great majority have had no such experience. Twelve towns — three in America—had the same trouble to a more or less extent. Without wishing in any way to disturb the piece of mind of those who have recently adopted electric traction, the writer notes that in all places where this action has developed electric traction has been in use for a considerable time, and a large proportion of those towns reporting no trouble with trailing points have had only a short

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experience of the wear and tear of heavy electric cars. The writer has been giving attention to this matter for some time, and is satisfied that the wearing of the floor of the casting is the cause of the springing upwards of the tongue, and that the depression on the top of the tongue is caused by the consequent heavy blow which it receives on rising to meet the advancing wheel. A pin in the nose of the point tongue lessens this evil to only a limited extent.

The replies regarding the use of hardened steel renewable centre pieces are remarkably unanimous. About 30 towns, including four in America, have these in use, 20 are pronouncedly in favour, two—Montreal and New York—consider them unsatisfactory, the others have not had sufficient experience to express an opinion.

The essential feature of hardened steel renewable centres is that these can be renewed. It is certainly strange to find such perfect belief in this work as the replies disclosed, when practically the whole of the believers have had no experience of how this essential feature will work in actual practice. Carried out as directed by all the makers of this work, the results are anything but satisfactory. Great difficulty is experienced in cutting out the spelter and getting at the keys, and even when this is accomplished the centre piece itself is difficult to lift out of its bed. In some cases the whole casting has to be lifted and taken to the yard, and the renewable piece removed there.

As will be seen from the report, the replies give very little help in this matter with the exception of three from America. Two indicate the method of replacing, but only one, that from New York, gives the whole operation. It is as follows: "Melt zinc with blow lamp or torch, wedge centre in place, and pour in melted zinc, caulking well around the edges."

This is not quite such a simple matter as it seems, especially with large castings and long renewable pieces. After about a year's intermittent experiments, the writer has devised a means of melting out and renewing which will enable the work to be done in about one-fifth of the time formerly required, and effect a considerable saving in cost.

About 21 towns have in use, to a greater or less extent, special work of wholly manganese steel. In most cases the work seems to have been lately laid down, and no opinion is expressed as to its merits, but five towns approve of this material.

In the list of queries sent out, one question, No. 27, was, I am afraid, not quite clearly stated, and has in some instances been misunderstood. The information sought for in this question was as to the effect of special work constructed wholly of manganese steel throughout (as distinguished from manganese steel renewable pieces) in wearing down or cutting away the flanges of steel-tyred or other wheels. One or two replies to this question have been received from towns, which state that they have no special work wholly of manganese steel. Deducting all doubtful replies, the experience of four towns has been that there is considerable wear and chipping with this class of work. As a very considerable number of towns have put down this type of special work recently, this seems a point which it would be of considerable value to the association to have a report further on.

In laying new track where a new concrete bed is required, the replies show that engineers are divided almost exactly between two methods. The one section lay the concrete bed first. The rails are then laid down, lined, and packed with fine concrete. The other section lay the rails first, setting them up to line and level on blocks. The concrete bed is then put in below the rails and levelled up tightly under the flange. In several cases the adherents of each system state that they purpose to adopt the other system in future. The balance of converts is slightly in favour of the method of laying the rails first and levelling the concrete bed up to them.

Wooden sleepers are used only to a limited extent in this country, but largely in America and on the Continent. The claims put forward on behalf of this construction are easier traction, more elasticity, easier riding of cars, acts as an anchor for rail, keeps track to gauge, and lessens the noise. Toronto has used them under the old work, and is of the opinion that cross sleepers are of no advantage.

The dimensions of the sleeper vary on different systems, but the general practice seems to be about 7ft. by 8in. by 6in. Naturally, the timber used differs in different countries and localities. In this country Baltic redwood is the most usual, and this is creosoted in every case. Two replies from the Continent state that oak is used untreated. Oak chestnut, long leaf yellow pine, and cedar are used in America, and in the majority of cases are not treated. The general practice is to place the sleepers between 2ft. to 3ft. apart. In Leeds, however, eight sleepers are put in under each 60ft. length, the ones at the joints being 1ft. 8in. apart, and the others about 9ft. 8in. apart. The rails are usually fixed down to the sleepers by spikes, but in Leeds ¾in. bolts with fang washers and clips are used.

The majority of the systems reporting pave the tracks with granite setts, wood being the next in favour, and then basaltic setts. It is unfortunate that only in very few cases is the class of wood used specified. The general experience with wood paving seems favourable with light traffic, but of doubtful efficiency in city streets, especially alongside the rails. From a limited experience of wood paving in Glasgow, the writer is of opinion that the nature of the grouting of the joints has a considerable influence on the success or failure of wood paving, provided, of course, that the wood itself is satisfactory. The experience of those with large areas of wood paving would be of value to the association, especially in view of the present crusade against "noisy streets."

In about a dozen towns widening of the gauges has resulted from the expansion of the wood paving.

The testimony against the use of asphalt between and alongside the rails is very strong. In most cases a toothing of stones or wood is laid alongside the rails, but even with this protection the asphalt has in most cases proved unsatisfactory except under very light traffic.

Many towns experience trouble from the paving setts or blocks rising alongside the rails. This has been assigned to several causes, as water getting down under the setts and rails the bitumen grouting in hot weather forcing the setts up, the setts resting on the rail flange, action of heavy traffic, etc. Probably each of these has at different times been a factor in raising the paving. The writer considers it certain that in almost every case where this evil of rising paving has been met with, it will be found that the rail is not lying soundly on its bed and is springing with the traffic. A small movement in the rail will raise the setts butting against it very considerably. Each time the rail rises it takes up the paving sett, and when it goes down again it leaves the sett up, allowing sand and dirt to drop in beneath, and this taking place time after time packs the sett up. In wet weather this takes place much more quickly owing to the water below the rails and paving.

The following are some of the remedies suggested in the replies: anchor joints, holding-down bolts, use mastic packing to prevent the rail springing, use well-tarred chippings laid on bottom flange to keep out water.

"Rutting" of the paving by heavy traffic seeking the rails is a source of expense in towns. About a dozen systems use cast-iron blocks chilled on the surface and laid alongside the rails to mitigate this wear. In Glasgow we have found them of very considerable value where the weight of individual vehicles is not excessive.

By far the greater number of towns use bitumen and oil for grouting the paving joints, some using this for part of the joint and cement and sand for the remainder.

The construction of the duct or cable track is a matter of great importance and interest, and more information on this subject would have been of value. Earthenware ducts or pipes are used on 65 per cent. of the systems reported on. Almost all these lay the ducts solid in concrete; 13 per cent. of the replies state that the cables are laid in earthenware or wooden troughs, and run solid with bitumen, while the cement-lined iron duct laid in groups in concrete claims 9 per cent. in its favour. The remainder are in pipes presumably of cast iron. Note may

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be taken of the method in Zürich, where the earthenware ducts are laid in sand, and Zürich where the lead cables armoured with iron strips lie in the earth without any special duct. It is a matter of regret that the position in the roadway of the duct track was not stated, also the cost per yard and the depth at which the ducts are laid.

The spacing of manholes varies remarkably on different system. The shortest distance apart recorded is 30 lineal yards, and the maximum 300 lineal yards. The average distance is about 100 yards. Only three systems go beyond 150 lineal yards. All these distances are, of course, on the straight; on corners the distance apart must vary with the radius of the curve.

The replies show that in no case has any chemical action on the cables from the material of the duct track been found. In view of sinister rumours which probably most of you have heard, this is a reassuring return. The replies giving the methods of bonding were, unfortunately, not detailed enough to be of much value. The general result shows that by far the greater number of lines are bonded with solid or flexible Chicago or Neptune bonds. Plastic bonds claim one-sixth of the whole returns. It is greatly to be desired that the general practice as to the number and weight of bonds at each joint will be brought out in the discussion.

Cross-bonding of the track is almost universal. The usual distance apart of the bonds is 40 lineal yards, but seven systems place these as far apart as 80 yards, which is the maximum distance recorded. In only four cases has any trouble been experienced from bonds working loose. The method of bonding up the special work is on almost all tramways the same as that adopted on straight track with the addition of long bonds round the castings. Dublin varies its practice by bonding ordinary work into the web, and special work into the flange. Toronto, Canada, bridges the whole special work with cables. In Glasgow we are now adopting this system, and about a month ago applied it to a large and intricate three-way junction with a very considerable saving in time and cost.

We in Glasgow have had a considerable number of the horseshoe bonds in the flange of the rail cut by the working of the paving stones under heavy traffic. Practically all the replies stated that this had not been experienced. Five towns—two in Britain and three in America—had found the same trouble. The very exceptionally heavy vehicular traffic in Glasgow is the chief cause of the evil.

The returns of the cost per mile of single track are interesting, but not of much practical value without full particulars in each case. The cost is greatly affected by so many different conditions, as the nature of the paving, the road bed, whether in the central districts of a town or suburban, the facilities allowed for opening up the roads, and many other contingencies.

The average cost of 4ft. 8½in. track per mile of single line seems to be between £5,500 and £6,000.

Regarding the actual construction of the lines, one half of the systems reporting do the work themselves and the other half by contract—a few adopt both methods.

On very few systems does it seem possible to estimate the wear due to electric traction. In almost every town with tramways in the streets the vehicular traffic takes advantage of the easier traction on the rails to as large an extent as possible. This is bound to cause considerable wear, the extent of which it is difficult to arrive at. Figures for the wear due to both electric traction and vehicular traffic are of value only at the place where they are taken, unless particulars of the class, speed, and frequency of the vehicles are given in addition to the car service. One reply states that a rail, after having been in position for 5¼ years and having carried 185,000 cars, showed $\frac{1}{16}$in. of wear. But we do not know the quantity or class of vehicular traffic over this rail. The general opinion appears to be that the wear from vehicular traffic is small compared with that from electric cars.

The writer, taking the replies of the number of men in the various permanent-way squads, endeavoured to arrive at an estimate of the average number of men per mile of track maintained, but found it was impossible to get this satisfactorily adjusted. The systems which have been longest in operation naturally have a larger proportion of men than those whose lines are recently put down. Towns with large engineering works, causing heavy vehicular traffic, have much more repair of paving than those where such wokrs are few. Each town and system must be considered by itself, in conjunction with the special conditions obtaining there.

It is also useless to attempt any summary of the annual cost per mile of track for maintenance, the replies showing in some cases a few pounds and in others many hundreds.

The general indication is that the greater part of the cost of maintenance in most towns is expended on the paving. It would be interesting to know the general practice of allocation of the cost of restoring paving which has become disturbed (as distinguished from rutted or worn) alongside the rail. This is not really a paving cost. The writer suggests that a good criterion of the actual *wear* on the paving would be the ratio of new stones used on repairs to the whole area of paving. In Glasgow "new setts" is a very large item of maintenance. Great numbers of setts, even of the hardest Scotch granite, are shattered and split the whole depth (6in.) of the sett, and are, of course, useless for redressing.

The limitations imposed on lines laid down in streets is well brought out by the return showing 21 systems on which it has been necessary to use curves of a radius of 35ft. and under. The nicety of adjustment of both wheels and track to avoid severe grinding on such a curve must be patent to everyone. In aggravation of this, one often finds that owing to the hang of the street surface the super-elevation must be put on the wrong rail.

In considering the question of curves, it is interesting to note that there is very little variation in the lengths of the single-truck car wheel bases. Very few of the returns show a wheel base outside the limits of 5ft. 6in. and 6ft.

The grades in streets where it is imperative to have a tramway are frequently very severe. One system has a grade of 1 in 8·4, while there are seven records of grades less than 1 in 10.

The returns show that 65 per cent. of the tramways sand both rails on gradients while the remainder sand one rail only.

A mechanical track cleaner is used on several systems, but its success seems doubtful. Information as to its ability to remove iron punchings, etc., jammed in the rail would be valuable, as these are very frequent in large towns.

The need of an emery rail grinder seems to be felt only on very few tramways. This is probably accounted for by the fact that the majority of the replies come from recently laid or relaid systems.

Seventeen tramways report the use of portable temporary cross-overs or shunts with electric cars without experiencing much trouble. It would be of value to know in how many of these cases bogie or double-truck cars were used.

Eight towns make provision for obviating a stoppage of the car traffic when the hose of the fire brigade is laid across the car lines. Six towns use a fire bridge which carries the cars over the hose. In three towns—Dublin, New York (Street Railway Company), and Glasgow—the bridge accompanies the emergency wagon. In Newcastle and Munich the bridge is brought by the fire brigade. In Montreal the hose is carried by slings from the span wire. Ayr gets rid of any chance of stoppage from hose across the track by duplicating the fire hydrants.

The writer is well aware of the many imperfections of this report, and would plead in extenuation the shortness of time permitted to him for the consideration of so many voluminous and valuable replies.

FORTHCOMING EVENTS.

Iron and Steel Institute.—Summer meeting, Barrow-in-Furness, September 1-4.

Municipal and County Engineers.—Meetings: Aberdeen, Aug. 20, 21, and 22; Hastings, September 11 and 12. Detailed programmes will be issued when definite arrangements are made.

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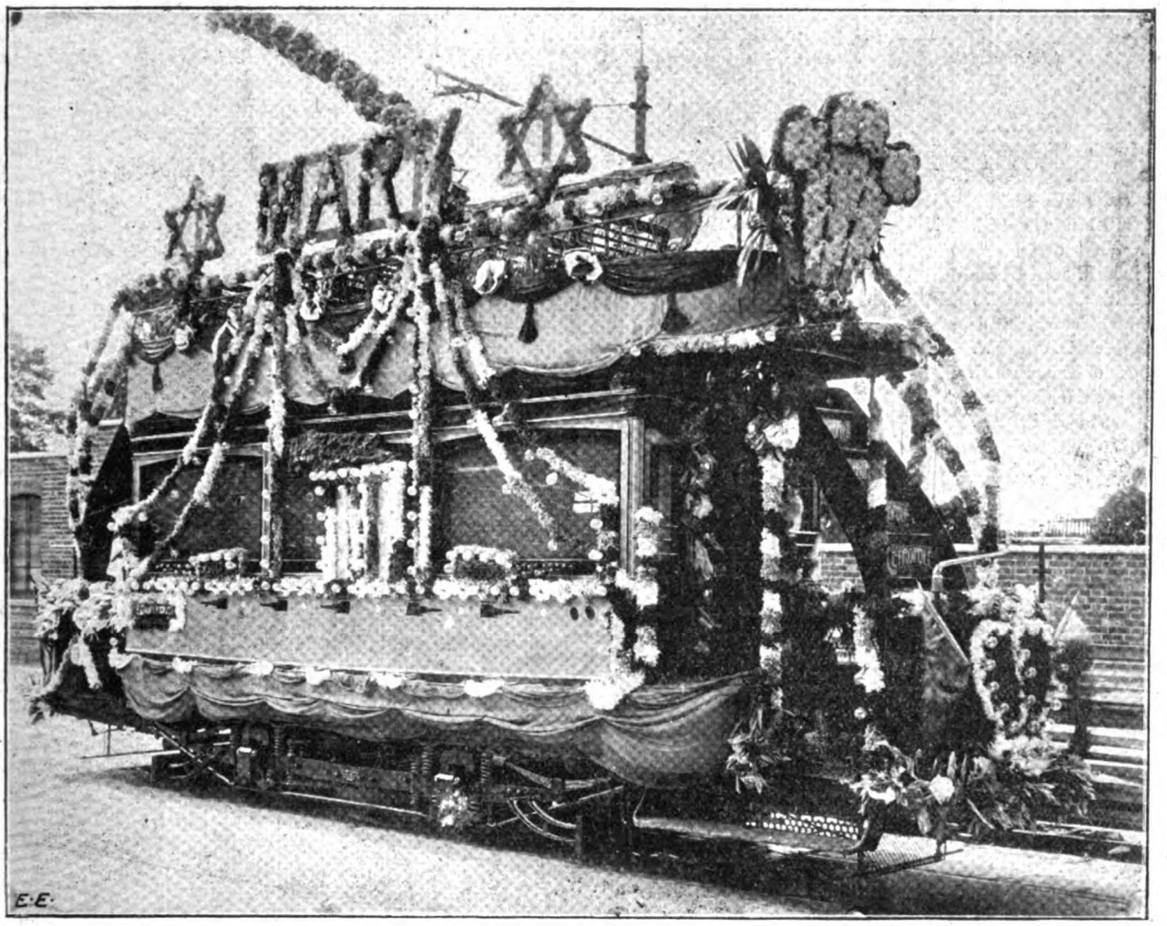
TRADE NOTICES AND NOVELTIES.

Illuminated Electric Car.

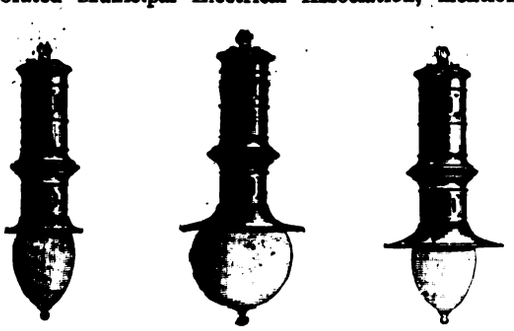
In honour of the visit of the Prince and Princess to Devonport, Mr. J. W. Endean, general manager of the Devonport and District Tramway, provided what was considered one of the finest electric displays seen in the West. It took the form of an electric illuminated and decorated car, which, as seen in the accompanying illustration, represented the battleship "King Edward VII." under steam, the ship being wholly outlined in electric lights, and surmounting the masts on either side were outlined



the Christian names of T.R.H.—viz., "George" and "May"—flanked on either side by a huge star. The canopy at each end was surmounted by the Prince of Wales's feathers, resting on a cushion of flowers, flanked with palms, while the dash of the car was covered with a large crown, flanked by the Royal standard, and resting on a cushion of flowers, the whole being outlined in electric lights from the trolley wheel to the truck. The car ran over the whole of the different routes, and at various points crowds of spectators assembled to see it pass. Mr. Endean purposes giving another exhibition of this battleship car on Thursday evening after the launch of the "King Edward VII." Mr. Endean has since received information from their Royal Highnesses the Prince and Princess of Wales that a photograph of the decorated and illuminated car would be acceptable to them.

Miniature Arc Lamps.

In the recent paper by Mr. W. A. Chamen read before the Incorporated Municipal Electrical Association, mention was



made of the improvements in small arc lamps. As an evidence of what is being done in this direction, we give herewith three illustrations of small arc lamps now being supplied by the Union Electric Company, Limited, of 151, Queen Victoria-street, London, E.C. The lamp itself is very small, being 15in. over all in length, and from 3½in. to 5in. in diameter, according to whether it is used with a pear-shaped globe and single enclosed arc, or a round globe and double enclosed arc. The lamp burns with 1½, 2, and 2½ amperes, and may be burnt in single parallel on a circuit of 100 to 115 volts, or two in series on 200 and 230 volts. The candle-power of the lamp is 160 with the smaller current and up to 250 with the larger current, this candle-power being the mean hemispherical. The makers claim that in simplicity, small number of working parts, and ease in trimming, these small lamps leave nothing to be desired. Owing to the constancy of illumination and good efficiency, they look to these lamps to replace the larger sizes of incandescent lamps. For private house work they can be supplied with silk shades to harmonise with the decorations, but the lamps will have a larger field in the industrial world.

PERSONAL.

The Tramway Committee of Walsall Town Council have decided to recommend the appointment of Mr. R. L. Horsfield, chief assistant in the tramways department of the Bradford Corporation, as tramways manager for Walsall Corporation, at a commencing salary of £200 per annum, to be increased to £250 per annum.

Mr. G. W. Spencer Hawes, M.I.E.E., of Westminster, has been elected a director of the Harrow Electric Light and Power Company, Limited.

The appointment of Mr. R. A. Chattock, at present electrical engineer to the Bradford Corporation, to the post of electrical engineer for the city of Birmingham, at a salary of £1,000 per annum, as already noted by us, has been confirmed.

The annual dinner in connection with the Croydon electricity works was held at the Café Royal on Friday, the 31st ult., and the opportunity was taken to present Mr. Scott, the chief engineer, with a case of cutlery and plate on the occasion of his approaching marriage. The presentation was made by the chairman of the Electricity and Lighting Committee, Mr. Alderman Miller, on behalf of the staff and employés. In making the presentation he referred to the good work accomplished by Mr. Scott during his period of office, and also to the able and hearty co-operation of the staff. Mr. Scott in his reply endorsed the remarks of the chairman with regard to the work of the staff. A lengthy programme of vocal and instrumental music was carried on to a late hour by the various members of the staff and friends. At the last meeting of the Electricity and Lighting Committee Mr. Scott was presented by Mr. Alderman Miller, on behalf of the committee, with a handsome marble and bronze clock.

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TO CORRESPONDENTS.

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THE WEST HAM AWARD.

Elsewhere in this issue will be found the full text of an award recently given by the Hon. Alfred Lyttleton, M.P., as arbitrator for the Board of Trade between the West Ham Corporation and the West Ham Gas Company. The importance of this award to the tramway industry as a whole cannot be over-rated, especially as it is the reverse to that given by another arbitrator on a somewhat similar issue. We refer to the Ilford case, on which a leader appeared in our issue of Jan. 23, 1903. In that case the arbitrator's award, which was confirmed in the Court of Appeal, forced the Ilford Corporation to remove and relay a gas-main which would have been covered by the concrete foundation of the tramway. We concluded that leader by the following sentence: "The decision as it stands practically enables gas and water companies to demand a new system of supply pipes from any tramway promoter who has to place a track over one old pipe; and this is carrying the principles guarding vested interests in this country to a point which heavily handicaps any improved means of locomotion." The West Ham Gas Company were not slow to take advantage of the Ilford award. When the Corporation commenced to put down tramways, the gas company demanded not only that all pipes which would be under the track should be moved, but also that duplicate gas-mains should be laid on either side of the road in order to avoid the frequent crossing under the track of service pipes. They claimed all this under Section 30 of the Tramways Act. The consulting engineer to the Corporation (Mr J. E. Waller, of Messrs. Kincaid, Waller, Manville, and Dawson) advised the Corporation to dispute the gas company's reading of the clause in question. This time the Board of Trade appointed as arbitrator the Hon. Alfred Lyttleton, who is naturally more competent to decide as to the correct interpretation of the Act than an engineer would be. The result quite justifies Mr. Waller's advice, as the gas company have lost their case and have to pay the cost of the reference and of the award. It will be seen from the full text of the award that the arbitrator considers Section 32 of the Tramways Act settles the point at issue. This section provides that nothing in the Act shall "take away or abridge any power to open or break up any road along or across which any tramway is laid or any other power vested in any local authority or road authority for any of the purposes for which such authority is respectively constituted." The clause goes on to give the requisite protection to companies supplying gas or water. The fairness of the award will be appreciated if the matter is looked at from an independent standpoint of the Corporation as the road authority. Thus, if the West Ham Corporation were to pave all their streets which may now be macadamised with granite or wood, they would use a concrete foundation, which would obstruct access to the gas company's mains. As the road authority, they have a perfect right to do this, and the gas company would have no redress whatever. If, on the other hand, they lay a tramway down, which would obstruct access to the pipes to a smaller degree, as the concrete foundation is confined to the centre of the road, the gas company claim to have new mains laid down for them in duplicate, which is obviously interfering with the vested powers which are guarded under the Tramways Act. We congratulate the West Ham Corporation and their engineers on having secured a decision of the above importance, and trust that it will remind gas and water companies that they cannot share the advantage of progress without contributing to a small extent to the extra cost involved. Tramways properly laid down and run involve enormous increases in the demand for gas and water, as they develop

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land which would not otherwise be built upon. That such tramways may involve the gas and water companies in slight extra cost in making services is obvious, but the inconvenience is mutual. It must also be remembered that in no case do these users of the subsoil under our streets pay for the rights they enjoy.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

SECRECY OF MESSAGES IN WIRELESS TELEGRAPHY.

SIR,—I have just noticed an article on recent progress of wireless telegraphy in the *Electrical World* of New York of June 20. In the illustration (Fig. 3) of this article a patented arrangement of Mr. Lee de Forest is illustrated, which has for its object the limiting of the space over which waves are transmitted. It consists, briefly, of an earthed metallic screen partially surrounding the vertical wire. I do not wish in any way to detract from the credit of Mr. Lee de Forest, who has proved his energy in carrying out so much good work in the domain of wireless telegraphy; I only desire to put on record my evidence which goes to show that this invention is very similar to my own. Without wishing to mention patents and publications, I only call your attention to the article contributed by Lieutenant Poncelet and myself in the *Electrical Engineer* of July 12 and 19, 1900, in which are described successful trials for the limitation of the space over which the waves are transmitted by means of a metallic net connected to earth. Since then I continued experiments for two years, using as a receiver the common telephone, without coherers or other accessories. This receiver has the advantage of giving quantitative indications—that is to say, it enables one to estimate the intensity of the field. These trials, made with earthed screens and antennæ of variable height, have shown that with this arrangement it is possible to limit the space and direction over which waves are received or dispatched. However, this arrangement has the great disadvantage of diminishing considerably the energy of the transmission. This is explained by the fact that the screen counteracts the action of the aerial wire. I have made several successful experiments both in open country and in woods, one of which gave some curious results. Whilst working in a pine forest I observed that when the weather was dry the wood was almost transparent to the waves, and they could be received without trouble. Second, when it rained, the wood behaved as a kind of screen and stopped the transmission. Third, if one then placed the transmitters outside the wood and the receiver in the wood, the transmission could not be carried on; while if the receiver was outside the wood the messages could be sent without difficulty. This is in accord with some observations recently made by Captain Terrie, in which rain generally diminished to a considerable extent the distance to which transmission was possible. I will conclude by saying that after a great deal of research, and, in spite of the statement of Mr. Nevil Maskelyne to the contrary, the absolute secrecy of dispatches by wireless telegraphy is possible if one takes certain precautions and does not require to signal over very great distances.—Thanking you for the use of your column, yours, etc., EMILE GUARINI.

MAGNETIC SURFACE-CONTACT SYSTEMS.

SIR,—The *Electrical Engineer's* issue dated May 24 contained a report, which we have only recently noticed, on the magnetic surface-contact system. These, and chiefly the Diatto system, are criticised by Mr. G. Paul in the same manner as he has already done in the French papers.

We have already answered once, but other more recent articles by the same author have convinced us that to endeavour to make Mr. Paul understand the Diatto system would mean a great loss of time. We can only apply to this gentleman the proverb, "*There are none so deaf as those who will not hear.*" We did not wish to enter into any discussion, but we should like to state the following facts:

1. The town of Tours has employed the Diatto system since May, 1898. At present extensions of some of the suburban lines are being completed. After five years of satisfactory working, the City Council of Tours specifies the Diatto system wherever trolley lines are objectionable.

2. The Diatto system has been erected on all the lines of Lorient since January, 1900.

3. The operation of the Diatto system has not been discontinued in Paris. Temporary trolley lines have been erected in one of the main streets in view of allowing greater facilities for the construction of the Metropolitan Underground Railway.

The occasional failures which happened in Paris were caused by badly-built tracks and by the very poor method of erecting the Diatto system on the roadway and on the cars. Most of the electric tramway lines were built in a great hurry, so that they might be completed for the Paris Exhibition in 1900, and it is therefore not to be wondered at if the erecting was rather faulty, even though we had to supervise this part of the work. But then, again, lack of time prevented any kind of supervision.

We also wish to state that the Diatto system has never caused any injury to pedestrians, either in Paris, Tours, or Lorient. These are facts

The city councils of the above towns—and especially that of Tours—would confirm the truthfulness of our statements.—Yours, etc., THE DIATTO COMPANY.

13, Rue Grolée, Lyons, France.

QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any questions should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

607. What is the best way to doctor small accumulators for electric ignition which have been over-discharged and become badly sulphated?—A. J. R.

608. An engine I have charge of is constantly breaking one or the other of the cross-head bolts. Can this be remedied? The cross-head has a double guide similar to the marine type. When the keep is screwed up tight there is about ¼in. clearance between cross-head and keep. After working a few days the bolts get loose and then break.—C. B.

ANSWERS.

Question No. 599.—Describe the electrical equipment necessary for a large 500-volt electric crane to lift, say, 50 tons, preferably a travelling crane, with special reference to the method of starting and controlling.

Answer to No. 599 (*awarded* 10*s.*).—The most advanced practice in overhead travellers is to use a separate reversing motor for each motion. In the case of a large 50-ton crane, it would be generally advisable to have two separate hoisting motors—one for raising the heavy loads at a slow speed and the other for quickly dealing with light loads. The following particulars will give an idea of the size of motors, etc., required for a 50-ton crane. A 50-ton crane recently installed was fitted with four series-wound motors. Main hoisting motor lifts 50 tons at the rate of 4ft. per minute, and takes 25 e.h.p. under full load; auxiliary hoisting motor lifts up to five tons at the rate of 15ft. per minute, and takes 12 e.h.p.; travelling motor takes 5 e.h.p., crane travelling 80ft. per minute. It is good practice to

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fix this motor in the centre of the bridge, so that each end starts at exactly the same instant. If the motor is fixed at one end, and the gearing is not carefully looked after, that end has a tendency to start first, and slightly twist the crane on the rails, causing an excessive starting current. Cross-traverse motor takes 7 e.h.p., and causes the crab to travel across the bridge at the rate of 40ft. per minute. The total electrical horse-power required at full load is 49. Having these particulars, the sizes of the cables and switches, etc, required can be worked out.

Both hoisting drums should be controlled by electric brakes (see Fig. 1). The electromagnets should be wound with copper tape of sufficient section to carry maximum current taken by the hoisting motors. The magnets are

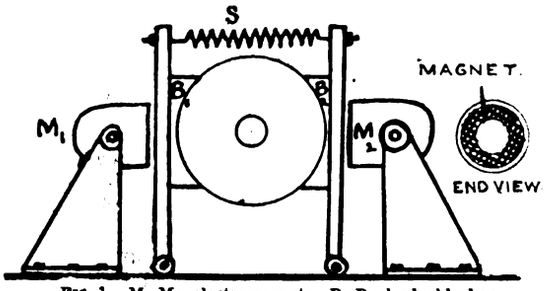

FIG. 1.—M_1 M_2, electromagnets; B_1 B_2, brake blocks; S, spring acting against magnets.

connected in series with the motors. Should the current fail from any cause the brake goes on immediately, and prevents the load falling. When the crane is set to lift or lower, the current taken by the motor passes through the magnets, and these pull the brake off immediately. If the load being lowered drives the motor too rapidly, the back E.M.F. of the motor reduces the current flowing in the circuit, and the brake goes on sufficiently to retard the speed. Fig. 2 is a sketch of the connections of a three-motor crane.

The usual practice in England is to operate the crane from a case suspended from one end of the crane girders where the man stands, switching the motors on or reversing them according to the signals he receives. Liquid starting

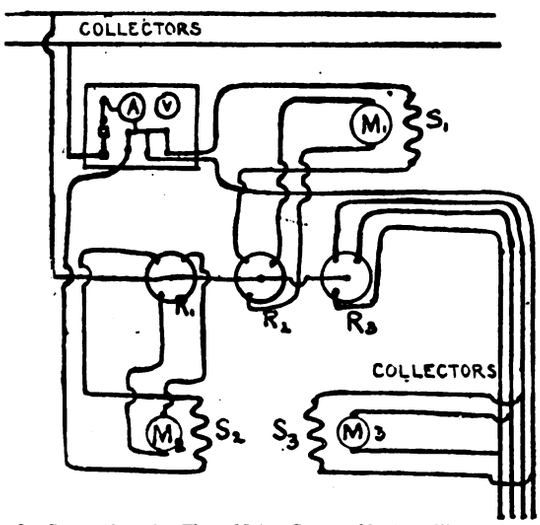

FIG. 2.—Connections for Three-Motor Crane. M_1, travelling motor; M_2, cross traverse motor; M_3, hoisting motor; S_1 S_2 S_3, series windings of motors; R_1 R_2 R_3, starting and reversing switches.

and reversing switches are very generally used. The objections to these are that the heat generated by the resistance causes the liquid (usually a solution of soda) to boil up and produces short-circuiting. Also the liquid gradually evaporates, making the solution stronger, and thus in starting up a greater strain is thrown on the motors.

On the Continent wire resistances (Fig. 3) are largely used for crane work, both for starting and regulating the speed of the motors, and a special feature is that nearly all the cranes are controlled from the ground. The frame carrying the resistance coils and switches is fixed to the centre of the crane girders, and chains hang down from the switches with labels attached to the handles to guide the person working the crane. With the wire resistances and a large number of contact points on the switch a wide range of control is obtained. The voltage mentioned is high for crane work, and special attention would have to

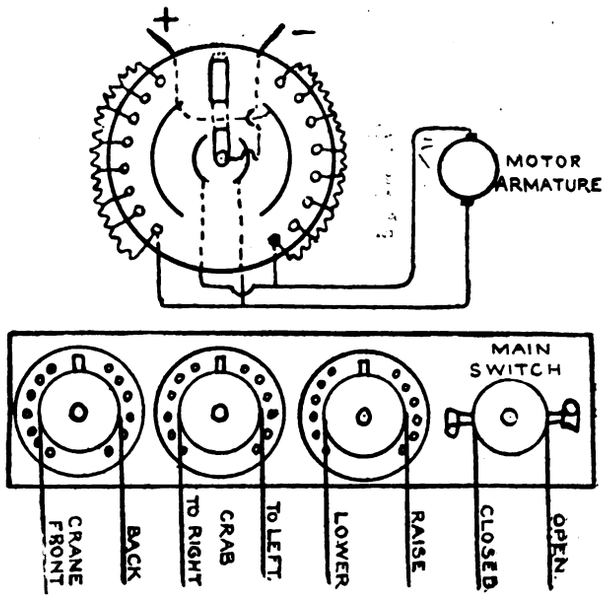

FIG. 3.—Details of Connections for starting and reversing switch.

be paid to the switches to avoid destructive sparking and also to the insulation. For collecting the current from the line and also for the hoisting motor, either trolley wheels could be used or a collector, as shown in Fig. 4, having a bearing surface of carbon, which allows copper conductor

FIG. 4.

to make excellent contact and has given much satisfaction in practice.—W. A. T.

Answer to No. 599 (*awarded* 10*s*).—The following is a description of a 50-ton 500-volt overhead travelling crane actually in use. The electrical equipment consists of three series-wound motors—one 10-h.p. for hoisting, one 5-h.p. for travelling, and one 5-h.p. for traversing. Each motor is controlled separately by the operator, who sits in a cage fixed at one end of the crane. The controllers are similar to an ordinary tramcar controller, but with the series notches only. A double-pole switch is also fixed in a convenient position in the cage within easy handling distance of the operator, for should anything go wrong with one of the controllers—suppose, say, that he could not switch the current off through a controller jamming—he could easily pull the main switch and thus avert an accident. A pair of trolley wires, + and −, are run the whole length of the engine-house. Fig. 1 shows the arrangement for fixing the trolley wire at each end. I is an insulator to which the trolley wire is fastened. B is a bracket fixed in a convenient position on the gantry along which the crane runs; the tension on the trolley wire can be adjusted by means of the nuts, $N N_1$. The trolley wires rest on insulators carried by brackets, spaced at suitable distances, along the whole length of the engine-house. These wires are fed by mains from some convenient source of current, and sweated on at one end. The current is taken from the trolley wires by means of a pair of shoes fixed to, but insulated from, the frame of the crane, and leads are taken from these shoes to the double-pole switch in the operator's cage.

As soon as the operator switches off the current, the crane motors are stopped by means of an electromagnetic friction brake. A sketch of this brake is shown in Fig. 2; from this its action will be easily understood. P is a pulley keyed on to the armature shaft. The parts shown shaded are wood blocks fixed to iron levers, L, which are pivoted at X. These levers form the armatures of the two electromagnets, I. G is a strong spring which, when no current is passing, holds the wood blocks tight on to the pulley, and thus brakes the motor. The electromagnets, I, are fixed on to, but magnetically insulated from, the cast-iron

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frame, F. The coils, C C, are in series with the motor armature. As soon as the current is switched on, the electromagnets, I I, draw away the levers, L L, thus releasing the pulley and allowing the armature to turn.

Fig. 3 is a diagram of connections from which the controlling arrangements will be easily seen. T and T_1 are the trolley wires running along the side of the engine-house; M is the double-pole main switch and fuse; C is a controller, only one out of the three being shown in the figure to economise space. C_1, C_2, etc, are bare copper

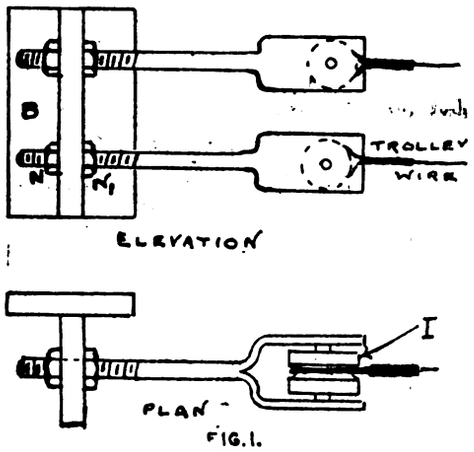

FIG. 1.

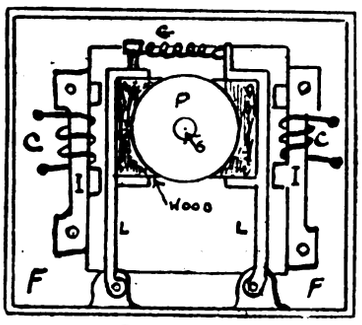

FIG. 2.

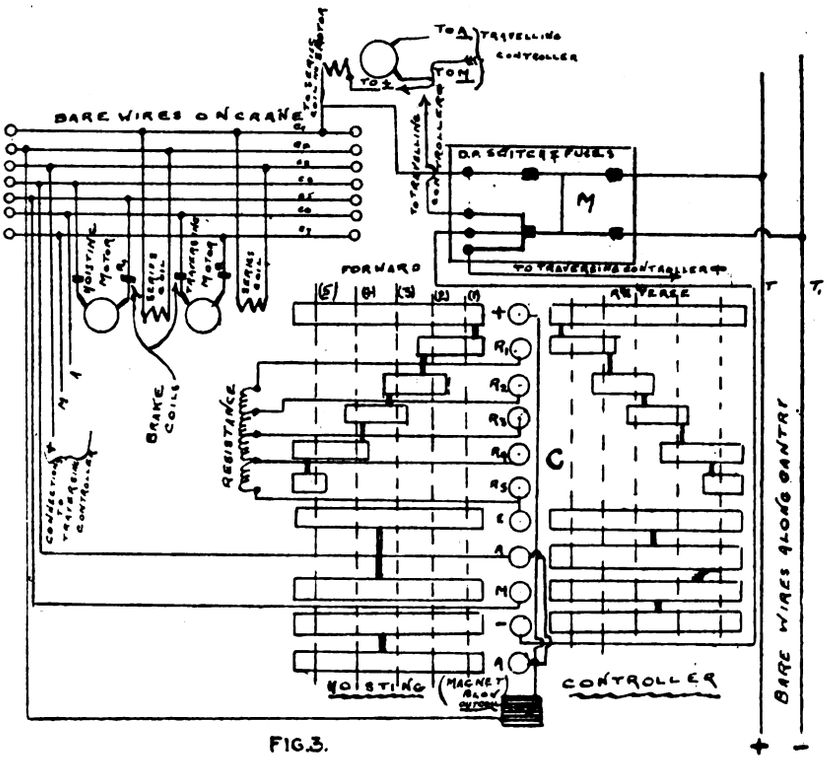

FIG. 3.

wires fixed on to insulators on the sides of the crane, enclosing the space where the ropes for hoisting and traversing pass. Current is taken from these wires by means of metal shoes, similar to those which take the current from the main trolley wires already referred to. Sliding contacts are here, of course, necessary, as the hoisting gear has to move from one end of the crane to the other. R R are the brake coils, and are in series with the armature of each motor. The letters A M refer to leads which go to similar terminals on the traversing and travelling controllers respectively. In conclusion, this crane has been in constant use for nearly two years without giving the slightest trouble.—C. N. V.

Answer to No. 599 (*awarded* 10*s.*).—One of the finest examples of electric travelling crane construction in this country is to be found in the Pinkston power station of the Glasgow Corporation tramways. In the main engine-house there are two travelling cranes, each of 50 tons capacity, while in the condensing-room there is another of 30 tons capacity, all being worked off the 500-volt circuit. These cranes were built by the Clayton Engineering and Electrical Construction Company, Limited, of Hyde, near Manchester, the leading particulars being given in the following table:

TABLE I.

	50 tons	30 tons.
Centres of runway rails	73ft. 0in.	38ft. 6in.
Centres of girders	11ft. 5in.	8ft. 10in.
Centres of cross-traverse runners	9ft. 10in.	8ft. 1in.
Longitudinal travelling speed in feet per minute	80ft.	100ft.
Cross-traverse speed in feet per minute	80ft.	100ft.
Hoisting speed in feet per minute	8ft.	10ft.
Hoisting motor	50 h.p., 350 r.p.m.	30 h.p., 475 r.p.m.
Motor for longitudinal travelling	25 h.p., 400 r.p.m.	15 h.p., 400 r.p.m.
Motor for cross-traverse travelling	25 h.p., 350 r.p.m.	15 h.p., 400 r.p.m.
Diameter of hoisting barrel	2ft. 11in.	2ft. 0½in.
Diameter of longitudinal runners	2ft. 9in.	1ft. 10in.
Diameter of cross-traverse runners	1ft. 6in.	1ft. 2in.
Head room required from top of rail	10ft. 2in.	6ft. 5in.

The hoisting and cross-traverse motors are contained in the crab, the necessary speed reduction being obtained by spur gearing. The longitudinal travelling motor is mounted alongside one of the main girders at the middle of the crane, and drives a cross-shaft through spur gearing. This shaft runs the whole length of the crane, and has at its ends pinions, by means of which the longitudinal runners are driven. The controlling switches and resistances are contained in a cage slung from one end of the crane, and from this point all the motions of the crane can be controlled. The controllers are of the standard type, being similar in appearance to those used for traction work, and the resistances are also of the traction type. The motors are totally enclosed, the horse-power being given in the above table. The hoisting and cross-traverse motors receive their current from two sets of trolley wires running the whole length of the crane and two trolleys on the crab. An automatic magnetic brake, similar to the standard type used for crane work, is supplied to the hoisting gear. It may be mentioned that these cranes, before being thoroughly finished off, lifted over 3,000 tons of material when the 5,000-h.p. main engines and generators were being erected at the before-mentioned power station.

Some very good examples of 50-ton travelling cranes are due to Messrs. Joseph Adamson, of Hyde, Cheshire, and Messrs. Vaughan and Son, of Manchester. An example of the former firm's construction is to be found in the steelfoundry of Messrs. Charles Cammel, of Sheffield. This crane is of 50 tons capacity, with a span of 62ft. The motor for longitudinal travelling is fixed in the centre of the crane at the side of one of the girders. This motor drives a cross-shaft, which drives the longitudinal runners. The speed for longitudinal travelling is 60ft. per minute, while that for cross-traversing is 40ft. per minute, and the full load is hoisted at 3ft. per minute. The various motions are controlled from a cage slung at one end of the crane, metallic resistances being used. The hoisting motor is fitted with an automatic brake applied to a brake pulley on the motor spindle. When the current is off, the brake blocks are kept in contact with the brake pulley by means of springs in duplicate. An electromagnet draws these blocks off as soon as the current is switched on.

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It may be of interest to give two examples of travelling cranes operated by polyphase current, to enable a comparison to be made with those given in Table I. In Table II. are given the leading particulars of a 40-ton and a 25-ton travelling crane. The former is operated by three-phase and the latter by two-phase current:

TABLE II.

	40-ton.	25-ton.
Centres of runway rails	62ft. 4in.	71ft. 3in.
Centres of cross-traverse runners	6ft.	5ft.
Longitudinal travelling speed in feet per minute.....	130ft.	100ft.
Cross-traverse speed in feet per minute.....	66ft.	100ft.
Hoisting speed in feet per minute	6ft.	{ 0-10 tons, 3ft. 10-25 tons, 12ft.
Hoisting motor	25 h.p., 550 volt	6 h.p., 730 r.p.m.
Motor for longitudinal travelling	25 h.p., 550 volt	9½ h.p., 730 r.p.m.
Motor for cross-traverse travelling	10 h.p., 550 volt	3 h.p., 730 r.p.m.
Diameter of hoisting barrel...	2ft. 5½in.	1ft. 4¾in.
Diameter of longitudinal runners	3ft.	2ft. 1in.
Diameter of cross-traverse runners	1ft. 6½in.	1ft. 4in.
Head room required from top of rail	14ft.	9ft. 3in.

The 40-ton crane is one spanning the foundry in the Vulcan Shipyard at Stettin, the crane being built by the Stückenholz Company and equipped by the Allgemeine Elektricitäts-Gesellschaft, Berlin. The motors are of the latter firm's standard three-phase type, and work at 550 volts, 50 periods. The hoisting and cross-traversing motors are mounted on the crab, while the motor for longitudinal travelling is mounted at the side of one of the girders at the centre of the crane, driving the runners by means of a cross-shaft and spur gearing. All the motors have the rotors provided with slip-rings and liquid resistances; the starting, reversing, and controlling switches being contained in a cage slung from one end of the crane. The hoisting motor works through worm gear, and two speeds are obtainable by a double clutch. The traversing motor is provided with an electrically-worked band brake, while the travelling motor has a foot-brake.

The 25-ton crane spans the main engine-house of the Midland Electric Power Corporation at Ocker Hill, Staffordshire, and was built by Messrs. Higginbottom and Mannoch, of Manchester, the electrical equipment being supplied by the Oerlikon Company. The motors are 200 volts, 50 periods, the rotors being provided with slip-rings. The various motions are controlled from a cage slung from one end of the crane. Each motion is regulated by means of a combined reversing and resistance switch, the resistances being "star" connected. They are adjusted to give the maximum slip between no load and full load. When hoisting empty a speed variation of 15 per cent. can be obtained by the resistance, while for travelling light the speed can be varied about 40 per cent. Automatic electric brakes are fitted to all three motors.

A few words may be said about controllers and resistances. The liquid type of resistance is used by some Continental crane builders, but this type, in the writer's opinion, is entirely unsuitable for crane work. The advantages due to simplicity in connections and operations are entirely displaced by the disadvantages due to maintenance, renewals, etc. With continuous-current series motors, which are now practically "standard" for crane work, controllers which are practically the same as those used for traction purposes give the best results, and should always be employed. In order to simplify the handling of these, the controllers operating the hoisting and cross-traverse motors respectively may with advantage be connected in such a way that one handle will command both motions. The Union Electricitäts-Gesellschaft, of Berlin, and Messrs. Lahmeyer have a very neat arrangement of this kind. By a universal joint one handle operates two ratchet wheels, each of which works a pinion connected to the controller spindle. The handle in its normal "off" position is vertical; when moved forwards and downwards, it means *lowering*; when moved backwards, *lifting*; when moved to the right, *traversing to the right*; and to the left, *traversing to the left*. Lifting and traversing can proceed simultaneously by moving the handle in a diagonal direction. The resistances should be of the "traction" type to give the best results. This may be of the "grid" or "strip" variety, each kind being absolutely fireproof. The motors, too, should be of the totally enclosed type, those similar to traction motors being preferable, on account of the facilities offered by this type for inspection. Traction motors are always to be preferred on cranes which are subject to severe working conditions, as this type has been thoroughly standardised to meet the severe conditions required in traction work. By adopting this type for the motors, and the "traction" type of controllers and resistances, breakdowns will be of rare occurrence.—A. D.

Answer to No. 599 (*awarded* 5*s.*).—The crane, the electrical equipment of which is here described, is a three-motor travelling crane. All controlling apparatus is confined to a small cab, suspended from the crane, in which the driver sits. Fig. 1 is a sketch of one of the starters.

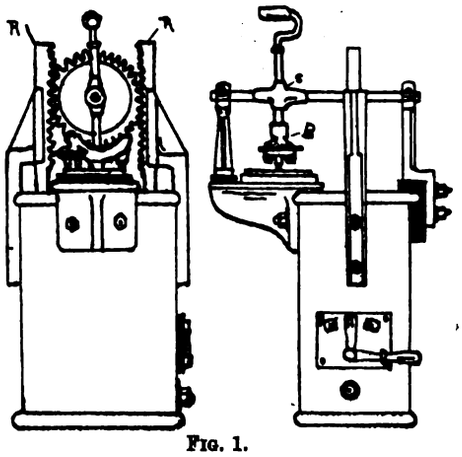

FIG. 1.

They are liquid resistances, the liquid being a solution of caustic soda, and the reversing arrangements are over each tank. Referring to the sketch, two bearings (one not shown in left-hand view) support a spindle on which is fastened a spur-wheel and a special sleeve, S. The wheel engages with two rack rods, at the bottoms of which are the wrought-iron electrodes or "dippers." The sleeve is keyed on to the shaft, but is not fastened on to the vertical handle spindle. This spindle can turn freely except for a square end at the bottom, which slides in the bridge, B. On this bridge three brass plunger contacts are secured, one connected to the bridge electrically, the other two connected together but insulated from the rest. The bridge can turn and the plungers move over contacts arranged on a slate base as shown in A, Fig. 2. Because of

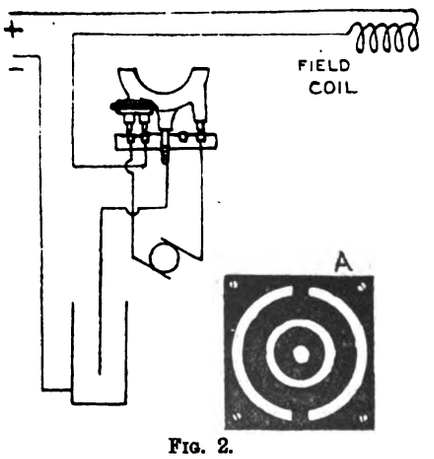

FIG. 2.

the construction of this switch the bridge can only be turned when its axis is in line with the handle spindle—that is, when the latter is vertical. Thus the contact is made on the switch before the dippers can descend; also, on breaking the circuit, the current is cut off at the surface of the liquid before the switch can be put in the "off" or "reverse" position. This arrangement is well adapted for high-voltage work, doing away, as it does,

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with burnt contacts. Along the bottom of each tank is a contact bar with spring clips on. When the dippers descend they are pushed into the clips, and thus make a good connection.

The current is supplied to the crane by two single bare No. 4 gauge wires stretched the full length of the shop just below one rail and resting on wide insulators placed at intervals. When the crane comes along, these wires are picked up by brass collectors, and the current is taken to a double-pole automatic cut-out, from which it goes to each motor and starter. For the long traverse a 9-h.p motor is used, and is capable of attaining a speed of 100ft. per minute along the track with full load on. The con-

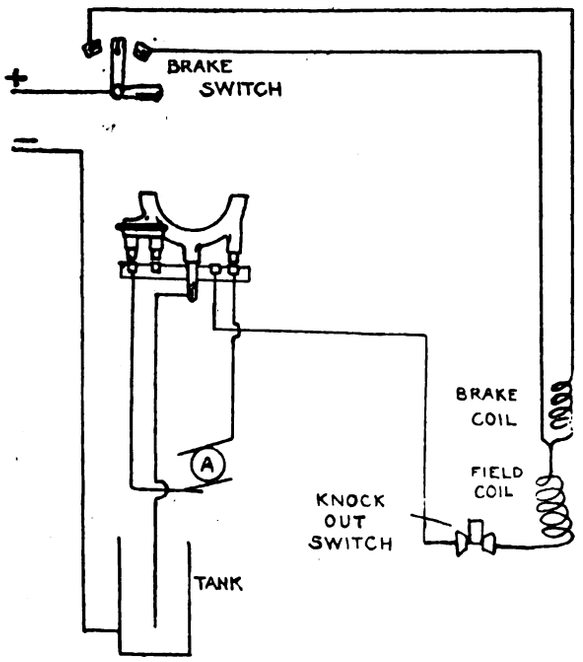

FIG. 3.

nections for this motor are given in Fig. 2. This motor, as are also the other two, is series wound. A $^{19}/_{21}$ cable comes from the main through the field coil to the inside ring of the reversing switch. From this ring the current flows through the plungers to either of the outside half rings. These semi-circular pieces are each connected to one side of the armature, and the single plunger makes the connection for armature return. As will be seen from the sketch, the connection is taken from the central spindle to the dippers, through the contact bar, and back to the negative main. The cross-traverse motor is 4 h.p., and can move the crab at a speed of 50ft. per minute. The connections for this motor are the same as in Fig. 2, but the two field and two armature leads are bare, and stretched across the crane. The crab is fitted with four collectors, to pick up the current as it moves backward and forward. Fig. 3 gives the connections for the 12-h.p. hoist motor. This motor will raise the full load at the rate of about 3ft. per minute.

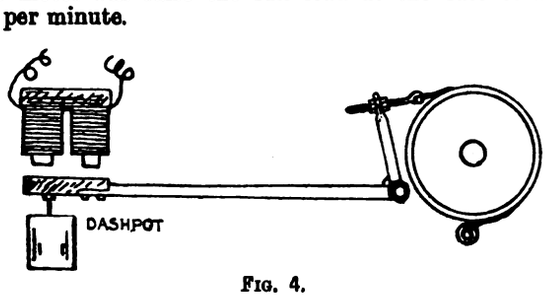

FIG. 4.

To prevent the load falling when the current is switched off, a magnetic brake is used. The current which goes through the motor excites the magnet, shown in Fig. 4, attracts the keeper, and so holds a steel strap off the grooved wheel. As soon as the current is switched off, however, the weight of the keeper applies the brake. To work with this arrangement, the brake switch, which is for convenience on the front of the hoist tank, must be on the left contact. When lowering work into a lathe, etc., it is necessary that care be taken, and so the switch is put on the right-hand side, thus leaving the brake on all the time and using power to lower. This allows of more exactness, and the brake, to prevent jerks, is fitted with a dashpot. It must be noted that five wires are needed for this motor—two for the armature, two for the field, and an extra one for the brake. These are also bare, and stretched across for collectors to work on. In order that the driver may not raise the bottom block too high, a knock-out switch is put in circuit, and is worked by gearing from the winding drum spindle, as in Fig. 5. This is so set that when the blocks get dangerously near together, a projecting stud on the larger wheel hits the lower end of the switch arm, and knocking it out, breaks the circuit.

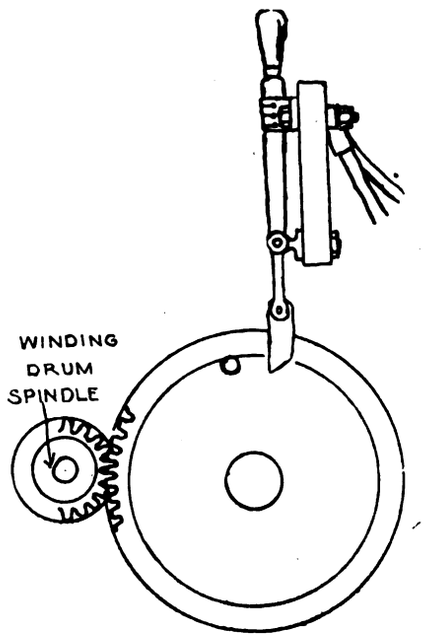

FIG. 5.

The chief danger to be on the look out for in this type of crane is the insulation of tank fittings. If they are not well looked after they soon cause trouble, due to the vapour rising from the liquid.—P. D.

Question No. 600.—Distributors run along a main road, and a consumer's residence is situated 180 to 190 yards up a side road, which is a public bridle path and footway. Is it legal to charge the consumer for the whole cost of such main, or would he come under the Board of Trade minimum charge clause of the provisional order—*i.e.*, "to pay in the aggregate for a supply of energy for three years a sum not exceeding 20 per cent. upon the cost of laying such distributor to the nearest available source of supply"?

Best Answer to No. 600 (*awarded* 10*s.*).—It would be illegal to charge the consumer mentioned by "H. F." with the whole cost of such main, yet he comes under the Board of Trade minimum charge clause. The cost of the extension comes under the following clause: "The cost of so much of any electric line for the supply of energy to any owner or occupier as may be laid upon the property of such owner or in the possession of such occupier, and of so much of any such electric lines as it may be necessary to lay for a greater distance than 60ft. from any distributing main of the undertakers, although not on such property, shall, if the undertakers so require, be defrayed by such owner or occupier." So that the consumer should be charged for so much of the cost of the extension that is a greater distance than 60ft. from the undertaker's distributing mains.

It will be seen that the cost of the extension is not paid for by the consumer under the Board of Trade minimum charge clause, yet it is directly connected with the cost of the extension, or, to speak correctly, with the capital outlay. The undertakers can compel by their provisional order, if they desire, *any* consumer to enter into an agreement to pay a sum not exceeding 20 per cent. for three years upon the cost of laying such distributor, whether it is an extension or whether the supply is taken from existing mains. The payment is meant as a security for interest, binding the consumer to pay for so much energy in advance

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in return for the capital outlay. It would be quite legal for the undertakers in question to compel the consumer to pay under this clause for the 60ft. of main which has to be laid by the undertakers.

I have only heard of the minimum charge being carried into effect in one or two cases. There are one or two London companies that insert in their conditions of supply the following: "In any event the consumer undertakes to pay for a minimum charge for electricity supplied a sum of £3 per annum, and also to pay for the service line from the company's mains."—J. W. W.

Answer to No. 600 (*awarded* 5*s.*).—It would seem from the facts stated that the corporation or the undertakers supplying current are not legally bound to supply this consumer with current, as he is such a distance from the nearest distributing main. If the consumer is only likely to require a small amount of current, it would probably not pay for either the consumer or the undertakers to pay for the main in question. If there are other persons on the route that are likely to require current in the future, some arrangement might be made for each to contribute a portion of the cost of the main. Section 27 of the schedule of the Electric Lighting Clauses Act, 1899, provides that undertakers shall, upon being required to do so by the occupier of any premises situate within 50 yards from any distributing main of the undertakers in which for the time being they are required to maintain a supply of energy for the purposes of general supply to private consumers under the special order of the Board of Trade regulations, give and continue to give a supply of energy for those premises in accordance with the provisions of the special order and of the said regulations, and they shall furnish and lay any electric lines that may be necessary for the purpose of supplying the maximum power with which any such occupier is entitled to be supplied under the special order, etc. A consumer that is 180 to 190 yards away is therefore not legally required to be supplied with current. But if the undertakers desire to supply the consumer with current, and the consumer is prepared to pay his legal share of the cost of the main, then the undertakers may call upon the consumer to defray the cost of so much of any electric wire which may have to be laid on his premises, and of so much of any electric lines as it may be necessary to lay for a greater distance than 60ft. from any distributing main of the undertakers. The consumer can thus be legally charged for 160 to 170 yards of the necessary main.—W. A. T.

LONDON TRAFFIC ENQUIRY.

Members of the Royal Commission, which is enquiring into the subject of locomotion in London generally, on Friday last journeyed in motorcars through the Metropolis and several suburban districts, in order to gather a more practical knowledge of the areas over which their enquiry extends. The trip was made at the invitation of the Automobile Club, who took this novel form of offering evidence before the Commission. The districts traversed included all the more representative thoroughfares in London, and with the assistance of officials of the club the Commissioners were able to gain much valuable information which will help them in their labours. The Commission has now risen for the summer vacation, but we understand that several of the members will shortly start on a visit to the States in order to examine and enquire into the transport facilities provided in some of the chief American cities.

APPOINTMENTS VACANT.

Chief Assistant Engineer, Ipswich, salary to commence at £160 per annum. See advertisement.

Three Charge Engineers, Ipswich, salary to commence at £90 per annum. See advertisement.

Two Switchboard Attendants, Ipswich, salary to commence at £60 per annum. See advertisement.

Instructor in Mathematics, Governing Body of the Northampton Institute, Aug. 24. Advertisement in last issue.

Assistant Engineer (temporary), London County Council, £4 to £5 per week (according to qualifications), 12th inst.

Electrical and Mechanical Draughtsman, Stalybridge, knowledge of central-station work. See advertisement.

Mains Superintendent. See advertisement.

DUDLEY ELECTRICITY UNDERTAKING.

Below we give abstracts of the accounts of the above undertaking for the year ended March 31 last, the capital expenditure on which date amounted to £67,392:

REVENUE ACCOUNT.

Expenditure.	£	s.	d.
Coal	2,072	5	8
Oil, engine-room stores, etc.	534	7	11
Wages at generating station	566	12	7
Repairs and maintenance of machinery, etc.	156	13	7
Repairs and renewals of mains	5	18	8
Repairs and renewals of meters	22	5	0
Public lamps—attending, etc.	137	12	7
Rent, rates, and taxes	353	17	11
Management expenses	511	4	1
Insurances	48	19	11
	4,409	17	11
Balance, gross profit carried to net revenue account	4,519	3	3
	£8,929	1	2

Income.	£	s.	d.
Sale of current per meter	7,781	3	3
Public lighting	649	10	11
Rent of motors	3	12	11
Sale and repair of lamps, etc.	34	16	7
Testing fees	1	1	0
Miscellaneous	458	16	6
	£8,929	1	2

BALANCE SHEET.

Liabilities.	£	s.	d.
Capital account—mortgage loans (£63,500), less repayments (£2,701. 6s. 2d.)	60,798	13	10
Sundry creditors	4,887	19	10
Surplus—loans repaid	2,701	6	2
Revenue Account—Sundry creditors	1,099	13	1
Interest on loans accrued	281	2	10
Cash balance due to treasurer	339	7	5
Net revenue account: balance—profit year ended March 31, 1903 (£1,186. 14s. 10d.), less loss to March, 31, 1902 (£390. 8s. 5d.)	796	6	5
	£70,904	9	7

Assets.	£	s.	d.
Capital account—capital expenditure (including cost of loans)	67,392	17	5
Cash balance	995	2	5
Revenue Account—Sundry debtors	2,289	14	0
Other debtors	4	3	6
Stores on hand	222	12	3
	£70,904	9	7

HAMPSTEAD ELECTRICITY ACCOUNTS.

Appended is an abstract of the electric light fund revenue account of the borough of Hampstead for the year ended March 31 last.

Dr. Expenditure.	£	s.	d.
Coal, etc.	11,802	0	2
Oil, waste, and engine-room stores	394	13	4
Wages at generating station	2,520	16	8
Water	600	11	0
Repairs and maintenance of buildings and plant	963	13	5
Repairs and maintenance of mains	801	12	0
Transformers, meters, switches, etc.	200	16	10
Loss on sale of old meters	266	7	11
Apparatus at distributing stations	106	9	4
Loss on sale of small transformers	453	10	0
Tests and certification of meters	187	5	2
Public lamps—repairs and renewals	586	9	3
General rate	3,211	13	4
Income tax on profits	40	2	3
Salaries of engineers, etc.	1,712	0	8
Salaries of meter readers	328	3	10
Printing, stationery, and advertising	202	1	3
General establishment charges	88	11	10
Transferred to general fund	730	9	1
Other charges	336	8	0
	25,533	15	3
Balance carried to net revenue account	22,011	1	6
	£47,544	16	9

Cr. Income.	£	s.	d.
Sale of current and meter rents	44,489	14	5
Sale of current—public lighting	2,827	15	8
Miscellaneous	220	14	3
Bonus return on fire insurance premium	6	12	5
	£47,544	16	9

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LEYTON ELECTRIC LIGHTING ACCOUNTS.

The accounts of the above undertaking for the year ended March 31 last show that the amount expended on capital account was £126,455. 8s. 11d. Below are given abstracts of the revenue account and general balance-sheet, together with statement of electricity generated, sold, etc.

REVENUE ACCOUNT.

Dr. Expenditure.	£	s.	d.
Coal or other fuel	2,554	9	6
Oil, waste, engine-room stores, etc.	232	16	4
Proportion of engineers' salaries	420	11	3
Wages at generating station	632	8	11
Repairs and maintenance of generating plant, etc.	435	11	11
Repairs and maintenance of mains	194	18	10
Meters, switches, fuses, etc.	45	3	1
Attending and repairs to public lamps	606	8	10
Renewal of lamps	170	0	4
Rents, rates, and taxes	463	18	11
Management expenses—salaries, etc.	1,233	1	5
Law expenses	102	6	3
Special charges—Insurances, etc.	103	0	4
Self-insurance against engine and dynamo breakdown	80	0	0
Interest on deposits	13	19	9
	7,288	15	8
Amount carried to net revenue account	7,795	16	7
	£15,084	12	3

Cr. Income.	£	s.	d.
Sale of current by meter and for public lighting, less bad debts	14,586	9	0
Rental of meters	326	19	4
Rents receivable	10	10	6
Profit on installation work and repairs	160	13	5
	£15,084	12	3

Dr. GENERAL BALANCE SHEET.	£	s.	d.
Capital account	125,678	0	0
Sundry creditors	3,042	16	10
Amount due to treasurer (less cash in hand)	10,969	7	10
Self-insurance fund	291	0	0
Consumers' deposits	479	13	0
Amount realised from sale of gas plant	727	5	6
	£141 188	3	2

Cr.	£	s.	d.
Capital account	126,455	8	11
Stores on hand	180	12	8
Sundry debtors for current	4,519	10	11
Sundry debtors for work done	213	3	9
Net revenue account	9,819	6	11
	£141,188	3	2

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T. units		1,222,711
Quantity sold { Public lamps	320,579	1,005,044
Quantity sold { Private consumers by meter	684,465	
Quantity used on works		66,543
Total quantity accounted for		1,071,587
Quantity not accounted for		151,124
Total maximum supply demanded (kilowatts)		778·8

Number of public lamps: 529 incandescents, 72 arcs.

ST. ANNES-ON-SEA ELECTRICITY ACCOUNTS.

The accounts of the above undertaking for the year ended March 31 last show that the capital expenditure on that day amounted to £25,382. We give below abstracts of revenue account and general balance-sheet, together with statement of electricity generated, sold, etc.

Dr. REVENUE ACCOUNT.	£	s.	d.
Coal or other fuel, etc.	301	0	3
Oil, engine-room stores, etc.	76	11	6
Wages at generating stations	59	8	11
Repairs and maintenance of generating plant, etc.	254	16	0
Wages to linesmen, etc.	26	5	7
Repairs and maintenance	4	12	9
Repairs, renewals of transformers, etc.	3	3	4
Attending and repairs to public lamps	92	8	1
Renewal of lamps	25	5	3
Rents payable	21	0	0
Rates and taxes	88	12	1
Management expenses—salaries, etc.	374	2	1
Special charges—insurances, etc.	12	0	0
Total expenditure	1,339	5	10
Discounts and bad debts	76	10	11
	1,415	16	9
Amount carried to net revenue account	1,519	8	5
	£2,935	5	2

Cr.	£	s.	d.
Sale of current per meter	1,541	14	0
Public lighting	1,324	15	2
Rental of meters, etc.	61	18	7
Sale and repair of lamps	4	9	3
Sundry receipts	2	8	2
	£2,935	5	2

GENERAL BALANCE-SHEET.

Dr. Liabilities.	£	s.	d.
Capital account	25,382	0	0
Sundry creditors	501	1	11
Net revenue account—balance at credit thereof	107	5	9
	£25,990	7	8

Cr. Assets.	£	s.	d.
Capital account	24,300	6	10
Stores on hand	274	11	5
Sundry debtors for current	1,055	5	4
Cash	360	4	1
	£25,990	7	8

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T. units		179,190
Quantity sold { Public lamps	71,791	155,555
Quantity sold { Private consumers by meter	83,764	
Quantity used on works		5,240
Total quantity accounted for		160,795
Quantity not accounted for		18,395
Total maximum supply demanded (kilowatts)		126

Number of public lamps: 32 arc lamps; 154 incandescent lamps.

WEST HAM TRAMWAYS AND THE GAS COMPANY.

The following is the award of the Hon. Alfred Lyttleton, M.P., in the important arbitration between the West Ham Corporation and the West Ham Gas Company with regard to what extent, if any, the Corporation should be called upon to remove the gas-mains consequent on the construction of the electric tramways at West Ham:

Whereas, by the West Ham Corporation Act, 1900, the West Ham Corporation were authorised and empowered to construct and maintain the tramways therein described within the borough of West Ham, and are the promoters of such tramways within the meaning of the Tramways Act, 1870. And whereas, by Section 30 of the Tramways Act, 1870, it is enacted that for the purpose of making, forming, laying down, maintaining, repairing, or renewing any of their tramways, the promoters may from time to time where and so far as it is necessary or may appear expedient for the purpose of preventing frequent interruptions of the traffic by repairs or works in connection with the same, alter the position of any mains or pipes for the supply of gas or water, or any tube, wire, or apparatus for telegraphic or other purposes, subject to the provisions of that Act, and also subject to the following, among other restrictions, that is to say, before laying down a tramway in a road in which any mains or pipes, tubes, wires, or apparatus may be laid, the promoters shall, whether they contemplate altering the positions of any such mains or pipes, wires, or apparatus or not, give seven days' notice to the company, persons, or person, to whom such mains or pipes, wires, or apparatus may belong, or by whom they are controlled, of their intention to lay down or alter the tramway, and shall at the same time deliver a plan and section of the proposed work. And whereas if it should appear to any such company or person that the construction of the tramway as proposed would endanger any such main or pipe, tube, or apparatus, or interfere with or impede the supply of water or gas, or the telegraphic or other communication, such company or person (as the case may be) may give notice to the promoters to lower or otherwise alter the position of the said mains or pipes, tubes, wires, or apparatus in such manner as may be considered necessary, and any difference as to the necessity of any such lowering or alteration shall be settled in manner provided by that Act for the settlement of differences between the promoters and other companies or persons, and all alterations to be made under the said section shall be made with as little detriment and inconvenience to the company or person to whom such mains or pipes, or tubes, wires, or apparatus may belong, or by whom the same are controlled, or to the inhabitants of the district, as the circumstances will admit, and under the superintendence of such company or person, or of their surveyor or engineer, if they or he think fit to attend, after receiving not less than 48 hours' notice for that purpose, which notice the promoters are hereby required to give. And whereas by Section 33 of the Tramways Act, 1870, it is, amongst other things, enacted that if any difference arises between the promoters or lessees on the one hand and any gas company on the other hand with respect to any interference or control exercised or claimed to be exercised by them or on their behalf, or by the promoters or lessees by virtue of that Act in relation to any tramway or work, or in relation to any work or proceedings of the company, or with respect to the propriety of or the mode of execution of any work relating to any tramway, or on the question whether any work is such as ought reasonably to satisfy the company concerned, or with respect to any other subject or thing regulated by or comprised in that Act, the matter in difference shall (unless otherwise specially provided by that Act) be settled by an engineer or other fit person nominated as referee by the Board of Trade on the application of either party, and the expense of the reference shall be borne and paid

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as the referee directs. And whereas the West Ham Gas Company (being a company within the meaning of the said Sections 30 and 33 of the Tramways Act, 1870) has caused to be served on the said Corporation of West Ham a notice, under Section 30 of the said Act, requiring the said Corporation to execute certain alterations and works, and to lower certain mains and pipes. And whereas a difference as to the necessity of such lowering or alteration has arisen between the said parties. And whereas by an agreement in writing dated the 25th day of April, 1903, expressed to be made between the said Corporation of the one part and the said gas company of the other part, reciting that the said parties had applied to the Board of Trade to nominate a fit and proper person as referee to settle such differences, and that the Board of Trade in exercise of their said powers had nominated and appointed me, the Hon. Alfred Lyttleton, K.C., as referee to settle the matters in difference between the said parties, it was agreed between the parties thereto that it be referred to me, the Hon. Alfred Lyttleton, K.C., to award and determine:

1. Whether the Corporation under the provisions of Section 30 of the Tramways Act, 1870, or any other section of the said Act, ought to be required before laying down the tramways shown on the plans delivered by them to the company as aforesaid, to execute all, or some, or any of the alterations to the mains, pipes, tubes, or apparatus of the company, in the manner the company consider necessary as hereinbefore recited.
2. Whether the Corporation under the provisions of the said section, or any other section of the Tramways Act, ought to be required as aforesaid to execute any alterations to the mains, pipes, tubes, or apparatus of the company, other than or differing from the alterations to the mains, pipes, tubes, or apparatus of the company, in the manner the company consider necessary as hereinbefore recited.

Now I, the said referee, having taken upon myself the burthen of the said reference, and having heard and weighed the evidence, and having in particular considered the provisions of Section 32* of the said Tramways Act, 1870, do make and publish my award in writing of and concerning the premises. That is to say:

I award and adjudge that the Corporation ought not to be required before laying down the tramways shown on the plans delivered by them to the company as aforesaid to execute all, or some, or any of the alterations to the mains, pipes, tubes, or apparatus of the company, in the manner the company consider necessary as hereinbefore recited. And that the said Corporation ought not to be required to execute any alterations to the mains, pipes, tubes, or apparatus of the company, other than or differing from the alterations to the mains, pipes, tubes, or apparatus of the company, in the manner the company consider necessary.

And I further award and direct that the said West Ham Gas Company do pay to the said Corporation of West Ham their costs of the reference, and the costs of this my award, and that in case the said West Ham Corporation shall pay such last-mentioned costs, I award that the West Ham Gas Company do repay to the said Corporation the amount which they shall so pay.

In witness my hand this 13th day of July, one thousand nine hundred and three.

(Signed) ALFRED LYTTLETON.

* The following are the provisions of Section 32 of the Tramways Act referred to in the award:

32. *Rights of Authorities and Companies, etc., to Open Roads.*—Nothing in this Act shall take away or abridge any power to open or break up any road along or across which any tramway is laid, or any other power vested in any local authority or road authority for any of the purposes for which such authority is respectively constituted, or in any company, body, or person for the purpose of laying down, repairing, altering, or removing any pipe for the supply of gas or water, or any tubes, wires, or apparatus for telegraphic or other purposes, but in the exercise of such power every such local authority, road authority, company, body, or person, shall be subject to the following restrictions, that is to say: (1) They shall cause as little detriment or inconvenience to the promoters and lessees as circumstances admit. (2) Before they commence any work whereby the traffic on the tramway will be interrupted they shall (except in cases of urgency, in which cases no notice shall be necessary) give to the promoters and lessees, if there be any, notice of their intention to commence such work, specifying the time at which they will begin to do so, such notice to be given 18 hours at least before the commencement of the work. (3) They shall not be liable to pay to the promoters or lessees any compensation for injury done to the tramway by the execution of such work, or for the loss of traffic occasioned thereby, or for the reasonable exercise of the powers so vested in them as aforesaid. (4) Whenever for the purpose of enabling them to execute such work the local authority or the road authority shall so require, the promoters or lessees shall either stop traffic on the tramway to which the notice shall refer, where it would otherwise interfere with such work, or shore up and secure the same at their own risk and cost during the execution of the work there: Provided that such work shall always be completed by the local authority or the road authority, as the case may be, with all reasonable expedition. (5) Any company, body, or person shall not execute such work so far as it immediately affects the tramway except under the superintendence of the promoters, unless they refuse or neglect to give such superintendence at the time specified in the notice for the commencement of the work, or discontinue the same during the progress of the work; and they shall execute such work at their own expense, and to the reasonable satisfaction of the promoters: Provided that any additional expense imposed upon them by reason of the existence of the tramway in any road or place where any such mains, pipes, tubes, wires, or apparatus shall have been laid before the construction of such tramway shall be borne by the promoters.

LEGAL INTELLIGENCE.

A BRADFORD TRAM ACCIDENT.

In the Nisi Prius Court at Bradford on Friday, before Mr. Justice Grantham, an action arising out of an accident on the Bradford electric tramway system last September was heard with a special jury. The plaintiff was Mr. Joseph Drake, a commercial traveller, and the Mayor and Corporation of Bradford were the defendants, the claim being for £2,000 as damages. A sum of £500 was paid into court.

It appeared that on Sept. 1 last the plaintiff boarded one of the Bradford cars having its terminus in the City-square. At the corner of Harris street the car, it was stated for the plaintiff, was run at full speed instead of slowing down, with the result that the trolley pole came off the overhead wire, and became entangled with the overhead ducts. This broke the wire, which fell and brought the car to a standstill. The plaintiff was sitting close to the trolley pole, and received a violent shock. The peculiar feature of the case, said Mr. Macaskie for the plaintiff, was that there was no blow or impact from the pole or wire, the injury done to the plaintiff's constitution being entirely due to shock. The plaintiff had in consequence to give up business, and had to incur considerable sums in doctors' fees and enforced holidays at the seaside.

Evidence was called both for the plaintiff and defendants, and

His Lordship, in summing up, said everything pointed to the fact that the plaintiff was affected in some extraordinary way by the electric current. If the shock was the primary cause of his illness, he was entitled to recover, even if his health at the time of the accident was not so good as it might be. It was remarkable that the defendants had themselves given practically no explanation of the cause of the accident. It was an accident, and a bad one. It was very strange that they could not help them in the matter. The only tangible cause they could suggest was excessive speed.

The jury, after 15 minutes' deliberation, returned a verdict for the plaintiff for £450.

His Lordship: That will be a verdict for the defendants, for the Corporation have already offered £500.

Mr. Waugh addressed the Court on the question of costs, and the argument was adjourned.

ELECTRIC TRAMWAYS CONSTRUCTION AND MAINTENANCE COMPANY.

Before Mr. Justice Swinfen Eady, in the Chancery Division on Friday, in the action of the National Electric Traction Company *v.* the Electric Tramways Construction and Maintenance Company, Limited, **Mr. Deane**, for the plaintiff company, applied that his Lordship would continue the appointment of a receiver of the defendant company until judgment or further order.

Mr. Ashton Cross appeared for the defendant company, and stated there was a petition by a creditor for the winding-up of the company which came before Mr. Justice Bryne, and was standing over pending an arrangement being come to by which all the creditors would be satisfied.

After some discussion, **His Lordship** continued the receiver until the trial.

COMPANIES' MEETINGS AND REPORTS.

GREAT NORTHERN AND CITY RAILWAY.

The half-yearly meeting of the shareholders in this Company was held at the Westminster Palace Hotel on Tuesday, Sir Charles Scotter presiding.

The **Chairman** said, with regard to the construction of the railway, that the main line between Moorgate-street and Drayton-park was now almost completed. The generating station and the whole of the machinery were finished and ready to begin working. In addition, the greater part of the rolling-stock had been delivered, so that matters were in a forward state in view of the time when the contractors would be able to invite the Board of Trade inspector to make his official examination of the undertaking. Considerable progress had been made with the extension from Drayton-park to Finsbury Park. There was no reason why the work should not be completed within a short period. Before the next half-yearly meeting he believed that the line between Moorgate-street and Finsbury Park would be practically open for traffic. The extension to the Bank at Lothbury—a very important part of the system—would not be completed by then, but it was not intended to delay the opening of the main line on that account. Directly the railway was finished from the City to Finsbury Park, where the station was being built under the Great Northern Company's line at that place, it would be opened for traffic, and the directors had good grounds for hoping that its opening would be attended with success. The Board looked on the Finsbury Park extension and the extension to the Bank as most important factors in connection with the success of the railway; and, although they expected a heavy traffic to Moorgate-street, they felt certain that it would be largely increased so soon as they were able to carry passengers from Finsbury Park to the Bank. He concluded by moving the adoption of the report.

The **Earl of Lauderdale** seconded, and the motion was agreed to.

An extraordinary general meeting was afterwards held for the purpose of considering resolutions with regard to the creation and issue of £450,000 additional capital in the form of preference shares or stock, and £150,000 debenture stock.

Lord Lauderdale seconded the resolutions, and they were unanimously passed.

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CENTRAL LONDON RAILWAY.

On Wednesday the ordinary general meeting of the shareholders in this Company was held at the Holborn Restaurant under the presidency of Sir Henry Oakley.

The report of the directors for the half-year ended June 30 last stated that the amount expended on capital account during the half-year has been £84,373. Receipts from all sources of revenue amount to £187,235 and working expenses to £94,350, leaving a balance of £92,885 carried to the net revenue account. There is again a large increase in the amount paid for rates and taxes, the outlay under this head being now equal to 15 per cent. of the net receipts. The number of passengers carried was 23,179,138, an increase of 299,804. After providing for interest on the debenture stock and special expenses, amounting to £1,947, attending the vibration enquiry, the net revenue account shows a balance of £102,406, including £27,717 brought forward from last half year. The directors recommended a dividend on the undivided ordinary stock at the rate of 4 per cent. per annum, and on the preferred ordinary stock at the rate of 4 per cent. per annum. After putting aside £10,425 for the proportion applicable to the deferred stock—the dividend on which is not payable until the result of the year's working has been ascertained—there remains an unappropriated balance of £45,406. The Board deem it prudent to defer any appropriation of this balance. The whole of the trains on this Company's railway are now satisfactorily worked by motorcars on the multiple-unit system. It is anticipated that this new and improved service will enable the Company to give better accommodation to the public, and that, with further experience, material economy in working will result. To enable the lifts to be worked independently of the main railway electric service, a new sub-station is in course of construction at Bond-street Station. The large fan at Shepherd's Bush for the ventilation of the tunnels has been erected and tested, and will, as soon as possible, be regularly worked.

The **Chairman**, in submitting the above report, referred to the change over from locomotives to the multiple-unit system, in order to carry into effect the recommendations of the commission which enquired into the question of vibration. The Company had had 68 of these new motor-carriages at work for some time with remarkable success. By this method of working a saving had been made in the cost of coal, and there had been greater facility in the dispatch of trains at either end of the line, no time being lost, as was formerly the case, in changing engines. So far as it had been possible to test the new system, the directors thought that the discomfort complained of had been banished. There was, however, a disagreeable side to the subject. A number of engines which cost £69,000 had been thrown out of use. No doubt they were still worth something, but the difference between what they would realise and what they cost to capital would have to be paid for at some time out of revenue, so that their capital might be always represented by useful working material. A sub-station was in course of construction at Bond-street Station to enable the lifts and the lighting of the tunnels to be supplied with current, independently of the central power station. This improvement would, he considered, be appreciated by the public, as its effect would be to prevent their being left in darkness in the event of any temporary disorganisation in the main electric service. With regard to the ventilation of the line, he stated that a large fan had been erected at Shepherd's Bush, and, on the few nights on which it had been tested, it had been found possible to clear the whole of the air in the tunnels three times in one hour; and he was told by travellers that in the morning the air was remarkably fresh. He did not think that it continued quite the same throughout the day, because the presence of so many passengers rendered it warm and less pleasant than at first. However, he hoped that as time went on some means would be found for keeping the air fresh all day. The revenue account presented several satisfactory features. During the six months under review, 300,000 more passengers had been carried than in the corresponding period of 1902, when the traffic was increased, at the lowest computation, by 350,000 persons owing to the influx of visitors into London on the occasion of the peace festivities and the Coronation arrangements. During the past six months, therefore, they had, by the growth of the ordinary daily traffic, made up for the absence of the special traffic of last year, and gained an additional 300,000 passengers, making the increase upwards of 600,000. That was strong proof of the popularity of the line, and the Board had great faith in the maintenance of the present steady progress of the traffic. They now carried 2,900,000 workmen in the half-year, which was equivalent to 12½ per cent. of the total number, and as workmen were charged only half fare, the earnings per passenger amounted to 1¾d. Turning to the expenses, he pointed out that the Company had earned £2,100 extra at a decreased cost of £3,000. Unfortunately, the rates and taxes had risen by £4,301, so that the net improvement in the earnings was reduced to about £700. After a sympathetic reference to the death of Viscount Colville of Culross, one of the original members of the Board, the chairman stated that Sir Michael Hicks-Beach, M.P., had accepted an invitation to fill the vacancy.

Lord Rathmore seconded the motion, which was unanimously adopted.

METROPOLITAN RAILWAY.

The half-yearly meeting of the proprietors was held at the Cannon-street Hotel on Friday, Mr. J. J. Mellor presiding.

The **Chairman**, in moving the adoption of the report, said the contracts for the electrical installation were, for the most part, well in hand, the power-house, with the machinery, should be completed by the end of this year, and the boiler-house and boilers, steam-turbines, switchboard, electric cranes, and all the plant necessary to complete the installation were being proceeded with in a satisfactory manner. They were also pushing forward the equipment of the permanent way, and favourable contracts had been made for the conductor rails and for some corridor, motor, and trailer cars, which were now being built. The British Westinghouse Company were supplying the whole of the machinery and plant. Speaking on the general and future prospects of the line, he said he believed that the electrification would inaugurate a new era of prosperity, and that they would be able to carry on the circle no fewer than 50,000,000 passengers a year. The time was fast approaching when the line, freed from its red-hot fireboxes, purged of its sulphur and its smoke, instead of being shunned on account of its heated atmosphere, would be selected as the coolest, the sweetest, and altogether the most agreeable route in London; the coolest and freshest in summer and the warmest in winter, where neither rain or fog could penetrate.

The motion was carried unanimously.

A special meeting was afterwards held to authorise the issue of an further £300,000 of capital, the bulk of which was required for electrification and works in connection therewith. The motion was agreed to.

CROMPTON AND CO.

The annual general meeting of the shareholders in this Company was held at Salisbury House on Wednesday, Mr. J. Trotter presiding.

The report of the directors for the year ended March 31 last states that the net profit for the year amounts to £19,804. 18s. 9d., and after providing for debenture interest, the payment of the interim dividend, and other items set out in the net revenue account, there remains, with the sum brought forward from last year, a balance of £7,473. 10s. 9d. The directors propose to pay a final dividend at the rate of 5 per cent. per annum for the half-year, free of income-tax, making, with the interim dividend paid in January last, 5 per cent. for the year, and to carry forward a balance of £1,098. 10s. 9d. In spite of the business of the Company during the year having been the largest on record, both in the manufacturing works at Chelmsford and the contract department in London, there is a diminution in the net profits. This has been due to the continuance of the keen competition referred to in the directors' last report, and the consequent reduction in prices. To meet this competition many economies in the cost of manufactures have been introduced at Chelmsford, with the result that the margin of profit on present market prices is more satisfactory.

The **Chairman** said that the past year had been one of exceptionally hard work and very small profit. The poorer results had not been due to any want of energy on the part of the staff, for the sales had been by far the largest the Company had had to deal with. Competition had been very keen, and there had been very little profit to be made. Three years ago, when lighting on a large scale was concerned, there was really only three competitors, but now there were from 15 to 20. Municipal work a few years ago was fairly remunerative, but now the competition was fiercer in it than in any other. In 1899 the Company had got an order for a certain machine at £3,456, but a short time ago it had tendered £2,886 for the same article, and had not been low enough. No doubt the Germans and Americans were causing a good deal of trouble by selling their surplus stocks here. There was a good deal of truth in the statement that England was a dumping ground for surplus stocks. If protection could be got for the electrical industry only he would vote for it with both hands, but with general protection he was afraid it would be jumping "out of the frying pan into the fire." The remedy lay in the reforming of methods. A standardising of patterns would make competition with foreigners more easy. With hard work he hoped to see the Company go back to the good times of a few years ago.

The report was adopted.

BLACKPOOL AND FLEETWOOD TRAMROAD.

The half-yearly balance-sheet issued by the directors for the period ended June 30 last shows that the amount expended on the permanent way during the half-year was £382. 17s. 3d., making a total expended on it since the commencement of £197,987. 0s. 2d. The revenue account for the half-year, with the totals for the corresponding half-year, are as follows: Maintenance of ways and works, £686. 13s. (£635. 15s. 4d.); engine power, £1,898. 6s. (£1,819. 14s. 5d.); repairs to cars, £509. 19s. (£642. 5s. 1d.); traffic expenses, £2,063. 4s. 7d. (£2,062. 2s. 7d.); general expenses, £685. 6s. 9d. (£618. 16s. 4d.); and rates, taxes, and insurance, £971. 1s. 2d. (£871. 10s. 5d.) The income from traffic receipts was £10,550. 0s. 8d., as against £9,513. 10s. 9d. The balance available for dividend is £3,927. 9s. 8d. Of this amount £3,000 will be absorbed in paying 4 per cent. dividend for the half-year, £661. 11s. 6d. will be written off for depreciation reserve, and the balance of £265. 18s. 2d. is carried to the next half-year. The car mileage run during the half-year was 225,692 miles, as against 218,042 for the corresponding half-year.

METROPOLITAN DISTRICT RAILWAY.

The report of the directors for the half-year ended June 30 last, after recommending a dividend on the 4 per cent. guaranteed stock at the rate of 2 per cent. per annum, leaving £342 to be carried forward, states that the Ealing and Harrow Railway was opened on June 28, and is being worked by an electrical service of trains. The delay of the Metropolitan Company in the construction of the Harrow and Uxbridge Railway still inflicts considerable loss upon this Company. The work of converting the railway from steam to electrical traction is steadily progressing. The power-house at Lots-road is well advanced. The sub-stations are in a forward condition, and all necessary arrangements have been made with the Board of Trade and the public authorities for laying the cables. A consultative committee of the District and Metropolitan Companies has met from time to time to confer upon any electrical questions affecting the two companies.

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GREAT NORTHERN, PICCADILLY, AND BROMPTON RAILWAY.

The half-yearly ordinary meeting of shareholders in this Company was held on Saturday at Hamilton House under the presidency of Sir Henry Fowler.

The **Chairman** said that the capital expenditure during the half-year amounted to £658,331. The accounts showed that the expenditure up to Dec. 31, 1902, was £241,995. The total expenditure, therefore, to date was £900,326. The amount of share capital created was £4,825,000, and the amount still unissued was £4,003,450. The estimated expenditure for the current half-year was £750,000. The engineer's report showed satisfactory progress with the construction of the works. The rent became due from the Underground Electric Railways Company, Limited, on Saturday. He moved the following resolution: "That a dividend for the period from the respective dates of the respective instalments to Aug. 1, 1903, is hereby declared at the rate of 4 per cent. per annum, less income tax, payable to all shareholders on the register of the Company at the last-mentioned date, other than the Underground Electric Railways Company of London, Limited (or their nominees, Henry Smith and Thomas James Russell), according to the amounts paid or credited as paid on their shares.

Lord Farrer seconded the motion, and it was carried.

ANGLO-AMERICAN TELEGRAPH.

The half-yearly meeting of the shareholders in this Company was held on Friday at Winchester House, E.C., Mr. F. A. Bevan presiding.

The **Chairman** said that the Company had had to repair one of its deep-sea cables and £13,190 had been charged to the renewal fund, but that amount would not cover the whole cost, and another amount of the same magnitude might have to be added. The Company always had to face the contingency that one of its old cables would break down, and that it would be unable to lift it for repairs. The International Telegraphic Conference had been held, but the companies invited to attend it had no votes. The tendency of the conference was to reduce the companies' profits. The Governments had not got to pay dividends, but only to consider the advantages to the public. The tendency in the present case had been to reduce the companies' profit, but he hoped not to any considerable extent. The senders of telegrams wanted to use longer words, to the disadvantage of the companies. Shareholders, however, need not be greatly alarmed about their interests, and they had no great reason to complain. He was not very sanguine about the prospects for the next half-year, but hoped they would be as satisfactory as the last half-year.

The report and accounts were adopted.

LIVERPOOL OVERHEAD RAILWAY.

The report of the directors of this Company for the half-year ended June 30, 1903, states that the gross revenue receipts amounted to £41,664. 6s., and the working expenses to £32,005. 8s. 9d. The number of passengers carried during the half-year was as follows: first-class, 759,180; second-class (including tramways), 3,334,793; workmen (special return tickets), 1,420,116—total, 5,514,089, which indicates a satisfactory increase, and although the working expenses, due to the acceleration of the trains, are larger, yet the service has proved to be popular, and is leading to a steady improvement in the number of travellers. The Bill of the Cheshire Lines Committee for powers to effect a junction with the railway at the Herculaneum Dock has received the Royal assent. The Bill of the Seaforth and Sefton Junction Railway, which will connect with the line at Seaforth, has passed the committees of both Houses of Parliament. The negotiations with the Lancashire and Yorkshire Railway have made good progress. When the railway is connected up with these important main lines it will form a valuable link in their through traffic, from which considerable advantage is anticipated. The revenue account shows that the receipts from passenger traffic and miscellaneous receipts and interest amounted to £41,664. 6s. The working expenses amounted to £32,005. 8s. 9d., leaving a balance of £9,658. 17s. 3d., which, after deducting interest on mortgage debentures, £3,800, and adding balance brought forward Dec 31, 1902, £4,013. 8s. 7d., leaves £9,872. 5s. 10d. available for dividend. Out of this balance the directors recommend the declaration of dividends at the following rates (less income tax): 5 per cent. per annum on preference shares, £3,000; 1¼ per cent. per annum on ordinary shares, £3,125; leaving a balance of £3,747. 5s. 10d. to be carried forward to next half-year.

METROPOLITAN RAILWAY.

The total receipts for the half-year ended June 30, 1903 (deducting this Company's proportion of the revenue of the City lines and extensions), have been £424,467, and the expenses £211,251, leaving a profit of £213,216. The directors recommend a dividend upon the ordinary stock for the past half-year at the rate of £2. 10s. per cent. per annum, and to carry forward the balance of £26,255 to the next half-year's accounts. The British Westinghouse Electric and Manufacturing Company, Limited, are making satisfactory progress with the building of the power station at Neasden, and the generating plant and machinery are well in hand. The sinking of the two wells has been completed, and prolonged tests show an ample supply of water to be available. A reservoir is being constructed adjoining the generating station for the storage of water and for condensing purposes. It will be completed in about a month, when it will be filled from the two wells. The new railway from Harrow to Uxbridge, connecting with the railway at the former place, is approaching completion, and is being equipped throughout for electric traction. In view of the capital expenditure required for the electrification and works in connection therewith, resolutions will be submitted at the special meeting providing for the creation of the capital authorised to be raised by the Metropolitan Railway (Various Powers) Act, 1884, and the Manchester, Sheffield, and Lincolnshire Railway (Extension to London) Act, 1893. These capital powers were not required for the objects for which they were originally authorised, and parliamentary sanction has been given to their being applied to other of the Company's purposes.

NORTH METROPOLITAN TRAMWAYS.

The report of the directors for the half-year ended June 30 last states that the long-standing negotiations with the West Ham Corporation have been at length concluded, and the purchase of the lines within the Corporation area was carried into effect on June 30 last. The price to be paid for the depôts has yet to be settled. Referring to the sale which has recently taken place of the Company's lines in Middlesex to the Metropolitan Electric Tramways, Limited (mentioned in the directors' last report), it has now been decided to apply to the Board of Trade for permission to sell certain small portions of tramway within the county of London which still remain in the possession of the Company, and the user of which has been granted to the Metropolitan Electric Tramways, Limited. A resolution authorising the directors to carry out this sale will be submitted to the meeting.

GREAT NORTHERN AND CITY RAILWAY.

The directors in their report state that the main line from Moorgate-street, through Old-street and Essex-road, to Drayton-park station is now almost completed. The extension from Drayton-park to Finsbury Park is in a forward state, and the whole of the tunnels are expected to be completed by the end of August. The various and complicated arrangements at Finsbury Park Station are in a forward state, and it is expected will be completed by the end of the year. The station at Highbury, authorised by the Company's Acts, 1902 and 1903, is in course of construction. Preliminary arrangements are being made for an early commencement of the extension from Moorgate-street to the Bank at Lothbury, a work also sanctioned by the Company's Acts of 1902 and 1903. The electrical installation is completed and ready for working.

BRISTOL TRAMWAYS AND CARRIAGE.

The directors (Mr. George White presiding) at their meeting held on the 22nd inst. declared an interim dividend to June 30 last at 8½ per cent. per annum, the warrants for which will be posted to the shareholders on Aug. 7. The total receipts of the Company for the half-year were £121,934. 16s. 3d. against £111,849. 6s. 11d., an increase of £10,085. 9s. 4d. over the corresponding period, whilst the number of passengers carried was 21,398,765 against 19,523,245, an increase of 1,875,520. The interest on debenture stock, the preference dividend and interim dividend of 8½ per cent. per annum absorbs £35,316. 12s. 3d. against £34,075 in the corresponding period.

NEW COMPANIES REGISTERED.

Ekstromer Accumulator Company, Limited (78,175).—Capital, £25,000. Object: to acquire a patent, provisionally accepted in the name of E. O. Ekstromer and another, numbered 7,773 of 1903, relating to improvements in accumulators and apparatus for preparing and applying the same, and any foreign patents to be granted in respect thereof, to adopt an agreement with E. C. Ekstromer, G. H. Lloyd, and C. von Buch, and to carry on the business of manufacturers of and dealers in accumulators, dynamos, and electrical apparatus generally.

North Wales Power and Traction Company, Limited (78,193). Capital, £270,000. Object: to enter into contracts (1) with Bruce Peebles and Co., Limited; (2) with the Northern Counties Traction Company, Limited; (3) with J. Tomkinson, M.P., and Colonel H. Platt, C.B.; and (4) with the Portmadoc, Beddgelert, and South Snowdon Railway Company, and to carry on the business of electricians, electrical, mechanical, and general engineers, suppliers of light, heat, and power by electricity, galvanism, magnetism, gas, water, or otherwise, owners of tramways, railways, motorcars, and other means of transport, etc.

Nottingham Electrical Company, Limited (78,168).—Capital, £1,000. Objects: to carry on the business of electricians, suppliers of electricity for light, heat, motive power, etc., dealers in all apparatus and things for the generation, supply, distribution, accumulation, and employment of electricity; electrical and general engineers. Registered office: 13, Farmers' Factory, Sherwood-street, Nottingham.

British Electric Separating Company, Limited.—Capital, £6,000. Objects: to acquire the business of tin strippers, carried on at Swansea by Mr. H. A. Leaver, as "H. A. Leaver and Co.," and to carry on the business of stripping tin from tinplate scrap and other articles by electricity or otherwise and other business connected with the electro-deposition of metals. Registered office: Newcut-road, Swansea.

West London.—The following curt reply has been received by a correspondent who recently wrote to the manager of the London United Tramways asking, on behalf of the working classes, that ½d. fares be adopted by the company as has been done by the London County Council: "I am requested to inform you that it is not contemplated to introduce ½d. fares upon the system of the London United electric tramways."

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CONTRACTS FOR ELECTRICAL SUPPLIES.

Lisbon.—The Public Works Department require tenders for the public electric lighting of Macao. Tenders by Oct. 21.

Grimsby.—The Corporation invite tenders for a three-wire motor balancer and for automatic stokers. Tenders by 24th inst.

Brighton.—The Town Council invited tenders for the supply of meters for a period of one year from Sept. 1, 1903. Tenders by Aug. 10. Advertisement in last issue.

Accrington.—Tenders are invited for the electric lighting of new Wesleyan Sunday School. Specifications can be had from Mr. Pollard Barlow, 6, Hest-bank, Rough Lee-road, Accrington.

Sydney.—Tenders for the dynamo and engine for the tramways will close on Sept. 12. Particulars may be obtained from the Agent-General for New South Wales, 9, Victoria-street, Westminster.

London, S.W.—The London County Council invite tenders for two low-tension feeder switchboards. Particulars may be obtained at the County Hall, Spring-gardens, S.W. Tenders by 10 a.m. on Aug. 11.

Derby.—The Baths Committee invite tenders for the electric wiring of the Reginald-street Baths. Specifications, etc., may be obtained from the Borough Electrical Engineer, Full-street. Tenders by Aug. 11.

West Ham.—The Borough Council invite tenders for traction switchboard, etc. Particulars from Borough Electrical Engineer, Abbey Mills, West Ham. Tenders by 4 p.m. on Aug. 21. See advertisement.

Avila.—The Department of the Interior, Madrid, require tenders for an electric light installation for public and private lighting. The latter will require about 6,000 lamps. Particulars from the above. Tenders by Aug. 22.

Middleton (Lancs).—The Corporation invite tenders for the supply and erection complete at their electricity works of a grease extractor. Particulars may be obtained from Mr. S. Pauls, borough electrical engineer. Tenders by Aug. 11.

Madrid.—The Posts and Telegraph Department require tenders for installation and working of a telephone system in Gerona for twenty years, and also for installation of telephone between Gijon and Pola de Siero. Tenders by Aug. 21.

West Ham.—The Town Council invite tenders for traction switchboard, etc. Further particulars may be obtained from Mr. James K. Bock, Abbey Mills, West Ham. Tenders may be sent to Mr. Fred E. Hilleary, Town Hall, West Ham, by 4 p.m. on 21st inst.

Shanghai.—The French Colony propose to instal motor-propelled tramways. Tenders may be sent by Oct. 31, 1903, to Secrétariat de la Municipalité Française de Shanghai. Particulars may be obtained from l'Office National du Commerce Extérieur, Rue Feydeau, 3, Paris.

Utrecht.—The Town Council will receive tenders for supply and erection of a central electric establishment for lighting, power supply, and working tramways. Contract, conditions, etc., to be obtained at the "Gemeente Secretaire" of Utrecht, on payment of 5fl. (8s. 4d.). Tenders by Oct. 1.

Nelson.—The Education Committee invite tenders for the wiring of and the supply and fixing of electric fittings, etc., at the new Whitefield elementary schools in Norfolk-street. Specification, etc., may be obtained from Mr. W. Alan Fraser, borough electrical engineer. Tenders by noon on 8th inst.

Swindon.—The Corporation invite tenders for the supply, delivery, and laying of all the rails, points, crossings, and accessories for the permanent way of the Corporation's tramways. Particulars from the engineers, Messrs. Lacey and Sillar, Manchester and Westminster. Tenders by Aug. 26. See advertisement.

Launceston (Tasmania).—The Mayor and Aldermen invite tenders for the supply of 500 or more electric meters. Particulars may be obtained on application to Mr. William Corin, city electrical engineer, Launceston, Tasmania, or to Messrs. John Terry and Co., 7, Great Winchester-street, London, E.C. Tenders by Sept. 28.

London, S.W.—The London County Council invite tenders for the supply and delivery of two low-tension feeder switchboards, and for the erection of one of them in each of the Council's sub-stations at Camberwell and New Cross respectively. Particulars may be obtained at the County Hall, Spring gardens, S.W. Tenders by 10 a.m. on Aug. 11.

London, S.E.—The London County Council invite tenders for the supply, delivery, and erection in the electricity generating station to be established by the Council at Greenwich of four 5,000-h.p. vertical-horizontal steam-engines, each suitable for driving a three-phase generator. Particulars, etc., may be obtained at the County Hall, Spring-gardens, S.W. Tenders by 10 a.m. on Oct. 6.

Madrid.—The Posts and Telegraphs Department require tenders for the supply of 25 telegraph apparatus of the Hughes system and 25 motors with weight elevators for the same, for the service of the telegraph stations of the State, at the upset price of 2,530 pesetas, or about £73, for each apparatus with its accessories as detailed, and 408 pesetas, or about £12, for each motor with its corresponding elevator.

Cardiff.—Tenders are required for new electrical department for lupus treatment, etc., at the Cardiff Infirmary. Plans, etc., may be seen at the office of the architect, Mr. Edwin Seward, F.R.I.B.A., from whom bills of quantities may be obtained on payment of cheque for £1. 1s., to be returned on receipt of a bona fide tender. Tenders, endorsed "Electrical and X-Ray Department," to be delivered to Mr. Leonard D. Rea, secretary and general superintendent, by 12 noon on 18th inst.

Cheadle.—The Urban District Council are prepared to receive tenders for the supply of materials and execution of works in the laying of concrete foundations, fixing rails, points and crossings for the tramway permanent way complete, including taking up present macadam and paving setts, but except fixing bonding. Particulars may be obtained on application to Mr. Chas. R. Brady, A.M.I.C.E., 13, Warren-street, Stockport. Tenders by 12 noon on Aug. 17.

Birmingham.—The Tramways Committee require the names of contractors who are desirous of tendering for the supply and delivery of materials and fittings as follows: (Section A) manganese steel points and crossings; (B) tapered steel side poles and bracket arms; (C) suspension ears, pull-offs, section insulators, and other overhead materials; (D) hard-drawn copper trolley wire and stranded steel span wire. Mr. John Price, city engineer, Council House, Birmingham.

Northampton.—The Corporation are prepared to receive tenders for the supply, delivery, and erection of the following in connection with the Corporation electric tramways: (Section No. 1) boilers, steam, exhaust, and water piping, condenser, cooler, water-softening plant, mechanical draught, etc.; (2) steam generators, dynamos, battery, and booster, switchboard, travelling crane, station lighting, etc.; (3) overhead trolley equipment; (4) underground feeders, pilot, and telephone wires; (5) cars; (6) permanent way; (7) power station buildings; (8) car-sheds, workshops, offices, etc. Particulars on application to the borough engineer, Mr. Alfred Fidler, A.M.I.C.E., Guildhall, Northampton. Tenders by 12 noon on Aug. 15.

Northampton.—The Corporation invite tenders for the supply, delivery, and erection of the following in connection with the electric tramways: (Section No. 1) boilers, steam, exhaust, and water piping, condenser, cooler, water-softening plant, mechanical draught, etc.; (2) steam generators, dynamos, battery, and booster, switchboard, travelling crane, station lighting, etc.; (3) overhead trolley equipment; (4) underground feeders, pilot, and telephone wires; (5) cars; (6) permanent way; (7) power station buildings; (8) carsheds, workshops, offices, etc. Trades union rates of wages and hours of labour apply to the contract. Drawings may be seen and forms of tender obtained after 25th inst. from Mr. Alfred Fidler, A.M.I.C.E., Guildhall, Northampton. Tenders to Mr. Herbert Hankinson, Guildhall, Northampton, by 12 noon on Aug. 15. See advertisement.

RESULTS OF TENDERS.

Derby.—The tender of the Lancashire Dynamo and Motor Company has been accepted for two sets of balancers, one set of reversible boosters for lighting, and one set of automatic reversible boosters for traction.

Reigate.—The Town Council have accepted the tender of C. Nightingale and Sons, Lesbourne-road, Reigate, at £2,023, for the construction of extensions to their electric lighting station near to Wray Common-road.

Bracebridge Asylum.—The following tenders are under consideration: Chloride Electric Storage Company, supply and erection of a storage battery, etc., £459; W. Foster and Co., supply and erection of two engines and dynamos, one motor-generator, main switchboard, meters, etc., £1,211; H. T. Hazzledine, supply and fixing of electric wires, switches, etc., £2,250.

Superheated Steam.—Messrs. Easton and Co. report recent orders for Schmidt and Bolton superheaters, amounting in all to 9,000 h.p., the purchasers being as follows: Durham Street Weaving Company, Belfast; Metropolitan Electric Supply Company (six); J. and E. Hall, Dartford, Kent; Kirkpatrick Bros., Ballyclare; Shirebrook Colliery Company; Thomas and Green, Wooburn Green.

Norwich.—The following tenders have been accepted: Accessories (at schedule prices) to March 31, 1904—Edison and Swan United Electric Light Company, Hull; Hands Bros., 30, Snow-hill, London, E.C.; Metallic Seamless Tube Company, Birmingham. Meters (at schedule prices)—Schattner Electricity Meter Company, Upper-street, London; Chamberlain and Hookham, Birmingham; Johnson and Phillips, Old Charlton, Kent, centrifugal pump and motor, £150.

Roofing.—Messrs. Mellowes and Co., Sheffield, and 28, Victoria-street, Westminster, report orders for the glazing for the following roofs on their "Eclipse" patent imperishable system; Dick, Kerr, and Co.'s premises, Preston; Ipswich electric station and car sheds; gasworks, Tynemouth; Yoker generating station; Motherwell generating station; Bath generating station; car sheds, Bath; Swan and Hunter's premises, Newcastle-on-Tyne; Guinness's Brewery, Dublin; National Gas-Engine Company's premises, Oldham; new tyre shop for Messrs. J. Brown and Co., Sheffield.

Bath.—The Corporation have received the following tenders for the supply and erection of a main switchboard at their new generating station, Dorchester-street:

Verity's Limited, King-street, Covent Garden, London.	£1,434	0	0
Johnson and Phillips, Old Charlton, Kent	1,540	0	0
Electric Construction Company, Dashwood House, 9, New Broad-street, E.C.	1,543	0	0
J. G. Statter and Co., Birmingham (accepted)	1,544	0	0
Crompton and Co., 4, Queen Victoria-street, E.C.	1,560	0	0
Cowans, Springfield-lane, Salford, Manchester	1,574	0	0
Electrical Company, Limited, London	1,580	0	0
Siemens Bros. and Co., 12, Queen Anne's-gate, Westminster	1,632	0	0
General Electric Company, 67, Queen Victoria-street	1,650	0	0
Witting, Eborall, and Co., London	1,670	0	0
Kelvin and White, Glasgow	1,686	17	6
Ferranti Limited, Hollinwood, Lancs.	1,750	0	0
E. F. Moy, Limited, Greenland-place, Camden Town, London, N.W.	1,985	0	0

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BUSINESS NOTES.

TRACTION.

Middlesex.—The laying of the tramway tracks in the Edgware and Great North roads is to be proceeded with by the present contractors.

London's Tube Railways.—It is stated that London's tube railway schemes, realised and projected, involve the investment of upwards of £50,000,000.

Manchester.—The Corporation Tramways Committee have revised the fares on many routes, introducing fares of 1½d. in a large number of cases where 2d. is now charged.

Rotherham.—The Corporation trams carried considerably over twice the total number of the population of the borough during the week ended on Thursday, the 30th ult.

Crewe.—A proposal to withdraw the Council's support to the tramway scheme being promoted by a syndicate for the town was defeated at Wednesday's meeting of the Town Council.

Beckenham.—The constructional plans of the proposed tramways have been approved, the company having agreed to pave the track in Croydon-road and Beckenham-road with wood at their own expense.

Liverpool.—The City Council on Wednesday refused to confirm the decision of the Tramways Committee not to proceed with the construction of a line of tramways connecting Lodge-lane with Aigburth-road.

Dumbarton.—The enquiry under the Private Legislation (Scotland) Act into an application for a provisional order in connection with a tramway scheme for Dumbarton was held on Friday. There was little opposition, and the preamble was proved.

Southampton.—The Tramway Committee have decided to charge 1d. fares only to all passengers before 7.30 a.m. Consideration of the subject of return tickets has been referred to the chairman to make enquiries at the conference to be held at Glasgow.

Batley.—Disappointment prevails that the electric cars will not run in the borough for the present. It is understood that the cars are not yet ready. It was hoped that the public service would come into operation directly after Major Druitt's official inspection last week.

Liverpool Overhead Railway.—A fire, fortunately confined to the driver's cabin, occurred on one of the trains leaving Prince's Dock Station on Wednesday last week. The fire brigade was summoned, and the fire extinguished. It is supposed to have been caused by a short-circuit.

Barnsley.—The Town Council have recently been considering the question of the purchase of the undertaking of the Barnsley and district tramways scheme, but at a meeting last week the committee before whom the matter was brought decided not to purchase on the terms suggested.

Hayes.—At a special meeting of the Parish Council a resolution was passed that the Council, whilst not opposing the extension of time applied for by the tramway company, at the same time expressed their earnest hope that the Board of Trade will insist on the company completing the work within the time now stated.

Lewisham.—The Borough Council have rescinded their resolution, "That the London County Council be informed that the Lewisham Borough Council will be prepared to consent on terms to the introduction of the tramways proposed in their letter dated June 14, but decline to make any contribution to the cost of the same."

Brighton.—The Tramways Committee have considered a long report from the engineer and manager, Mr. Holliday, in reference to the proposed tramway along the Preston-road, from the junction with Beaconsfield and London roads to the borough boundary near Clermont-road, making several recommendations as to the manner in which the work shall be carried out.

Wolverhampton.—After a lengthy discussion the Town Council have adopted a resolution calling on the Tramways Committee to establish communication with outside districts without delay. The debate arose out of a memorial presented by the local tradesmen's association asking for the removal of the isolation of Wolverhampton from neighbouring towns which now exist.

Stockport.—Colonel von Donop visited Stockport on Saturday on behalf of the Board of Trade to inspect the extension of the Corporation tramways on the Cheadle side of the borough. The portion inspected was the length from the Robin Hood Inn to the borough boundary. He gave his sanction to the immediate running of the cars, and after the inspection the public were able to utilise the route.

Norwood.—As a result of a canvass of the inhabitants of Upper Norwood, made by the Upper Norwood Ratepayers' Association, it has been ascertained that 2,328 inhabitants are in favour of the introduction of electric trams, whilst 448 are against it, and 223 are neutral. A memorial is consequently being prepared praying the London County Council and the Croydon Council to extend their electric tram system to Upper Norwood.

Lambourn Valley.—An enquiry has been held at the Board of Trade to hear objections to the application for the light railway order. Sir Herbert Jekyll, after hearing Mr. Bayliss, objector, and Messrs. Le Brasseur and Squires on behalf of the company, said he would report to the Board of Trade, but did not think he would be justified in holding out strong hopes that the Board would accede to the addition of 25 per cent. to maximum rates.

Ashton.—Negotiations are proceeding between the Corporation and the Manchester Carriage Company with regard to the cost of the taking over of the tramways and as to the inclusion of the depôt in Cowhill-lane and about a dozen cars and 144 horses, which it is contended are Ashton's share of the liability. A deputation is to wait upon the representatives of the company, and it is hoped the matter will be settled without recourse to arbitration.

Paisley.—The purchase agreement between the directors of the existing horse tramways in Paisley and Mr. Murphy, promoter of the electric tramways, has been signed, payment to be made within two months. Mr. Parshall, Mr. Murphy's electrical engineer, has written to the burgh electrician stating his opinion that current may be wanted at the end of March, when part of the lines will be open for traffic. The whole system is expected to be open in June next year.

Lancashire and Yorkshire Railway.—A good start has been made with the laying of the cables at Southport in connection with the electrification of the Liverpool-Southport line on the Lancashire and Yorkshire Railway system. The work is being pushed through Birkdale and on to Ainsdale, and a considerable portion of the remaining distance is already completed. The chief generating station is at Formby, and sub-stations are being erected at Birkdale and Seaforth.

Aston.—The Tramways Committee report that the Birmingham District Tramways Bill, as amended by the committee of the Lords, has been submitted to a committee of the House of Commons, with the result that the clauses enabling the various local authorities who are promoting the Bill to purchase and lease the tramways in their districts before the expiry of the respective orders under which such tramways were authorised and constructed were approved by such committee.

Collision in South London.—On Saturday an accident occurred at Kennington Cross. One of the London County Council electric cars from Tooting was proceeding up Kennington-road towards Westminster Bridge when it dashed into a Brixton horse car which was leaving the stable yard. The entire front of the horse car was smashed in, while the force of the impact caused several passengers to be dislodged from their seats on the electric car. Happily no person was seriously injured.

Liverpool-Manchester Monorail.—The secretary of the Manchester and Liverpool Electric Express Railway Company states that the applications received for shares in the above company do not in the directors' judgment offer capital of a sufficient amount to guarantee the successful completion of so important an undertaking. Arrangements for the provision of the full resources required are under consideration, but meanwhile they think it advisable to allot no shares at the present stage.

Burton.—The electric trams are now in full use. A start was made on Bank Holiday, when the Mayor and members of the Corporation formally declared the system open. The Mayor said that up to the present about £80,000 had been expended. They had 5¾ miles of rails, about half of which were double. They had 20 cars, costing £550 each, 17 of which would provide a full service. A *plébiscite* of the borough is to be taken during the week on the question of running on Sundays.

South London.—Another electrical tramway has been added to the South London system. This is the branch described from the terminus at Vauxhall Station, *via* Harleyford-road to Kennington Church and Camberwell green. The cars were timed to cover the distance from Vauxhall to the Green in 12 minutes. Few of them, however, required so long, despite the heavy vehicular traffic. It is anticipated that nine-tenths of the tramway system controlled in South London by the County Council will be running electrically before the end of the year.

Kingston-upon-Hull.—The accounts of the electric tramway undertaking for the year ended March 31 last have just been issued, and reveal a healthy state of affairs. The total capital expenditure during the year amounted to £31,414. 5s. 7d. The revenue account shows a total expenditure of £48,939. 9s. 11d. as against a gross income of £92,343. 4s. 6d., leaving £43,403. 14s. 7d. to be carried to the net revenue account. After providing for interest on loans and sinking and reserve fund charges there is a handsome balance of £14,500 remaining.

Additional Traffic Returns.—Anglo-Argentine, £1,559 increase; Barcelona Ensanche y Gracia, £200 increase; Barcelona, £194 decrease; Brisbane, £85 decrease (month of July, £10,160, increase £4); British Columbia Electric (month of March), gross earnings £10,352, net income £2,658; Buenos Ayres and Belgrano Electric, £23 increase (month of July, £13,269, increase £1,142); Calcutta, £613 increase; Cape Town (month of April), receipts £16,003, expenditure £8,313; Isle of Thanet Electric, £184 decrease; Mexico Electric (month of June), receipts £46,270; Perth Electric, £125 increase; Port Elizabeth (month of April), receipts £4,292, expenditure £2,281.

Lowestoft.—The electric trams, which were opened on July 22, have up to the present justified their construction in a most gratifying manner. Having taken as much as £64 and £63 last Saturday and Sunday respectively, which were up to that time "record" receipts, these figures were far exceeded on Bank Holiday. Although actually all the cars were not in use, as many as 22,570 passengers were carried (and again hundreds were unable to obtain a ride), and the earnings reached £111. 7s. 4d. It is stated that the earnings of the cars during the first 12 days (three of which, by the way, were only half days), including about the wettest week of the season, were £729—an average of about £60. 10s. per day.

Bury, Rochdale, and Oldham.—As the result of prolonged negotiations between the local authorities and the directors of the Bury, Rochdale, and Oldham Tramways Company, a provisional agreement was come to whereby the authorities would take possession of the undertaking as from July 31. The formalities, however, have not been completed, and the agreement is not yet signed. Until this is done application will not be made to the Board of Trade to fix the date of the arbitration on the question of the price to be paid for the company's undertaking. Meanwhile the Rochdale Corporation is taking steps to complete the lines along Milnrow-road and Tweedale-

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street, and as soon as possession is assumed they will have the right to begin the work of reconstruction.

West Manchester Light Railway.—The Davyhulme and Flixton Parochial Committees have received the report of the Joint Committee appointed to meet the promoters of the proposed light railway from Trafford Park to Irlam locks, which will cross on the level several main roads in Flixton and Davyhulme. The committee hold that the construction of a light railway in these residential districts would be objectionable, although to the construction of a tramway there might not be the same opposition. The promoters, who say the proposed scheme is simply an extension of the powers they have already acquired in Trafford Park, point out that the construction of the line will develop the townships named and will lead to the erection of considerable new property to accommodate the men now employed in the park.

Leeds.—An amicable arrangement between the Tramways Committee and their employés is being negotiated. Permission, however, has been granted to the men by the Amalgamated Association of Tramway and Vehicle Workers to enter upon a strike at an early date if the committee will not accede to their demands. Fresh terms have been offered by the organising secretary of the union, and the committee are now considering these modifications of the original terms. It is hoped that within a short time a rearrangement of hours and wages may be arrived at which will be mutually satisfactory both to the men and the committee. On Wednesday it was decided to grant the men concessions in wages and hours which represent an increased expenditure to the department of £4,600 per annum. There is a probability that the men will demand still more, as the minimum for which they have been agitating has not been reached.

Accident.—The Salford borough coroner has held an inquest on the death of Nathaniel Leather, aged 31, a carter, who was killed in a collision between a tramcar and a lurry in Salford. Witnesses stated that at 10.30 on Saturday morning they saw Leather riding on his lurry, and noticed him stop at the shop of a butcher. The man was next seen turning his lurry round. He got the lurry half turned when an electric tramcar collided with it and pushed it along the road for a few yards. Leather was knocked off his seat and injured so badly that he died. Alfred Lacey, the car driver, said he saw Leather at the corner of Howard-street attempting to cross the road and get round another lurry. Witness sounded his gong and gave Leather a signal to get out of the way. Leather, however, suddenly drove across the road and turned his lurry on the tramline. It was impossible then to avert the accident. Other witnesses stated that they did not see a second lurry. The jury returned a verdict of manslaughter against the driver, and he was committed to the next Manchester Assizes on the coroner's warrant. The coroner accepted bail in two sureties of £25 and Lacey in £50.

Tramways Competition with Railways.—At the meeting of the South-Eastern Railway Company the Chairman said there was a considerable increase in the short third-class journeys. He could not help thinking that the trams had more or less had their day, and that owing to the increasing punctuality and regularity of their suburban service, the third-class passengers, whose time was most valuable, were coming back to the railway as the most certain way of getting to business. Speaking at the half-yearly meeting of the Lancashire and Yorkshire Railway Company on Wednesday, Sir George Armytage said there could be no doubt that the falling off in the number of passengers carried was entirely due to the fact that the tramways had taken a great many short-journey passengers from them; but he was pleased to be able to say that their efforts to encourage passengers to take longer journeys had again been successful, and he thought, therefore, they might fairly claim that in spite of the tramway competition they had been able to hold their own in all classes, having received considerably more revenue for passenger traffic than in the corresponding half-year, notwithstanding the diminution in numbers.

Private Bills.—On Friday the following Bills were read a third time and passed in the House of Lords: Stroud and District Tramways Bill, Erith Tramways and Improvement Bill, and North Metropolitan Electric Power Supply Bill. In the House of Commons, on the consideration of the Lords' reasons for disagreeing to one of the Commons' amendments to the Carmarthen Electric Power Bill, Mr. J. W. Lowther moved, "That this House do not insist on their amendment." The motion was agreed to. The following Bills were read a third time: the Nottinghamshire and Derbyshire Tramways Bill, and the Hove, Worthing, and District Tramways Bill. In the House of Lords on Tuesday last week the Baker-street and Waterloo Railway (Extension of Time) Bill was read a third time. In the House of Commons the Lords' amendments to the following Bills were considered and agreed to: the Great Northern, Piccadilly, and Brompton Railway (Various Powers) Bill, and the Watford and Edgware Railway Bill. The following Bills were read a third time: the Dewsbury, Batley, and Birstall Tramways Bill, the Manchester Southern Tramways Bill, and the Worthing Corporation Tramways Bill. On Tuesday last the Lords' amendments to the following Bills were considered and agreed to: Baker-street and Waterloo Railway (Extension of Time) Bill, and the London County Council (Tramways and Improvements) Bill. The Somerset and District Electric Power Bill was read a third time.

Leeds Tramways Manager.—The proposal of the Leeds Tramways Committee to increase the salary of Mr. J. B. Hamilton, the tramways manager, from £900 to £1,200 at once, and by three annual instalments of £100 to £1,500 per annum, was defeated in Council of the Corporation on Wednesday by 25 to 30 votes. The decision was arrived at after a lengthy debate, which was chiefly characterised by disorderly interruptions from the public gallery, and the disgraceful demonstration with which the result was received by the occupants of the gallery. We cannot help thinking that in deciding not to advance Mr. Hamilton's salary the Council have allowed themselves to be influenced by the public feeling which had been voiced during the week at numberless meetings and gatherings in the city, at one of which some 6,000 people entered their protest against the proposed increase. As our readers know, Mr. Hamilton had an offer from Birmingham of £1,500 a year, which he was induced to decline on the Leeds Tramways Committee agreeing to recommend the Council to advance his salary to that figure within three years. In declining Birmingham's offer Mr. Hamilton was obviously putting his own private interests on one side, but we doubt whether he would have so far sacrificed himself had he not regarded his committee's promise of an increase as practically binding on the Council. As it is, the appointment at Birmingham has been filled, and Mr. Hamilton's salary remains as it was before. Throughout the debate in the Leeds Council signs are not wanting of the reputation he has established for himself as an administrator during the time he has been at Leeds, and we are convinced that in refusing to compensate Mr. Hamilton for his sacrifice of his own interests to those of the city, the City Council have made a great mistake, and one which they will probably regret before very long.

Liverpool.—The auditors' annual report with regard to the tramways and electric supply undertaking was issued on Friday. It states with regard to the tramways accounts that the contribution to the sinking fund last year amounted to £51,924, and after providing this amount, in addition to all interest charges, there remained to the credit of revenue account the sum of £75,497. This balance has been dealt with according to the provisions of the Act, 1902, £50,351 being set aside for reserve, renewal, and depreciation, and the balance of £25,166 has been taken in relief of rates. In the reporters' opinion the figures justify such a transfer. In comparing the amount set aside for depreciation with the total capital expended, it must be borne in mind that a large amount of the expenditure was incurred on account of assets, acquired from the late company, that will not require to be renewed, and the debt will be fully written off by the operation of the sinking funds, and it will not become necessary to raise further sums in order to replace these assets. In such assets they class goodwill, old cars, and horses, and the old tramway lines. The cost of horses has already been written off. The sinking fund also should be more than sufficient to provide for the expenditure on the land and buildings. The assets remaining that require to be maintained to keep the concern in working order are of a capital value of about £875,000. The sum written off for depreciation, etc.—*i.e.*, £50,331—is equal to 5¾ per cent. on this figure, and the sinking funds are also providing for the redemption of the expenditure incurred on these assets. The city engineer is satisfied (having regard to the amounts charged for renewals and maintenance, £63,174. 6s. 8d., and the principle adopted for making these charges) that the amount set aside for depreciation, in view of the sinking funds in operation, is amply sufficient. The reporters consider it as much as, if not more than, a prudently conducted company would have written off.

Bradford.—The report on the working of the city tramways for the year ended March 31 shows that the total traffic and other receipts amount to £173,534; the passengers carried to 41,000,000; car miles run, 4,013,191; receipts per car mile, 10·377d.; average length of 1d. stage, 1 mile 1,156 yards; route miles of tramway, 39 miles 645 yards; and the electric power consumed to 6,067,387 units. The amount paid to the electricity and other departments of the Corporation has been £28,952. The revenue account discloses the fact that the total expenditure has been £117,495, of which £39,755 went in wages, £24,956 in maintenance of rolling-stock, £5,758 in maintenance of permanent way, and £1,804 in maintenance of overhead equipment, the expenditure on electricity account being £26 931. The gross income was £173,534, leaving a gross profit of £56,038. Against this has to be set interest on loans, sinking fund, etc., £36,188, leaving a net balance of £19,849. The capital of the tramways is estimated at £700,000. It will be remembered that at a meeting of the Tramways Committee held recently a general desire was expressed for the amalgamation of the committee with that of the electricity department, the ground being that the amalgamation would tend to greater efficiency and economy in view of the fact that the two committees are so closely connected in their work. The matter has come before the members of the Electricity Committee, but it has not met with much support, the idea of the appointment of a manager to look after both departments not finding favour. The committee decided to advertise for a successor to Mr. Chattock, who was until recently the electrical engineer. The arbitrator appointed to determine the amount of compensation to be paid by the Corporation to the representatives of the Bradford Tramway and Omnibus Company, Limited, for the interference of the traffic of the company during the relaying of the lines and the fitting up for electric traction has presented his award. He determines that the company are entitled to £1,698. 7s., together with the sum of £77 as interest upon that amount from Feb. 1 last year, when the tramways were taken over.

Glasgow.—The ninth annual report of the Tramways Committee of the Town Council for the year ended May 31, 1903, has been issued. The result of the year's working shows that the revenue amounted to £656,572. 7s. 11d., and the working expenses, including depreciation, to £431,870. 2s. 11d., thus leaving a gross balance of £224,702. 5s. The revenue of the previous year was £614 413. 4s. 11d., and the working expenses, including depreciation, £405,103. 0s. 7d., leaving a gross balance of £209,310. 4s. 4d. This year's gross balance thus shows an increase of £15,392. 0s. 8d. The gross balance of £224,702. 5s. has been applied in meeting interest and sinking fund, etc., on cost of Govan and Ibrox tramways, interest on capital, sinking fund, and annual payment to the common good, these payments amounting in all to £124,425. 7s. The net balance remaining amounts to £100,276. 18s., out of which an extra payment of £10,000 has been made to the common good. On account of the high rates prevailing for electrical material during the period of construction, £40,000 has been written off the cost of feeder cables and overhead equipment; £25,000 has also been written off the cost of buildings originally constructed for horse

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traction. The balance, amounting to £25,276. 18s., has been added to the general reserve fund. It will be observed, the report continues, that the traffic revenue, although £40,373. 15s. 10d. in excess of the previous year, works out at ·47d. per car mile less. It will also be observed, however, that the working expenses show a decrease of ·31d. per car mile. As the lines are extended and the service of cars increased, it is quite probable that the revenue per car mile may in future be still further reduced. It may be taken, however, that the working expenses have now almost reached a minimum. The amount of the capital expenditure account on June 1, 1902, as reduced by depreciation, was £2,041,035. 19s. To this sums falls to be added £227,514. 16s. 7d., being the net amount expended on capital account throughout the year. There falls to be deducted from capital expenditure account the sum of £74,038. 14s. 7d., being the amount of the annual depreciation written off for the year, and the special depreciation, amounting to £65,000. The net amount expended on capital account as at May 31, 1903, was therefore £2,129,512. 1s. The total amount borrowed for capital purposes is now £1,889,311. 12s., of which £48,000 was borrowed during the past year. The sum at the credit of the permanent-way renewal fund is £136,789. 9s. 7d. During the year £2,071. 3s. 9d. was expended under this head. At the end of last year the amount at the credit of the general reserve fund was £383. 18s., this year the sum at credit amounts to £21,134. 10s. 8d. During the year more than 13 miles of double track extension has been constructed, and the total length of the tramways owned and leased by the Corporation now amounts to between 64 and 65 miles double track. During the past year the sum of £21,021. 4s. 5d. has been expended on the upkeep of the roadway between the tramway tracks. In addition to this sum, £53,516 has been charged against revenue, being the estimated annual expenditure necessary for the renewal of the track, calculated at £450 per annum per mile of single track. The cost of repairs to the power plant and machinery was £4,249. 16s. 2d. In addition to this sum £20,555. 4s. 9d. was charged against revenue to meet depreciation. The total number of cars in stock is 611, and at present 70 additional cars are in course of construction The total cost of inspection and repairs of cars for the 12 months was £27,529. 11s. 4d., and a further sum of £25,086. 11s. 1d. was laid aside to meet depreciation. The number of passengers carried exceeded 177 millions, and the distance traversed by the cars amounts to fully 14 million miles. The average drawing per mile is 14·19d. In exhaustive general remarks embodied in the report, the committee express satisfaction at the financial results of the first year of exclusive electric traction. The large extensions during the year, the lowering of fares, and the increased car service had all tended to keep down the earnings per car mile, but it was gratifying to note that expenses had also been considerably reduced.

LIGHTING AND GENERAL.

Bo'ness.—The generating station is to be erected on a site adjoining the gasworks, acquired by the Council some time ago.

Whitby.—The Urban District Council have decided to borrow a further sum of £2,500 for extending the electric lighting.

Carmarthen.—Two electric companies intend to apply for a provisional order to supply electric lighting in the district.

Aberdeen.—The Council have resolved to borrow a further sum of £65,000 for the purposes of the electric lighting undertaking.

Ilkeston.—The Electric Lighting Committee will charge 2d. per unit for power and 4d. per unit for lighting for the first 800 units.

Carnarvon.—Plans of the new electric light works have been adopted subject to their being approved by Sir Wm. Preece, the consulting engineer.

Stokefleming.—The Parish Council have decided to approach the Urban Electric Supply Company, Dartmouth, with regard to their terms for lighting the village.

River Wear Commission.—The agreement between the Sunderland Corporation and the Commissioners, relating to the laying of electric cables, has been sealed.

Beckenham.—The Urban District Council have decided that it be an instruction to the officers to invite fresh tenders for free wiring as soon as the Council's Bill becomes law.

St. Albans.—The Corporation have received offers from three companies to take over their electric lighting order, and have appointed Mr. E. Macgregor Duncan to advise them thereon.

Tolworth.—The new electric light works are now practically completed, and will be formally opened on Aug. 11, after which date current will be available in the greater part of the district.

Bootle.—At the last Council meeting sums to the amount of £13,000 were authorised to be borrowed for the supply of additional electrical plant required in the electricity station at Pine-grove.

Brompton and Kensington Electricity Co.—The directors have declared a dividend on the ordinary shares for the half-year ended June 30 last at the rate of 9 per cent. per annum (4s. 6d. a share).

Erith.—With reference to the proposed further loan of £20,000 for electric lighting, the Local Government Board have promised to sanction the borrowing of the money. A transformer station is proposed to be erected at Belvedere.

Fire.—We regret to hear that the buildings of the Westminster Electric Supply Corporation in Davies-street, Oxford-street, received some damage by a fire which occurred on Tuesday. Captain Hamilton, the new chief officer, was in attendance.

Argentine.—The Argentine Government have issued a decree authorising the construction of telegraph lines in the province of La Rioja between Patquia and Quines, of a total length of 411 km., for which a credit of about £11,554 has been granted.

Charing Cross and Strand Electricity Supply Co.—The directors of the Charing Cross and Strand Electricity Supply Corporation, Limited, have declared an interim dividend at the rate of 8 per cent. per annum for the half-year ended June 30, 1903.

Portsmouth.—The accounts of the Corporation's electric light undertaking for the year ended March 31 last show that during the year £28,128 was derived from the sale of current, against £24,828 from the same source during 1901. The cost of production rose by £3,158.

Goole.—The Urban Council have confirmed informal arrangements for the purchase of property in Edinburgh-street and Mason-terrace, the cost of which is estimated at £9 600, for the purposes of an electricity station, and will apply for sanction to purchase the property.

Midlothian.—The District Committee of the County Council have received notice of a provisional order granting to the National Electric Wiring Company, Limited, powers within the whole of the parish of Inveresk, and a sub-committee has been appointed to watch the interests of the District Committee in the matter.

Barnsley.—Mr. S. E. Bastow, A.M.I.E.E., has resigned his appointments as borough electrical engineer and resident engineer to the Barnsley and District Traction Company, and will shortly open offices in Manchester for Messrs. D. Bruce Peebles and Co., Limited, as their representative for the Manchester district.

Stourport.—The Shropshire and Worcestershire Electric Power Company intend to apply for a provisional order to supply electricity within the Stourport district. The Urban District Council have decided to obtain expert advice and assistance in negotiating with the company the terms on which they would lay mains and supply electricity in bulk.

Stepney.—The electric light was switched on to the Burdett-road, Mile End, last week, thus completing the present part of the installation of the Stepney Borough Council. Cable-street and other riverside streets are next to be taken in hand. Up to the present over £150,000 has been spent by the Stepney Council on the work, which last year earned a net profit of over £5,000.

Eton.—The Pumping Station Committee have adopted definitely the system of pumping by electricity, the six months' experiment being now concluded. The Windsor Electrical Installation Company, who have executed the work to the great satisfaction of the committee, have obtained the contract, the terms being 3d. per unit for the first 6,000 units and 1½d. for each unit in excess.

Removals.—Messrs. Gent and Co., wholesale manufacturing electricians, Faraday Works, Leicester, have removed their London offices to more commodious premises at 3A, Upper Thames-street, two doors from St. Paul's Station. Mr. L. Gaster, consulting electrical engineer, has removed to 32, Victoria-street, Westminster, S.W. This notice appeared in our last issue, but the name was mis-spelt "Gaston."

Sunderland.—The estimates adopted by the Lighting and Electricity Committee for the ensuing half-year show a total estimated expenditure of £11,339. 5s. 1d., and an estimated revenue of £22,747. 2s. 11d., the estimated gross profit being, therefore, £11,407. 17s. 10d. Of this, interest will absorb £3,877. 11s. 10d., and sinking fund £7,500, so that it is estimated that the net profit will be £30. 6s.

Reigate.—At the close of the first year of its installation—March, 1902—the cost of the Town Council's electricity undertaking was £1,566, and the revenue only amounted to £955. The last quarter, however, shows an increase in the revenue of 50 per cent., and now the limit of the number of consumers the Council can at present provide for has been reached, and it will be necessary to extend the works.

Hackney Technical Institute.—The governors of the Hackney Institute have made the following appointments: head of the physics and electrical engineering department, Alfred Hay, D.Sc., F.P.S., M.I.E.E., professor of electric technology and physics at the Royal Indian Engineering College, Coopers Hill; head of the chemistry department, E. C. Jee, D.Sc., F.I.C., F.C.S., assistant lecturer and demonstrator in the chemical department of the Borough Polytechnic; head of the natural science department, E. J. Collins, B.A., natural science master at Walthamstow Technical Institute. The institute will commence work next session at the new buildings in Hackney Downs, close to Hackney Downs Station.

Bath.—On the presentation of the Electric Light Committee's report at the last Council meeting, Mr. Hatt said, in reference to the request by the committee that the Council should authorise them to accept tenders for the supply of additional switchboard, condensers, feed and other pumps and pipes in connection with the enlargement of the works, that the tenders for the supply of condensers, etc., had already been received and reported upon by Mr. Manville, who had recommended the acceptance of the tender of Messrs. Babcock and Wilcox. The tenders for the switchboard had also been received, and opened and forwarded to Mr. Manville. He could assure the Council that even if the highest tenders were accepted the cost would come well within the estimate. The report was adopted.

Stock Exchange.—The Stock Exchange Committee have appointed Aug. 18 a special settling day for British Electric Transformer Company (1903), Limited, 30,390 6 per cent. cumulative preference shares of £1 each fully and partly paid, Nos. 1 to 30,390, and 69,114 ordinary shares of £1 each fully and partly paid, Nos. 50,001 to 119,114; and ordered the South African Lighting Association's further issue of 1,000 shares of £10 each fully paid, Nos. 6,001 to 7,000 to be quoted in the official list. Applications have been made to the Exchange Committee to allow the following securities to be quoted in the official list: Edmundson's Electricity Corporation's further issue of 20,000 ordinary shares of £5 each fully paid; and Vickers, Sons, and Maxim's, £1,000,000 4½ per cent., second mortgage debentures of £100 each, in lieu of the script now quoted.

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Wrexham.—The price of current for motors has been fixed at 2½d. per unit within the regulation area, and the minimum reduced from £10 to 30s. The borough electrical engineer, in his last report, states that the units generated during June, 1903, were 29,094, as against 8,164 in 1902. One consumer had been connected during the month—20 lamps of 8 c.p. The total number of consumers now connected was 130.

Hamilton.—The lessees under the Corporation—the Edmundsons' Electricity Corporation, Limited—commenced their 24 hours' continuous supply on Friday last, and announced that they were in the position to guarantee a current for lighting and power at all hours. Already the light has been very largely taken advantage of, and we are informed the consumers are satisfied with the result alike as regards cost and efficiency.

Holidays.—We have received an advance copy of this year's issue of the Great Eastern Railway Company's handbook "Holiday in Eastern Counties," edited by Percy Lindley. Prominence has been given to some less known districts in East Anglia, and the illustrations have been made a special feature, and a list of East Anglian golf links has been added. The little book is well got up and teems with useful information of all kinds.

Willesden.—Lord Stanmore's committee of the House of Lords have ordered the report for third reading of the Bill which seeks to empower the North Metropolitan Electric Power Supply Company to purchase from the Willesden Urban District Council a power generating station situated in Willesden, and to authorise the company, after the purchase, to supply electricity in bulk to certain bodies, including the Willesden Council.

Finchley.—The engineer in his last report states that the buildings were sufficiently advanced to enable the work in other departments to proceed. The contractor would probably finish at an early date. Two of the boilers had passed the preliminary test, and were being bricked in. He had arranged for the work to proceed at all hours between daylight and dark. Considerable progress had been made in the laying of the cables, and a large amount of jointing-up had been done.

Luton.—The electrical engineer in his last report states that since June 19 7,293 units had been generated, an equivalent to 373 8-c.p. lamps and five motors of 16 h.p. connected, making a total of 110 consumers with 7,776 lamps and 21 motors of 64 h.p., and that at the present time over 660 additional lamps and seven motors of 17 h.p. were being wired. The number of units generated was an increase of 88 per cent. over the number generated during the corresponding period of last year.

Croydon.—The Lighting and Electricity Committee have adopted the report and estimate noted in our last issue, and application is to be made for sanction to the borrowing of £70,950. The borough electrical engineer's last report states that 11 applications have been received, being equivalent to 479 8-c.p. lamps; 16 consumers have been connected, being equivalent to 694 8-c.p. lamps. He appended the following figures: private lighting, current sold, 1903, 51,141 units (corresponding period last year, 35,630 units); public lighting, 24,948 units (17,868 units); traction, 92,080 units (81,811 units).

Guildford.—The Guildford Electricity Supply Company, Limited, have been requested to extend their mains by the main Epsom road to the village of Merrow. On account of the expense required they have asked the Council to allow them to erect overhead wires. The Board of Trade have no objection to this if the consent of the local authority is obtained. The matter has been referred to the County Council, with an expression of the Rural Council's opinion that it was not desirable that electricity should be conveyed by means of overhead wires. The Inland Waterways, Limited, intend to apply to the Board of Trade next session for a provisional order to enable them to supply electricity in the Council's district.

Carmarthenshire Electric Power Bill.—In the House of Commons last week the Lords' reason for having disagreed to one of the Commons' amendments to the Carmarthenshire Electric Power Bill was considered. Mr. J. Lowther moved that the House do not insist on the amendment to the Bill providing that the expression "authorised undertakers" means any authority authorised by any general or special Act to undertake or contract for the lighting of streets, bridges, or public places within any part of the area of supply as defined by the Act. The ground of the Lords' objection to this amendment was that the expression "authorised undertakers" did not appear elsewhere in the Bill. The motion was agreed to.

Egypt.—Messrs. Eug. Nahman and Co. have obtained from the Egyptian Railways Administration an order for the electric lighting plant of the Gabbary Station, Alexandria. The whole plant comprises two groups of 55 arc lamps each, in series, and 200 incandescent lights. The engine-house comprises three groups of Robey's compound high-speed vertical engines and condenser; Babcock and Wilcox's steam boilers with economisers; and superheaters, series-type dynamos, and arc lamps of the Brush Electrical Manufacturing Company's make; also two groups of Crossley's oil-engines, and shunt dynamos of Brown-Boveri's make. The work is being carried out under the supervision of their engineer, Mr. R. Levi, C.E.

West Bromwich.—The Highway Committee of the Corporation have issued a report with respect to the lighting test between gas and electricity which has been going on in the town's main thoroughfare for some three months past, and which has created considerable local interest. After the experiment had been carried out the respective committees submitted quotations of the prices at which they would be prepared to continue the lighting of the tramway poles. The committee, after carefully considering the matter, recommend that electric lighting by means of two 1,000-c.p. arc lamps on alternate poles be adopted from Carter's Green to the Beeches-road, and that the existing gas lamps be removed. The net cost will be £600 per annum.

Londonderry.—At a special meeting of the Corporation last week a motion was carried in favour of issuing mortgages of the rates for the purpose of carrying out the private electric lighting and power scheme at a cost of about £15,000. It will be remembered that the Local Government Board had sanctioned the loan, but the Board of Works refused to issue the money on the ground that the electric light scheme was a commercial enterprise, and the Corporation could issue stock for both purposes. The Corporation, however, found that stock could not be issued at the rate of interest and minimum price fixed by the regulations made under the Local Government Board under the Public Health Amendment Act, and therefore will issue mortgages on the rates.

North-Western Electricity and Power Gas Bill.—The promoters of this Bill intend to ask Parliament, now that Cheshire has been excluded from the operations of the company, for power to construct in Derbyshire, on lands purchased by agreement all the apparatus necessary for the production of electricity and Mond gas for the northern part of Derbyshire. It has been intended to supply Glossop, New Mills, Disley, Buxton, etc., from a generating station near Macclesfield. The striking of Cheshire out of the Bill prevented that being used, and no specific station was mentioned in the Derbyshire area, which is now isolated from the others. The capital of the company, notwithstanding the restriction of its area of supply, will remain at its original figure of £1,500,000, and the Bill has been ordered to be reported for third reading.

Edinburgh.—A report is before the Works Committee in which the engineer says: "It is admitted by all public authorities that the best illuminating effect is obtained by a judicious distribution of comparatively small-power lamps, rather than by the concentration of high-power lamps at less frequent centres. The finest examples of this system are to be found in Paris, Berlin, Amsterdam, Cologne, and, in fact, one might say in all important towns and cities on the continent of Europe, where incandescent street-lighting may be said to reign supreme. In order, however, that a comparison may be made between the present electrically-lighted streets of Edinburgh and high-power gas-lighted thoroughfares, I have gone carefully into the matter, and I am prepared to advise the Commissioners to offer to supply lamps yielding an equal illuminating power to that given by the present electric arc lamps, including upkeep, lighting, cleaning, extinguishing, etc., at the rate of £10 per lamp per annum."

Bradford.—Last year's electricity fund revenue account shows a gross profit for the year of £40,057, against which £31,144 has been debited for interest and sinking fund charges, leaving a net profit of £8,923. Of this net profit £8,436 has been appropriated to depreciation account, leaving a surplus of £487. The total net profits since the commencement of the works in 1889 were £46,202, from which £31,911 was written off in respect of the depreciation of plant, leaving unappropriated the sum of £13,291, which has been accumulated in accordance with the provisions of the electric lighting order. Having regard to the very adequate amount provided under the head of depreciation (£32,911), in addition to setting aside £58,765 for extinguishment of debt, it must be conceded that the remaining surplus of £13,291 affords a sufficient argument from a financial point of view for the establishment by the municipality of this undertaking, which up to the present has proved itself capable of serving the public demand for this class of illumination and motive power.

Walton-on-Thames. — The clerk reported at the last meeting that, on perusing the draft agreement forwarded by the National Telephone Company in respect of the proposed fire calls, he found it to contain a clause which would involve the granting of wayleaves over all the Council's property for that or any other contract. He sought to limit them to the present contract, but the company wrote that they would be unable to connect Walton and Hersham unless the Council granted a free wayleave over the whole road. They pointed out that at Weybridge the local Council had agreed to a similar clause. The clerk observed that the company had always tried in their agreements to get something of the sort inserted, knowing that the Council objected to their putting up telephone poles promiscuously all over the parish. The Fire Brigade Committee reported that they had received a tender from Mr. V. C. Badois, of Windsor, for the provision of fire calls at Walton for £40, and at Hersham for £14, with £2. 10s. per annum for maintenance, and the erection of a line connecting Hersham with Walton for £50. 14s. They recommended that the tenders for the Walton and Hersham calls be accepted, but not that for the connecting wire. The report was adopted, it being stated that no further steps would be taken in regard to the suggested arrangement with the Telephone Company.

Hampstead. — With a view to improving the draught in the chimney at the electric lighting station, steam jets are to be fitted to two of the boilers, as an experiment, at a cost of £30. No objection will be offered to the Bill authorising the Board of Trade to make provisional orders for the supply of electricity in bulk by companies to local authorities and with reference to the compulsory power of purchase of land for generating stations. The borough accountant reported last week that the receipts from the electric lighting undertaking for the Midsummer quarter this year amounted to £6,850. 11s. 3d., as compared with £5,853. 5s. 4d. for the corresponding quarter last year. The chief electrical engineer reported that during the year ended March 31 the works costs had been reduced from 1·89d. to 1·61d., or ·28d. per unit; the coal being ·12d. less, which alone amounted to £1,296 on the units sold; that the works costs were this year £17,390 against £16,785 last year, or an increase of £605 for an increase in units sold of 465,301; the units sold the previous year (1901-2) being 2,127,173, against 2,592,474 for 1902-3; that these costs represented a percentage increase of 3·6 per cent. for 21·8 per cent. increase in units sold; that the total costs (excluding interest and sinking fund) were ·46d. per unit less than the previous year—reduced from 2·69d. to 2·23d.—being £23,832 for 1901-2 and

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£24,096 for 1902-3; that the actual average total cost (including interest and sinking fund) per unit sold for 1901-2 was 4·06d, while for 1902-3 it was 3·92d.; and that the actual average revenue per unit sold for 1901-2 was 4·34d. against 4·33d. for 1902-3. The Works Committee reported that the consumption of electric light in the workhouse was now normal.

Manchester.—The members of the Electricity Committee of the Manchester Corporation made their annual inspection last week of several of the sub-stations and some of the work in progress in connection with the street mains under the conductorship of Councillor Bowes, chairman of this department of the electricity undertaking. At the Hunt's Bank battery station Mr. Bowes spoke of the advisability of doing away with it so far as the accumulators are concerned, and simply using the place as a balancing station. In that way a considerable saving would be effected. Mr. Bowes also gave some figures to show the magnitude of the committee's work. There were 20 sub-stations, 12 within the city and the rest in the districts which the Corporation have agreed to supply with current. The total outlay for buildings and machinery will exceed £200,000. Ten of the sub-stations are in connection with Dr. Kennedy's installation of 15,000 h.p. at Stuart-street, and the other 10 are in conjunction with Mr. Metzger's extension of 12,000 h.p., which is now being installed at Stuart-street. The total length of mains on March 31 last exceeded 288 miles of actual main and 633 miles of single cable (exclusive of service cable). The capital expenditure on mains amounts to £670,000. The area supplied by the present mains is approximately 18 square miles, but as the total area in which the Corporation have power to supply current will embrace 43 miles, it is evident, he thought, that the work of the department could not be regarded as approaching its completion. During the past 12 months the units of electricity sold for lighting and power purposes were 9,352,000, and for traction purposes 7,986,000—a total of 17,378,000. It is estimated that in the current year the total sales will reach 26½ million units.

Islington.—The last report of the Finance Committee contains the following report: "It will be observed that in the estimate of the Lighting Committee provision is made for £9,912 as the cost of street-lighting by electricity. In our last half-year's report we drew the attention of the Council to the fact that the price paid for current to the electric arc lamps—namely, 3½d. per unit—does not represent the cost of production and maintenance, and that, as a matter of fact, there is a serious loss occasioned to the undertaking by pursuing this policy. Last year the loss amounted to £6,015. As we understand that the Lighting Committee are about to recommend the Council to pay an increased price for current in order to prevent the recurrence of these deficiencies, we do not propose to add to the observations which we made in our former report, but we trust the Council will see their way to adopt the Lighting Committee's recommendation, and so enable us to properly establish a depreciation fund (which we would again remind the Council has not yet been started), and thereby comply with the obligations imposed upon and accepted by the Council in connection with every loan sanctioned." The Lighting Committee have reported as follows: "We have had under consideration a report from the borough treasurer upon the accounts of the electric lighting undertaking for the year ended March 31, 1903, from which it appears that a heavy loss is caused to the undertaking by reason of the current for public arc lamps being supplied at less than cost price, thereby precluding the provision of a reserve fund for depreciation. The exact cost of production per unit of electricity during the past year as shown by the accounts was 4·44d., while the charge made to the Council is only 3½d. per unit. We are of opinion that the Council should pay the actual cost of the electricity consumed for public street-lighting, and we therefore recommend that as from March 31 last the charge for public arc lamps be increased to the exact cost to the undertaking of production and maintenance."

Liverpool.—The electric supply accounts, after paying interest, show a credit of £61,141. 14s. 8d., which has been dealt with as follows: sinking fund, £27,726. 5s.; reserve fund, £10,000; renewal fund, £11,386. 9s. 8d.; contribution to rates, £12,029—£61,141. 14s. 8d. The reserve and renewal fund has been formed for the purpose of providing depreciation, and it has now a credit of £83,243. 19s. The loans, the repayment of which is provided by the sinking funds, are for periods of 42 and 25 years respectively—£500,000 for 42 years, this being the sum borrowed to purchase the undertaking and provide working capital, and £1,000,000 for 25 years. The whole of this last sum has not been raised or expended. The accountant in his report says: "With regard to the question of depreciation it is necessary to consider the different classes of assets which require to be maintained in order to keep the undertaking in efficient working order, and the amount expended on these assets. The provision made for the redemption of the debt by the sinking fund is, we consider, all that is necessary for certain assets, such as goodwill, land, and buildings. The remaining assets of the company consist of mains, and machinery, accumulators, meters, and electrical instruments. We are unable to arrive at the total expenditure on each class of assets, as the figures were not given separately in the company's balance-sheet. In the last balance sheet of the company mains and machinery stood at £214,578. The amounts expended by the Corporation are as under: mains, £377,549. 9s. 5d.; machinery, £267,121. 19s. 5d.; accumulators, £8,617. 9s. 11d.; meters, £20,221. 0s. 6d.; electrical instruments, £3,648. 9s. 1d.; old company's mains and machinery, £214,578; Garston undertaking (stations, mains, and machinery), £39,069. 4s. 1d.—total, £930,805. 12s. 5d. The engineer states that the depreciation on mains is very slow, and that it is more than provided for by the sinking fund in operation. It has, however, to be taken into consideration that in course of time, and as the demand increases, it may be necessary to replace some of the present mains and lay larger ones. This has already been required in some cases. The amount transferred this year for reserve and renewals is £21,386. 9s. 8d., this sum being equal to about 2·30 per cent. on the capital expenditure of £930,805, which is in addition to the provision of the sinking fund. The engineer informs us that, having regard to the fact that about one-half of the expenditure was for mains (not requiring any further provision than that provided by the sinking fund), it leaves a large portion of the reserve and renewal account to provide for depreciation on machinery account. He is of opinion that the course pursued by the committee, if continued, will leave the city with an undertaking free of debt and in working order at the end of the period over which the loans extend. The depreciation allowed is at a higher rate than that provided by the old company."

Electric Pumping in Collieries.—The Elswick Coal Company, of Newcastle-on-Tyne, have, we understand, placed a contract with Messrs. Ernest Scott and Mountain, Limited, of the Close Works, Newcastle-on-Tyne, electrical and general engineers, for a complete electric pumping plant for their North Elswick Colliery. The colliery company propose to take the electric current for driving the pumps from the town supply mains. The plant consists of a Scott and Mountain horizontal slow-speed, three-throw ram pump, delivering 400 gallons per minute against a vertical head of 800ft., the pumps being driven by a Scott and Mountain multipolar continuous-current electric motor being placed at the shaft bottom, and delivering to the rising main to bank. The current will be taken from the supply company's mains to the shaft top, then down the shaft to the pumps in-bye, these cables being of sufficient capacity to transmit 150 h.p. at 500 volts, the cables being insulated and heavily armoured for protection in the shaft. An installation of somewhat novel character, recently secured by the same firm, is for an electric conveyor of the Brothers type for conveying the railway material from side of the Victoria Falls on the Zambesia to the other, and also to be used in connection with the erection of a bridge which the Cleveland Bridge and Engineering Company are supplying. The electric conveyor consists of a hoisting and travelling gear, which runs upon a wire rope suspended from one side of the falls to the other, the distance being 830ft., and the weight of the rope and the load is supported at each end by balanced cantilevers. The wire rope is being supplied by Messrs. T. and W. Smith, of Newcastle, and the cantilevers and other work by the Cleveland Bridge Company. The current for driving this plant is generated by a steam-engine and dynamo on one side of the falls, the current being conveyed across the falls by a hard-drawn copper conductor, and collected by rollers as the traveller runs along. We are also informed that Messrs. Ernest Scott and Mountain are busy with mining work, having contracts in hand for Walbottle Colliery, Consett Iron Company, Limited, both these collieries being in the Newcastle district; also for Wigan Coal and Iron Company, Limited, near Manchester, the Llay Hall Colliery, North Wales, etc.

New Issues.—The North Wales Power and Traction Company are making an issue of 50,600 shares of £5 each. From the prospectus, which appears in another column, it will be seen that the scheme on which the company is based comprises the generation of electrical energy at a low cost by means of water power from lakes on Snowdon and in the neighbourhood of Conway, without steam power and the expense of coal. The current will be supplied to a short railway, subsequently referred to, which is to be extended and electrified; to certain towns in the district of Snowdon, to local quarry owners, and in bulk to more distant consumers. Under the Portmadoc, Beddgelert, and South Snowdon Railway Act, 1901, the Portmadoc Company was incorporated by the name of the Portmadoc, Beddgelert, and South Snowdon Railway Company, with an authorised share capital of £270,000, and with borrowing powers. One of the objects of this company is to acquire by subscription the whole of the capital that it may be found necessary to issue of the Portmadoc Company, which will own and operate the Portmadoc undertaking. Under the Act, the Portmadoc Company may abstract, impound, appropriate, and use the waters of Lake Lyldaw and Lake Teyrn, and develop power by means thereof. The directors anticipate that the whole of the power not required for the railway and lighting purposes will be readily disposed of for use locally. The area of supply under the Act is the parishes of Beddgelert, Criccieth, and Ynyscynhaiarn (Portmadoc), but it is expected that the cheap rates at which the company will be able to supply energy in bulk will induce railway companies and other large consumers at a distance to take steps to connect with the company's system. Subscriptions for 35,500 shares, which is the minimum subscription, having been guaranteed, the lists will close for town and country to-day.—The Consolidated Electrical Company, Limited, are making an issue of 15,000 cumulative 6 per cent. preference shares of £1 each. This company was formed on April 16, 1903, and is a reconstruction of the Consolidated Telephone Construction and Manufacturing Company, Limited, whose business was taken over as a going concern. The authorised capital is £125,000 in shares of £1 each, of which 109,096 have been issued as ordinary shares, and 904 ordinary shares are held in reserve for future issue. The object of the reconstruction was to provide the undertaking with working capital for the development of its manufacturing business, which is of a high-class character, and mainly with the General Post Office, the Admiralty, the War Office, and other Government departments, railway companies, telephone companies, and municipal authorities. The reconstruction gave the company an initial cash capital (subject to payment of preliminary and legal expenses, underwriting, etc.) of about £28,000, of which about £16,000 is still uncalled. According to the prospectus, which appears in another column, the net profits of the old company for the last three years, as per the published accounts audited by Messrs. Deloitte, Dever, Griffiths, and Co., after deducting administration and all other charges, debenture interest, etc., were: 1900, £2,982; 1901, £2,474; and 1902, £2,497. Hitherto the dividend on the Anglo-Portuguese Company's shares has been restricted to 3 per cent., about £40,000 of profits having been appropriated to capital purposes. The need for a continuance of this policy no longer exists, and future dividends should therefore be at a higher

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rate, the surplus net earnings being equal to more than 10 per cent. on the share capital. A dividend of 10 per cent. on the Anglo-Portuguese shares would give the new company an additional net income of nearly £2,000 per annum. A trading profit of only 10 per cent. on the new capital brought into the new company as the result of the reconstruction, etc., would further increase the income by about £2,500 per annum. These two additional sources of income, added to the profits above mentioned, would give a total net income of from £5,000 to £7,000 per annum, on which the preference dividend of £900 per annum would be a first charge.

PROVISIONAL PATENTS, 1903.

JULY 23.

16232. Improvements in the manufacture of electrical resistances. Thomas Edgar Weaver, 134, Claremont-road, Moss Side, Manchester.

16258. Improvements in rotors for electrical machines. Alfred George Brooks, 55, Chancery-lane, London. (Electricitäts-Gesellschaft Alioth, Switzerland.) (Complete specification.)

16294. Improvements in electric arc lamps. Heinrich Beck, 18, Southampton-buildings, Chancery-lane, London. (Complete specification.)

16300. A coupling for wires, cables, and the like adapted for use both for mechanical and electrical purposes. James Ernest Spagnoletti, 53, Chancery-lane, London.

JULY 24.

16348. Improvements in electrical stop motion mechanism for textile machinery. Joseph Botsford Whitney, 11, Southampton-buildings, Chancery-lane, London. (Complete specification.)

16360. Improvements in means for breaking electric circuits. Carl Bennett Auel and John Rudolph Spurrier, Westinghouse-building, Norfolk-street, Strand, London.

JULY 25.

16388. An improved tumbler switch for electrical purposes. Veritys, Limited, and Daniel Evan Rogers, Victoria Works, Plume-street, Aston.

16425. Improvements in telephone exchange systems. William Aitken, Milton-road, Edge-lane, Liverpool.

16440. Signalling apparatus worked by alternating currents. Siemens Bros. and Co., Limited, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Siemens und Halske Aktiengesellschaft, Germany.) Complete specification.)

16454. Improvements in shuttles and electrical mechanism for indicating approaching failure of weft in looms for weaving. José Reixach and Herbert Scott, 24, Southampton-buildings, Chancery-lane, London.

COMPLETE SPECIFICATIONS ACCEPTED.

To be published August 20, 1903.

1902.

16419. Shuttles used in weaving for electrically changing the shuttle before the weft has become completely exhausted. Davidson.

16439. Application of electric motors for automobile vehicles. Sefton-Jones. (Cantono.)

16529. Apparatus for reducing attenuation of electrical waves in conductors or cables. Pupin. (Date applied for under International Convention, Dec. 14, 1901.)

16550. Controlling alternating electric currents for signalling. Thompson.

16664. Trolley heads or collectors for electrically-propelled vehicles. Mercier.

16695. Prepayment or coin-controlled electric meters. Harrison and Bastian.

16904. Regulating devices for dynamo-electric machines. Lake. (General Electric Company.)

16927. Starting devices for induction and other electric motors. Lake. (General Electric Company.)

17300. Clamps for trolley wires. Lake. (General Electric Company.)

17630. Electric arc lamps. Lake. (General Electric Company.)

18066. Charging devices for electromobiles. British Thomson-Houston Company, Limited. (Cox.)

18068. Electric transformers. British Thomson-Houston Company, Limited. (Everest.)

18317. Electric motor control systems. British Thomson-Houston Company, Limited. (Mundy.)

18318. Electric transformers. British Thomson-Houston Company, Limited. (Moody.)

18319. Electric switches and cut-outs. British Thomson-Houston Company, Limited. (Badeau.)

18321. Electric motor control systems. British Thomson-Houston Company, Limited. (Case.)

18632. System of control for multiple-unit electric trains. Von Zweigbergk.

20886. Automatic lifeguard to be attached to electric cars. Palmer.

20931. Automatic electric fire-alarms and generally applicable to heat-operated signalling and controlling devices. Venner.

22233. Electric heating apparatus. De Mare.

22551. Electrical signalling system for railways. Mills and Piddington.

23461. Magnetic apparatus for the distribution of current to electric tramways and railways by road contact. Mills. (Diatto.)

1903.

2393. Electric power systems, especially applicable to railway and tramway vehicles. Thorn

6546. Electrically-operated railway switches and signals. Neelemans.

7713. Electric switching arrangements. Evans. (Allgemeine Electricitäts-Gesellschaft.)

9576. Telephonic apparatus. Wood.

10298. Secondary or storage batteries. Lake (Darling and Chronik.)

11125. Brush-holders for dynamo-electric machines and electric motors. Johnson-Lundell Electric Traction Company, Limited. (Lundell.)

11826. Electric driving mechanism for centrifugal machines. Evans. (Allgemeine Electricitaets-Gesellschaft.)

14558. Electromagnets. Lindquist.

14575. Holders for electric incandescent lamps. Kleber.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.	Last price
Commercial and Industrial.—	£	£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1 ..	½-¾
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1 ..	¼-½
British Insulated and Helsby Cables, Ord., 1-100,000	5 ..	6¾-7¼
—— 6 per cent. Cum. Pref., 1-100,000	5 ..	5¼-5¾
—— 4½ per cent. Mortgage Debentures	100 ..	102-106
British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red.	100 ..	104-106
British Westinghouse Elec. and Manuf., 6 per cent. Pref., 275,001-375,000	5 ..	5¾-6
—— 4 per cent. Mortgage Debenture Stock	100 ..	100-102
Brush Electrical Engineering, Ordinary, Nos. 1-105,731	2 ..	¾-1¼
—— Non. Cum., 6 per cent. Pref.	2 ..	1-1¼
—— 4½ per cent. 1st Debenture Stock	100 ..	99-102
—— 4½ per cent. 2nd Debenture Stock	100 ..	87-92 xd
Callender's Cable, Debentures	100 ..	106-110
—— Ordinary	5 ..	11½-12½
—— 5 per cent. Pref.	5 ..	5¼-5¾
Crompton and Co.	3 ..	2-2½
—— 5 per cent. Debentures	100 ..	101-105
Edison and Swan United, "A" Shares, 1-99,261	3 ..	¼
—— "A" Shares, 01-017,139	5 ..	1½-2¼
—— 5 per cent. Debentures	100 ..	75-80
—— 4 per cent. Deb. Stock, Red.	100 ..	71-75
Electric Construction, Limited, Nos. 1 to 112,100	2 ..	1½-1¾ xd
—— 7 per cent. Cumulative Pref.	2 ..	2½-3
—— 4 per cent. Perp. 1st Mort. Deb.	100 ..	99-102
Ferranti Limited, 5 per cent. 1st Mort. Deb. Stock, Red.	100 ..	90-95 xd
General Electric Company (1900), 5 per cent. Cum. Pref.	10 ..	9¼-10
—— 4 per cent. 1st Mort. Deb. Stock	100 ..	99-102
W. T. Henley's Telegraph Works, Ordinary	5 ..	14-15
—— 4½ per cent. Preference	5 ..	5-5½
—— 4½ per cent. Debentures	100 ..	108-112
India Rubber, Gutta Percha, and Telegraph Works	10 ..	18½-19½
—— 4 per cent. Debentures	100 ..	100-103
Parker, Thos., Limited, Ordinary	10 ..	14½-15½
Telegraph Construction and Maintenance	12 ..	32-35 xd
—— 5 per cent. Bonds	100 ..	100-103
Electric Lighting and Supply.—		
Blackheath & Greenwich District Ordinary 1,201-101,200	1 ..	¾-⅞
—— 4½ per cent. Deb. Stk. Certs., Red. and Conv.	100 ..	118-121
Bournemouth and Poole, Ordinary	10 ..	12½-13½
—— 4½ per cent. Cum. Pref., 7,501-15,000	10 ..	10-11
—— 6 per cent. Cum. Second Pref., 15,001-22,500	10 ..	10½-11½
—— 4½ per cent. Debenture Stock, Red.	100 ..	102-105
Bromley (Kent) Electric Light and Power Co., 4½ per cent. 1st Debenture Stock, Red.	100 ..	102-105
Brompton and Kensington, Ordinary	5 ..	10½-11
—— 7 per cent. Preference	5 ..	10½-10¾
Calcutta Electric Supply Corp., Ordinary, Nos. 1-40,000	5 ..	6½-7½
—— Nos. 20,001-30,000	5 ..	7-8
Cambridge Electric Supply Company, Ltd., £10 Ord.	8 ..	14½
—— " " " £10 Ord.	6 ..	10¾
Central Electric Supply, Ld., 4 per cent. Guar Deb. Stock	100 ..	106-109
Charing Cross and Strand, Nos. 1-70,000	5 ..	9-9½
—— 4½ per cent. Cum. Pref.	5 ..	5¼-6
—— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000	5 ..	4¾-5
—— 4 per cent. Debenture Stock, Red. (Prov. Certs.)	100 ..	104-106
Chelsea Electricity Supply	5 ..	5¾-6½
—— 4½ per cent. Debentures	100 ..	107-110
City of London, Ordinary	10 ..	10¾-11¼
—— 6 per cent. Cumulative Pref.	10 ..	13-14
—— 5 per cent. Debenture Stock	100 ..	121-126
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100 ..	102-105
County of London and Brush Provincial, Ordinary	10 ..	8-9
—— 6 per cent. Cum. Pref.	10 ..	11¼-12½
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	100 ..	109-112
Edmundsons' Electricity Corporation, Ordinary, 1-50,000	5 ..	6½-6¾
—— 6 per cent. Cum. Pref.	5 ..	6-6½
—— 4½ per cent. First Mort. Deb.	100 ..	106-109
Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-30,000	5 ..	3¼-4¼
—— 5 per cent. Debenture Stock, Red.	100 ..	95-98
Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000	5 ..	6-6½
—— 4½ per cent. First Deb. Stock, Red.	100 ..	100-103
Hove Electric Lighting, Limited, Ord., 1-13,000	5 ..	8-9
Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000	5 ..	10¼-11¾
—— 4 per cent. Debenture Stock Red	100 ..	103-106

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Name.	Amount paid.	Last price.
	£	£
Kensington and Knightsbridge and Notting Hill	100	103-106
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	9½-10½
London Electric, Ordinary	5	2-2½
—— 6 per cent. Pref.	5	5½-6
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	100-102
Metropolitan, Ordinary	10	17½-18½
—— 4½ per cent. First Mortgage Debenture Stock	100	108-112
—— 3½ per cent. Mortgage Debenture, Red.	100	97-100
Newcastle-upon-Tyne Electric Supply, Ordinary	5	100-103
—— Preference	4	102 105
Notting Hill Electric Lighting	10	13-14
—— 4 per cent. First Mort. Debs., Nos. 1-500 (Reg.)	100	99-102
Oxford Electric, Ordinary, 1-96 and 407-14,310	5	5-6
—— 4 per cent. Debenture Stock	100	98-101
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100	100-102
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5	3½-3¾
—— 4 per cent. Debenture Stock	100	88-90 xd
South London, Ordinary	5	3¼-4
St. James's and Pall Mall, Ordinary, 101-20,080	5	15-16 xd
—— 7 per cent. Pref.	5	8-9
—— 3½ per cent. Deb.	100	98-101
Urban Electric Supply Co., Ordinary, 8-30,007	5	5-5¼
—— 5 per cent. Cumulative Preference, 50,001-80,000	5	5-5¼
Westminster, Ordinary	5	12½-13½ xd
—— 5 per cent. Cum. Pref., 110,101-138,251	5	6-6½

Electric Railways.—

Central London, Ordinary	100	103-106
—— 4 per cent. Pref.	100	102-105
—— ,, ,, deferred	100	105-108
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100	115-118
City and South London, Consolidated Ordinary	100	63-65
—— 4 per cent. Debenture Stock	100	116-119
—— 5 per cent. Pref. Stock '91	100	128-132 xd
—— ,, ,, ,, '96	100	128-131
—— ,, ,, ,, '01	100	126-129
Liverpool Overhead, 5 per cent. Pref.	—	13-13½
—— Ordinary, 1-50,000	—	7⅞-8
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	—	102-104
Waterloo and City, Ordinary	100	97-100

Electric Tramways.—

Anglo-Argentine, 1-250,007	5	4¼-4⅜
—— Permanent 6 per cent. Debenture Stock, 1888	100	125-130
Blackpool and Fleetwood Tramroad	10	13½-14½
Brisbane Tramway Invest., Lim., Ord., 1-75,000	5	2¾-3¼
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5	4¼-4⅜
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100	100-103
British Columbia Electric Railway Co., Ord., Nos. 1-20,000	100	69-72
—— Non-Cum. 5 per cent. Pref., Nos. 25,001-38,600	100	92-96
—— 4½ per cent. 1st Mt. Debs., Nos. 1-6,250, of £40 each	40	104-106 p.c
British Electric Traction, Ord., 1-300,000 & 60,001-90,000	10	11¼-11⅝
—— 6 per cent. Cm. Pf., 30,001-60,000	10	11½-11⅝
—— 5 per cent. Perpetual Debenture Stock	100	122-126
Buenos Ayres and Belgrano Tram., Ord., 1-100,000	5	2⅜-2⅝
—— "A" 6 per cent. Cm. Pf., 1-40,000	5	5-5¼
—— "B" 6 per cent. Cm. Pf., 1-27,500	5	4⅜-5¼
—— 5 per cent. Deb. Stock, Red.	100	106-108
—— Prov. Cert., all paid	100	98-101
Cape Electric Tramways, Nos. 1-480,000	1	2-2¼
City of Birmingham Tramways, 5 per cent. Cum. Pref.	10	5-5¼
—— 4 per cent. 1st Mortgage Deb., 1-3,000 (1917)	100	99-102
Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red.	100	102-105
Cork Electric Tramways and Lighting Co., Ordinary	10	13-14
—— 5 per cent. Cum. Pref.	10	11-12
—— Debentures	100	96-99
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10	13-14 xd
—— 6 per cent. Pref., Nos. within 1-60,000	10	14½-15½
—— 5½ per cent. Mort. Debs., 1-3,000, Red.	100	94-97
Imperial Tramways, Ordinary	all	22-22½
—— 6 per cent. Cum. Pref.	all	14½-15½
—— 4½ per cent. Deb. Stock	100	112-114
Isle of Thanet Electric Tramways and Lighting, 5 per cent. Cum. Pref., Nos. 30,001-60,000	5	4-4½
—— 4 per cent. Debenture Stock	100	92-95
Kidderminster and District Lighting and Traction, Pref.	5	¾-1
London United Trys. (1901), 5 per cent. Cum. Pref.	10	11½-12½
—— 4 per cent. 1st Mt. Db. Stock, Red.	100	105-107
Metropolitan Electric Trams., Deferred, 1,000,001-1,314,016	1	3/16-5/16
—— 5 per cent. Cum. Pref., 500,001-814,016	1	¾-1⅛
New General Traction, Ordinary	5	¼-1
—— 6 per cent. Cum. Pref.	5	2-3
—— 5 per cent. Mortgage Debentures, 1-1,713 (Regd.)	100	88-93
Oldham, Ashton, and Hyde Tramway, Ordinary	10	10½-10⅝
—— 5 per cent. Cum. Pref.	10	11¾-12⅛
Perth Elec. Tramways (W.A.) 5 per cent. 1 Mort. Deb. Stk.	100	99-102
Potteries Electric Traction, Ordinary, 20,001-40,000	10	8¾-9¼
—— 5 per cent. Cum. Pref., 1-20,000	10	9¾-10¼
—— 4½ per cent. Debenture Stock	100	102-105
South Lancashire Electric Traction and Power Company—		
—— £250,000 Ordinary	1	1
—— £101,132 5 per cent. Preference	1	1
—— £528 093 4½ per cent. Debenture Stock	100 p.c.	100 p.c.

Telephones.—

National Telephone, Preferred	100	100-102
—— Deferred Stock	100	79-81
—— 6 per cent. Cum. First Pref.	10	13-14
—— 6 per cent. Cum. Second Pref.	10	13-14
—— 5 per cent. Non. Cum. Third Pref.	5	5-5¼
—— 5½ per cent. Deb. Stock, Red.	100	96-98
—— 4 per cent. Deb. Stock, Red.	100	101-103
Oriental Telephone and Electric Company	1	13/16-15/16

TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line	Traffic Returns for week			Increase or decrease.		Miles of single track open.		Accounts for past year.						Cost per car mile.
	Ending	1903.	1902.	Week.	Current year.	1903.	1902.	Ending	Total receipts	Passengers carried.	Car miles run.	Receipts per Pas-s'nger	Receipts per Car mile.	Receipts per Mile of track.	
		£	£	£	£							d.	d.	£	d.
Aberdeen Corporation	Aug. 1	1,251	1,319	− 68	+ 1,355	19½	17½	May 31	37,931	9,099,715	794,641	0·98	13·02	1,970	6·14
Ayr Corporation	—	—	—	—	—	8	6	Sept. 25	12,503	2,979,276	290,099	1·00	10·34	1,560	4·7
Birmingham Tramways	,, 1	5,112	4,881	+ 231	+ 7,269	6½	6½	—	—	—	—	—	—	—	—
Blackburn Corporation	—	—	—	—	—	24	24	March 25*g*	40,964	7,234,106	826,558	1·36	11·87	1,705	7·44
Blackpool Corporation	—	—	—	—	—	17½	16½	,, 31	211,168	6,169,121	784,443	1·52	10·8	—	—
Blackpool-Fleetwood Tramways	,, 1	1,176	1,183	− 7	+ 271	16½	16½	Dec. 31	30,923	2,049,677	584,989	3·62	12·68	1,932	6·99
Bolton Corporation	,, 1	1,791	1,609	+ 182	+ 4,810	25	25	March 31	85,704	17,761,605	1,896,247	1·15	10·75	3,430	5·87
Bournemouth Corporation	July 29	1,009	—	—	—	10½	—	—	—	—	—	—	—	—	—
Bradford Corporation	Aug. 3	4,035	3,390	+ 615	+ 7,938	39	—	—	—	—	—	—	—	—	—
Brighton Corporation	,, 3	1,033	998	+ 35	+ 5,417	6½	—	,, 31	—	10,432,508	1,031,928	1·00	10·10	—	—
Bristol Tramways Company	July 31	5,114	4,847	+ 267	—	51½	51½	Dec. 31	223,480	41,192,899	5,724,114	1·30	9·38	4,348	—
Burnley Corporation	Aug. 1	825	680	+ 145	—	—	—	—	—	—	—	—	—	—	—
Cardiff Corporation	,, 1	2,133	1,535	+ 598	+12,345	—	—	—	—	—	—	—	—	—	—
Carlisle Tramways Company	—	—	—	—	—	—	—	,, 31	—	2,216,583	320,129*h*	—	—	—	—
Central London Railway	,, 1	6,175	5,981	+ 194	+ 265*h*	6	—	,, 31	367,225	45,305,110	1,276,971*a*	1·87	66·6*a*	59,076	35·6*a*
City and South London Railway	,, 2	2,555	2,667	− 142	− 1,069	6⅜	—	,, 31	165,003*a*	19,069,319*a*	—	—	—	—	—
Cork E. T. and L. Company	July 30	737	788	− 51	− 527	—	—	—	—	—	—	—	—	—	—
Darwen Corporation	,, 10	220	243	− 23	− 113	7·23	—	March 31*g*	12,341	2,360,735	254,279	1·25	11·65	1,707	9·36
Dover Corporation	Aug. 1	270	276	− 6	+ 121	3	—	—	—	—	—	—	—	—	—
Dublin & Lucan Electric Railway	,, 2	132	128	+ 4	+ 51*h*	—	—	Dec. 31	5,796	364,796	102,087	3·81	13·62	859	7·68
Dublin U. T., electric cars	July 31	4,411	4,011	+ 400	+5,777	46	46	March 31	126,121	24,553,133	3,429,356	1·23	8·82	2,741	5·06*h*
Dublin S. District, Electric	,, 31	1,164	1,053	+ 101											
Dundee City Tramways	,, 15	834	718	+ 116	—	22	22	May 15	35,874	9,084,522	752,814	0·93	11·276	1,630	—
East Ham Corporation	Aug. 1	657	491	+ 166	—	10·75	7·52	March 31	25,341	9,971,337	650,224	0·61	9·35	2,357	—
Farnworth U.D.C.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Glasgow Corporation	,, 1	12,408	11,167	+1,241	+15,635	124	101	May 3	653,200	177,179,549	14,008,750	—	—	—	—
Halifax Corporation	—	—	—	—	—	30¼	27¾	—	—	—	—	—	—	—	—
Huddersfield Corporation	—	—	—	—	—	34	35	March 31	56,631*h*	9,758,213	1,218,539	1·4	11·14	1,618	6·38
Hull Corporation, E. S.	,, 1	1,827	1,681	+ 146	+ 2,017	19	19	,, 31	87,707*h*	21,065,999	2,218,696	1·00	9·49	5,004	5·07
Ilkeston Corporation	July 29	190	—	—	—	—	—	—	—	—	—	—	—	—	—
Kirkcaldy Corporation	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Leeds Corporation	Aug. 1	5,687	6,314	− 655	+ 5,934	77	—	March 25	262,656	57,239,779	5,773,651	1·11	10·91	3,283	—
Liverpool Corporation	July 25	10,815	10,243	+ 573	+11,082	101	95	Dec. 31	504,304	108,906,472	11,705,425	1·11	10·34	5,000	6·88
Liverpool Overhead Railway	Aug. 2	1,728	1,694	+ 34	+ 503	15½	15½	June 30	79,252	10,466,726	986,185*a*	1·82	19·30*a*	5,110	— *a*
Newcastle-on-Tyne Corporation	July 25	3,509	2,872	+ 637	—	36	36	Dec. 15	127,852	28,411,899	2,767,444	1·08	11·09	3,551	—
Portsmouth Corporation	—	—	—	—	—	29	29	Sept. 30	47,651	9,168,137	868,157	1·24	13·17	1,643	—
Rochdale Corporation	,, 20	157	164	− 7	—	4½	—	March 31	5,416	925,281	127,456	1·38	10·27	—	7·66
Salford Corporation	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Sheffield Corporation	Aug. 2	4,697	—	—	—	53½	46¼	Mar. 25*g*	216,709	56,812,049	4,926,083	0·904	10·428	7,510	7·03*f*
Southampton Corporation	July 23	1,115	995	+ 119	—	11	11	,, 31	35,874	9,084,522	752,814	0·946	11·436	3,760	—
Sunderland Corporation	Aug. 2	1,546	1,478	+ 68	+ 736	18·48	17·18	,, 31	59,930	13,987,121	1,270,957	1·03	11·3	3,243	6·43
Wallasey U.D.C.	,, 1	838	793	+ 45	+ 1,701	10·5	10·5	,, 31*g*	31,307	5,690,378	654,550	1·32	11·47	2,981	6·97

* Includes maintenance of permanent way and proportion of profits paid to the tramway companies for term of unexpired lease. *a* Train mile.
h Half-year's figures. *c* Include rail and tram. *f* Including one section of horse traction. *g* 1903.

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NOTES.

Junior Institution of Engineers.—We would remind our readers that the summer meeting of the above institution is to be held at Sheffield, commencing on Monday, Aug. 17, and concluding on Saturday, Aug. 22. The first day's proceedings will be opened at the town hall at 11 a.m., when the Lord Mayor will welcome the members to Sheffield.

The London Traffic Commission.—We are pleased to hear that the members of the Royal Commission on the London traffic continue to inspect the points of worst condensation in our public streets. They are aided in so doing by the Automobile Club, who place motors at their disposal. We believe that these rides through London have convinced the Commission that the traffic is much impeded by electric lamps placed in the middle of the road over refuges, as in Piccadilly.

British Association.—We would remind our readers that the British Association meeting is to be held at Southport, commencing on Sept. 9, with Sir Norman Lockyer as president. The meeting this year is likely to prove of exceptional interest, for the annual International Meteorological Congress is to be held at Southport at the same time, so that a large number of distinguished foreign scientists are likely to attend the meetings of the British Association.

Tunbridge Wells Telephones.—At the last meeting of the Council it was urged that the National Telephone Company had infringed the terms of the agreement made with old subscribers when they took over the municipal undertaking. In this agreement unlimited service for £6 per year was promised. The company are now demanding 5s. extra as stamp duty. The town clerk is to look into the matter. In the course of the debate it was said that the service had become much less efficient since the transfer. This is naturally to be expected as a consequence of the removal of competition.

Science Research Scholarships.—The Royal Commissioners for the 1851 Exhibition have made 15 awards this year for science research scholarships of £150 per annum. These are held, as a rule, for two years, subject to a satisfactory report of progress after the first year. The recipients hail from 12 of the principal colleges in the provinces and one in London. We are glad to see that the remaining two scholarships go respectively to students at the McGill University, Montreal, and the University of Sydney. The Commissioners have continued for a second year 15 scholarships granted in 1902, while six granted in 1901 have, for exceptional reasons, been renewed for a third year.

The Heligoland Lighthouse.—Germany is remarkably proud of the success of the new electric flashlight which has been erected on the island of Heligoland. It will be remembered that this island was transferred by us to Germany some years ago. Thus, with a view of supporting home industries, the new lighthouse equipment is entirely of German manufacture. It is claimed that it is fully equal to the best French revolving light. The apparatus consists of a revolving parabolic reflector made by the Schuckert Company, which is said to give 30 million candle-power. The flashes are a tenth of a second in duration, and succeed each other every five seconds. The light has been observed at a distance of 40 miles.

Heavy Electric Locomotive.—There has recently been turned out at the works of the General Electric Company in America what is stated to be the largest and most powerful electric locomotive yet built. It weighs 180 tons, and is designed to haul a freight train of 1,500 tons up a grade of 1½ per cent. The capacity of the motors is 2,000 h.p. The locomotive is made up of two units, each weighing 80 tons, and is so arranged that any number of units may be coupled together, making it as much larger as is desired. All the units are controlled from the one place. There are eight 42in. driving wheels on each unit, making 16 driving wheels on the locomotive. It is to be used in the tunnel of the Baltimore and Ohio Railway at Baltimore.

Value of the Ampere.—According to an American exchange, four professors of the University of Michigan have made arrangements to determine the exact value of the ampere. If the experiment be successful, the Government will be asked to change the present law stating the value of the ampere, which is the amount of current that will deposit 1·118 milligrammes of silver a second from a specifically prepared solution of silver nitrate. This is the law also in European countries and is slightly in error. Scientists have several times attempted to correct the last figure. The Michigan professors have constructed an absolute dynamometer which is not affected by heat, cold, moisture, or gravitation. No instrument quite similar has, it is said, ever been used before.

St. Louis Electrical Congress.—The International Electrical Congress in connection with the Universal Exhibition at St. Louis next year has been fixed for the second week in September. The congress will last from the 12th to the 17th, and will meet under the presidency of Prof. Elihu Thomson. It is proposed to divide up the congress into eight sections, the first of which will deal with general theory, both mathematical and experimental. The other seven sections will have to do respectively with general applications, electrochemistry, electric power transmission, electric light and distribution, electric transportation, electric communication, and electrotherapeutics. It is hoped that all the electrical associations and institutions of the States will meet at St. Louis during that week. All communications respecting the congress should be addressed to the general secretary, Dr. A. E. Kennelly, at the Harvard University, Mass.

Mediæval Opposition.—Truly extraordinary is a story of the failure of an attempt to establish a telephone service at Saint-Etienne des Gres, situated in the Tarascon district. The necessary apparatus had been packed all ready to start for the village when the carter heard that the inhabitants, being under the odd impression that the invention was the work of the Evil One, were determined to oppose its entry, and were resolved to arm themselves with their agricultural implements, and to make a fight of it. The man said that he was willing to confide his cart and its contents to the electricians, but that as for himself he would not risk his life in such an adventure. A telegram was forwarded to Marseilles asking for instructions, and the reply came that the cart was to be left at Tarascon What the sequel to the present deadlock will be remains to be seen, but meanwhile the good people of Saint-Etienne des Gres stoutly declare that they will have nothing to do with the telephone, which is "a diabolical machine."

Niagara Cable Conduit.—It will be remembered that in January last the whole of the Niagara Falls works were shut down by the burning of the cables which connected the two portions of the generating station. These were carried over a covered bridge, which served to concentrate the fire and to render it inaccessible. In order to replace these mains, a cable conduit 805ft. long was built over the canal, having 24 ducts. This was

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erected at once to enable the supply to be resumed. A new conduit is now being constructed, which will have 60 3½in. openings. These ducts are to be laid in groups of 12, with just sufficient concrete to hold them in place. This construction has been adopted to get as much ventilation as possible, so as to get rid of the heat due to ohmic loss in the copper. The ducts will also be ventilated by means of openings into a walk which is laid over and a little above the conduit. When this work is completed the old bridge will be taken down.

Platinum.—The report of the United States Geological Survey for the past year shows that the production of platinum from ores found in that country has decreased enormously during the year. In 1901 1,408oz. were produced as against only 94oz. in 1902. Platinum in the United States in recent years has only been obtained as a secondary product chiefly from gold placer deposits in Trinity and Shasta Counties, California. It is reported that the metal occurs, though not in commercially rich deposits, in many other gold placers of California, as well as in Washington, Oregon, Idaho, Montana, Colorado, and Alaska. The Rambler Mine, Wyoming, continues to attract attention, and during the year a considerable quantity of the metal was collected, but not marketed, by the Waratah Minerals Company at Kerby, near Grants Pass, Josephine County, Oregon. It would seem from the above that there is not much chance of the price of platinum being reduced by an increased output in America.

City of London Electric Contracts.—The final appeal in the long-drawn-out case between the City of London Electric Lighting Company, Limited, and the Mayor, Commonalty, and Citizens of the City of London was concluded in the House of Lords on Aug. 8. The result was that the decision of the lower Court stands, which condemns as unsound two of the agreements between the company and the Corporation, and confirms the third agreement, which was originally made between the Laing, Wharton, and Down Construction Syndicate and the Commissioners of Sewers. We have gone into this question so frequently that there is hardly need to again refer to the matters in dispute. We would conclude by saying that, however legal the result may be, it does not conduce to the credit of the Corporation of London. We should rather have expected a body with the reputation which this Corporation holds to stand by its contracts on which the public have expended money, even if these contracts were invalidated by a legal quibble. The only logical conclusion of the present case is that all prominent men within the city of London who are, or who are likely to become, common councillors, should be debarred from holding any shares in any limited liability company having the city of London in its sphere of operation.

Electrical Protection of Safe Deposits.—The protection of the safe deposits in the United States Treasury Department is by electrical means, the aim and effect of which are to guarantee that if any attempt is made to enter the strong rooms where the deposits are kept an alarm shall immediately be given. The vaults themselves are lined with hardwood, tightly joined at every corner. Inside this lining is laid a thin coat of tinfoil, and on the tinfoil is placed a fine netting or screen of wires, every wire of which is carefully joined and highly polished. Over this screen of wire mesh another lining of hardwood is placed. The wires run continuously in every strand, from the floor up the side, and join corresponding wires at the ceiling of the vault. At a point on top there is a feed wire, which connects with the wires of the netting and forms a complete circuit. This feed wire is run from the vault to the central station, which generates alternating current. Three times every five minutes it is varied, so that no succeeding five minutes will correspond to another five minutes. A contrivance is placed at the top of the vault which will automatically give notification at the central station if the electrical apparatus fails to work, or if the currents fail to charge all the wires. Thus, if the walls, ceiling, or floor of the vaults are tampered with, an alarm is rung at the station.

Selenium Cells. — Prof. Ruhmer's photo-electric selenium cells have been given the benefit of prolonged trial and experiment in the German navy in connection with light telephony. In the method adopted a beam of light projected by a parabolic reflector falls on another reflector connected with selenium cells and a telephone. Changes in the intensity of the beam of light can be effected at the sending station by superimposing on the electric light current the current through the telephone of the speaking station. This is sufficient to indicate the general principle of the method. These variations in light are recorded by the selenium cell at the receiving station, and are reproduced again as electric differences through the receiving telephone. The success of such experiments, however, depends on the trustworthiness of the selenium cells. That is by no means a fixed quantity, and the method is still a laboratory rather than a commercial success. A more novel use of selenium cells, and one which is very appropriate to their name, has lately been made by Prof. Ruhmer, who employs the cells to record an eclipse of the moon. The rays of the moon are reflected by a parabolic mirror on to the selenium cell, and the variations of the light as the moon enters the shadow of the earth and emerges again are all accurately recorded by the differences of intensity of the electric current as it passes through the selenium cell and the cell's resistance alters.

Pacific Cable Finances.—The further information which we give with regard to the finances of the "all-red" Pacific Cable may profitably be read in conjunction with that published in our last issue under this heading. Sir M. Hicks-Beach raised the subject in the House of Commons on Thursday, the 6th inst., asking the Chancellor of the Exchequer what is the total amount charged to the Exchequer up to March 31, 1903, in respect of interest, sinking fund, and working expenses of the Pacific Cable; how much of that amount is due from the Colonies which undertake to share the cost of the cable; and when this latter sum will be received. Mr. Ritchie, in his reply, said the audit of the Pacific Cable Board's accounts to March 31, 1903, had just been completed. The accounts have not yet been formally transmitted to the Treasury, but he has ascertained that they show a total net expenditure charged to the Exchequer grant up to March 31 last of £91,437. 4s. 11d. This charge covers interest and also the working expenses of the cable so far as they exceeded the traffic receipts. It includes nothing for the sinking fund, as the first instalment of the annuity for repayment of the money borrowed for construction does not become payable till December next. The share due from the contributing colonies in respect of the expenditure to March 31 last is £65,374. 5s. 4d., and payment will be claimed from the Colonies as soon as the Board's accounts are received.

Foreign Tramrails. — The recent action of the London County Council and some other municipal bodies in the country in accepting tenders for Belgian rails for electric tramways in preference to English rails, probably prompted the following question which Mr. Randles put to the President of the Board of Trade in the House of Commons on Thursday last week. He invited the Presi-

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dent to state what proportion of the tramrails laid in the United Kingdom during the last 10 years were of British manufacture, and what proportion of Continental manufacture, and would he also give the same particulars as to the tramrails laid in the metropolitan area in particular. Mr. Gerald Balfour said the Board of Trade had no information which would enable him to answer the first portion of the hon. member's question. With regard to the second paragraph, he had communicated with the London County Council, and they informed him that in connection with the reconstruction for electrical traction of their tramways about 5,000 tons of rails of British manufacture and 10,720 tons of rails of foreign manufacture have been purchased by the Council. Previously to the transfer the company used about 1,000 tons per annum of foreign rails and none of British manufacture. They add that they have no information as to the rails used by the North Metropolitan Tramways Company—the lessees of the Council's northern tramways — nor as to what is done by other tramway companies in London.

Institution Building Scheme.—As the outcome of the special meeting of Electrical Engineers which has been recently held, it is decided to purchase some ground for the Institution, so that we shall before many years have a building in which to hold the usual meetings. The site which has been acquired in Tothill-street is in a good position, and it is quite likely that a scheme can be devised which will enable certain portions of the building to be erected to be let at remunerative rates. The only question with which we are concerned at present, however, is that the Council should see to it that the acquisition of the site and the financial engagements which they would have to enter into in developing the same and in building shall not hamper the normal work of the Institution. If the scheme involves increased subscriptions to the younger members of the Institution, it cannot be too strongly condemned. It must be remembered that there is no electric lighting station in the kingdom which has such a bad load factor as an institution building. The number of hours per year when the lecture theatre is in use are few, and, unfortunately, the same may be said of the library. We do not mean that the library is not open to members, but that so few members make use of the convenience which the collection of books affords. The building may be said to be one for the honour of the profession, but this honour will not be advanced if heavy subscription rates prevent young men from joining the Institution.

New York Sunday Papers.—We know that all the best, most striking, and most far-reaching advancements in science first see the light in the columns of the New York Sunday papers. Out of a recent issue we notice two important scientific notices, to the first of which, however, the above can hardly be attributed. The interview in question is one with Mr. Barringer Cox, on the production of electricity direct from coal. The technical information given in this fits in with the details of the thermo-electric device which Mr. Cox exploited some years ago from St. Albans, the output of which was measured by multiplying the current on short-circuit into the voltage on open circuit and then applying a constant, which we could never obtain from the inventor. The second invention is one which is distinctly new. It is claimed for and by a Mr. Rudolf M. Hunter, of Philadelphia, that he has solved the problem of the alchemist, and will soon begin to manufacture gold on a large scale. This philanthropic inventor debated within himself for a long time as to whether he should keep his invention to himself, or rather the profits of his invention. He has decided, however, after many heart searchings, to accept £100,000 for working capital from outsiders. The lucky individuals who advance this are to receive no less than 57,000 per cent. per annum. We should not be surprised, however, to hear that Mr. Rudolf M. Hunter finds difficulty in raising his capital in the present depressed state of the money market.

Wireless Telegraphy in Naval Manœuvres.—The special correspondent of the *Standard*, in the issue of that paper for Aug. 10, gives a fair description of how wireless telegraphy systems interfere in practice. He says, "I have mentioned that our cruisers joined us on the Wednesday, and it was about noon on that day that we were able to establish wireless communication with the 'Europa,' the only first-class cruiser that is attached to the 'B 2' command. We were in communication with her, it was true, but continued interruption from the Marconi station at the Scillies prevented our getting much sense out of her messages—this the more aggravating as all we could make out was the startling announcement, 'Have collided with steamship "Rupert," 14 miles—' and then an abrupt termination. However, an hour and a half later a message from the Scillies was passed through to us by the 'Europa,' which ran: 'Melampus' collided at 3.15 a.m. with s.s. "Rupert," 14 miles S. ½ E. of St. Agnes Lighthouse. All hands saved. Damage "Melampus" being heavy, captain of "Europa" ordered her into Devonport with saved crew.' From this we deduced that the 'Melampus' had sent something to the bottom, and that for the forthcoming manœuvres, unless a new ship takes her place, Admiral Wilson's fleet is one second-class cruiser short. The method of our getting the news is illustrative as showing how very easily wireless telegraphy can be fogged, and how, at present at any rate, its utility is more or less of an uncertain character." Further comment is not needed.

Electric Automatic River Gauge.—In America the gauging of a river automatically by electrical means is being accomplished with considerable success. The apparatus is the invention of Prof. W. M. Fulton. It consists of two parts. One, the gauge, is located at the Tennessee River, and the other, called the recorder, is placed in the Chattanooga weather bureau station. The former consists of a large and a small pulley mounted upon the same shaft. A separate wire is wound around each pulley, one carrying a float and the other a counterbalancing weight. Connected to the shaft is a train of gears, so designed that a second shaft is given one complete revolution to a rise or fall of one-tenth of a foot in the float. In order that the weight and float shall always rise and fall in the same plane, as the wires are wound on the pulleys, the first-mentioned shaft has screw journals, which give the shaft a lateral motion, keeping the wires in the same vertical plane. The recording apparatus consists of a drum wound with a recording sheet, and is moved laterally by a screw shaft operated by pawls and ratchets. The pawls are so constructed that they act in a manner similar to a clock escapement, and thus the ratchets can be moved only one tooth at a time. The drum is revolved by clockwork. Connection between the recording mechanism and the gauge is electrical. When the second-mentioned shaft of the gauge makes one complete revolution in one direction, an electrical contact is made and an electromagnet at the recording apparatus operates one of the pawls, and the ratchet connected to it moves the pencil along the drum, which is at the same time revolving. If the float moves in the opposite direction another electrical contact is made, and the other set of pawls and ratchets move the pencil in the opposite direction along the drum. Thus a complete graphical record is obtained of every $\frac{1}{10}$ft. rise and fall of the stream.

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Profit-Sharing for Telephone Employes.—The *Electrical World* of New York gives the full text of a circular which Mr. F. S. Bickson, the president of the Cuyuhoga Telephone Company, of Cleveland, has just issued to the employés of the company. We extract from this the following particulars. Mr. Bickson tells his employés that: "Beginning on July 1, after paying all expenses, taxes, and the interest on our bonds, we will set aside one-fifth of the surplus remaining, and during January next we will distribute this among all of you who are in the employ of the company on Dec. 31, 1903, in proportion to the salary of each. Anyone who leaves our employ before Dec. 31 will have no share in this fund. Anyone going on a strike shall forfeit his share. Anyone who comes with us at a later date will only receive his fair proportion. In other words, the distribution will be based upon the total amount of salary paid between July 1, 1903, and Jan. 1, 1904. Now, what can you do for yourselves and for us on such a basis? If you do not earn a surplus for the company of £1,000 a month during the rest of this year, I will be both disappointed and surprised. If the surplus averages £1,000 a month, it would make a total of £6,000 for the half-year. One-fifth of this would be £1,200. In June, 1903, we paid out a total of £2,348 in salaries Distributing such a sum on such a basis would give every one of you an interest in the profits equal to more than half a month's salary. Remember, the easiest way to make money is not to spend it. Do you realise that all of you are spending money for us? If you injure any part of our apparatus, you have spent the money it costs to repair it. If you cut wire to waste, you have spent the difference in value between good copper wire and junk. If you use a good sheet of paper to figure on where the back of an old envelope would serve as well, you have added to the cost of operating this plant." We wish the telephone operators of London were profit sharers.

"Electric Museum."—Mr. A. W. Hill, of Colombo, Ceylon, has started a fortnightly paper, which he has christened the *Electric Museum*. A feature is made of answers to correspondence, and the editor seems to have a wide range of useful queries to reply to in the first issue of his paper now before us. Amongst the "Museum" notes is the following: "An authority on forestry announces the discovery, in the primeval forests of India, of a tree with the most curious and inexplicable characteristics. Its leaves are so highly electrical that whoever touches one of them receives a severe electrical shock. Even upon the magnetic needle this tree has a strong influence, causing magnetic variations at a distance of 70ft. The electrical strength of the tree varies according to the time of day. It is strongest at noon, but its power almost entirely disappears at midnight. Its electricity also disappears in wet weather. Birds never rest upon its branches, nor have any insects been seen upon it." A forest of these trees would be as "thick" as the primeval forest at Epping, described by George Robey, which became so thick that the then London County Council had to close it. Mr. Hill has a reasonable explanation for the effects of wet on the above tree, but he does not attempt to explain its action on a magnet. Another editorial note is the following: "I note the interesting fact that at 10 p m., or so, one can observe a few dozen of frogs near the ornamental posts for electric arc lamps situated near the General Post Office in Colombo. It appears that a great number of flies and other winged creatures are attracted by the glare of the arc lamps; not being able to crack the glass globes, these flies soon fall to the ground exhausted, and are promptly devoured by the intelligent, patient frogs." This is a good argument in favour of electric street-lighting, and our contractors might supply an arc lamp, 12 spare carbons, and 24 frogs as a standard fly-catching plant. We wish Mr. Hill's venture every success.

Removing Silica from Coke.—In the manufacture of aluminium and other metals by electrolytic processes the carbon used in the electrodes must be free from silicon compounds, and particularly silica, otherwise, when the electrodes are consumed in operation, the silica originally contained in the same is taken up by the aluminium, thus yielding an impure product. In order to avoid this, it has been proposed to use in the electrodes petroleum coke, because it is practically free from silicon, but such coke is more expensive. Mr. Charles M. Hall, the inventor of the Hall aluminium process, has now devised a method, which has just been patented to him, for removing silica from the ordinary and cheaper kinds of coke. The method, which is described in the *Electrical World*, consists in mixing with the pulverised coke a metallic fluoride which will react with the silica, giving a fluoride of silicon, which goes off as a gas during the process of baking the electrodes. Sodium fluoride, cryolite, and fluospar give good results. The powdered coke and fluoride is then mixed with pitch or another suitable binder and formed into blocks, or whatever form of carbon is desired. These are then baked in a furnace of the form shown in a diagram. The wall of the furnace is built of brick, and in it the carbon blocks are placed, insulated from each other. In the centre of the furnace a core of a suitable material is provided which can be heated to an adjustable temperature by means of an alternating current supplied through binding posts. The temperature should be somewhat higher than in the ordinary baking furnace, in order to facilitate the chemical reaction between the fluoride and the silicon. Instead of mixing the coke, fluoride, and pitch, and forming them into the desired shape before baking, thereby combining in one process both the purification of the coke and the manufacture of the electrodes therefrom, the purifying step may be carried out separately by heating the mixture of coke and fluoride alone. The operation of the process in two steps has one advantage—namely, that the material then receives two heatings—thus insuring the completion of the desired chemical reaction.

Emanations of Radium—Sir William Crookes's paper before the Royal Society on the above subject is abstracted in a very concise manner in the current number of the *Journal* of the Chemical Society. Describing the experiments, the author states that in presence of some feebly luminous radium nitrate, a barium platinocyanide screen glowed with a green light, the phosphorescence disappearing whenever the screen was removed. A zinc sulphide or blende screen was found to be almost as luminous as the platinocyanide screen under the same conditions, but the residual phosphorescence lasted for some time. When the blende screen is tapped with a knife-point, a sudden spark of light is produced, and a scratch gives rise to an evanescent luminous line. An accidental contact of a few tiny particles of the radium salt with the blende screen caused the surface to become dotted over with specks of green light markedly larger than the inducing particles. A microscope, in a dark room, shows each spot to have a dull centre with a surrounding luminous halo, whilst outside the halo the dark surface of the screen scintillates with sparks of light. When solid radium nitrate is brought near the screen the scintillations increase rapidly in number and intensity, with the effect that after a certain point there is a residual phosphorescent glow, not observed when the scintillating points are few. A platinum wire, dipped in radium nitrate solution and dried, has the same effect if brought near the screen; if allowed to touch the screen it produces a luminous

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spot, which is an active centre of scintillations for weeks afterwards. No variation in the scintillations could be detected when air was blown between the radium salt and the screen. Polonium sub-nitrate has a similar effect on a zinc sulphide screen, but the scintillations are less numerous. Comparison of the effects produced on platinocyanide and zinc sulphide screens by exposure to radium nitrate and polonium sub-nitrate leads to the view that the luminosity on the blende screen, whether due to radium or polonium, is caused by emanations which will not penetrate card. The scintillations caused by these emanations are distinct on the blende and feeble on the platinocyanide screen, because with the latter the sparks are seen on a luminous ground of general phosphorescence. The scintillations described above are regarded as associated with the impacts on the screen of the electrons thrown off by the radium salt, and from his experiments the author concludes that the number of electrons hitting the screen in a given time is not inconceivably great.

Echoes of the War.—The following official record of the South African War appears in the *Royal Engineers' Journal* for Aug. 1 under the heading "Electrical Engineers R.E. (Volunteers)." The searchlight detachment sent to South Africa in March, 1900, under the command of Major Crompton consisted of two sections. They were on arrival attached to the military railways, and worked under Colonel Girouard, R.E. A portion of the detachment, under Captain A. Bain, was detailed to repair the railway telegraphs in the Orange Free State and Transvaal. This portion remained throughout its service with the railways, and was employed in reconstructing and organising the railway telegraph and telephone systems, and the electric block and signalling system in the Transvaal and Orange River Colonies. Captain Bain acted throughout as chief engineer for railway telegraphs. The remainder of the detachment was employed during the reconstruction of the railway in lighting the deviations and bridges during construction. When the railway got through to Pretoria the detachment was placed under the C.R.E., Pretoria, acting as a separate unit, and not attached to any regular one. The men ran traction engines for transport, and put in order the electrical machinery in the forts. They installed and ran electric lights at Machadorp, Komati Poort, and at one of the general hospitals in Pretoria, current in this last case being supplied from the town mains; also installed and worked a defence searchlight at a colliery on the eastern line. The whole of the detachment returned to England in December, 1900. Almost immediately after the 1900 detachment returned home a new detachment, consisting of two companies, was sent out under Major A. Bain. The establishment was later on increased to five companies, organised as a battalion, the first and only complete battalion of volunteers from one corps that has served in the field during the history of the volunteer force. These five companies formed a distinct and separate command under Major Bain, who received his orders direct from army headquarters. They were employed on the following works: Lighting the large hospitals—*e.g.*, at Johannesburg, Pretoria, Elandsfontein, Kronstadt, Bloemfontein, Newcastle (Natal), Krugersdorp, De Aar (Cape Colony), etc.; erecting and running search lights at occupied townships—*e.g.*, at Heidelberg, Standerton, Ermelo, Vryheid, Vryburg, Komati Poort, Barberton, Middelburg, Klerksdorp, etc.; running searchlights on armoured trains; running traction engines; erecting and running ice-making plant—*e.g.*, at Newcastle, where from 1 to 1½ tons daily were turned out; lighting railway bridges—*e.g.*, Norvals Pont, Bethulie, Vereeniging; installing and maintaining electric light in army post offices, and in the offices of G.O.C.'s, etc.; working the large permanent installation in the artillery barracks, Pretoria; assisting the army telegraph department in permanent telegraph and telephone construction (a whole company being employed for a few months towards the end of the war on this last work); and, generally, doing any other electrical or mechanical work required for military purposes in South Africa—*e.g.*, connecting the defences by telephone and laying down electrically-fired land mines at O'Okiep, erecting a reliable electric signal and flare system on blockhouse lines, erecting and maintaining lighting of prisoner-of-war camps, etc. In every case this battalion did everything connected with their work without outside aid; erected, worked, and repaired (when necessary) all machinery; and in most cases erected engine-houses, etc., as well. They supplied some 65 working parties in Cape Colony, Natal, Orange Free State, and Transvaal.

Testing for Dielectric Strength.—At the recent Niagara meeting of the American Institute of Electrical Engineers, Mr. P. H. Thomas read a paper on the testing of electrical apparatus for dielectric strength. From an excellent abstract in the *Electrical World* we gather the author pointed out that while the only practical method of testing high-tension apparatus is by means of over-potential tests, yet the latter involves dangers, and great care should be taken to avoid injury to the apparatus, and excessively severe tests, especially long-time tests at high potential, should be avoided. A disruptive test fails partially of its object in testing the fitness of the apparatus for actual service, because the conditions of the test do not approximate closely the conditions of the service, either normal or emergency conditions. In general, electrical apparatus is never in a condition so poorly adapted to stand dielectric strains as when first installed. Insulation tests require special testing apparatus and expert and experienced direction, which are very often not available, and without which great risk is run in attempting such tests; as an exception it may be mentioned that some simple types of apparatus, such as high-tension series transformers, high-tension 'bus-bar insulation, etc., may be readily tested without great danger. Among the specific practical suggestions made by the author for tests of dielectric strength are the following: In high-tension apparatus—*e.g.*, 20,000 volts and above—only moderate, short-time, over-voltage tests should be specified in contracts. Such tests should be used once for all when the apparatus is known to be in good condition, preferably at the factory, by experts, to give assurance that the specification has been met. Such tests should not be made a second time. After installation, a considerably lesser test should made upon the apparatus, which will detect any serious injury in transportation and installation. Any moderate deterioration due to absorption of moisture, etc., will right itself with service, provided no abnormal deterioration has occurred. It is preferable to make high-potential tests by increasing the voltage upon the apparatus as it is designed to operate, one terminal at a time remaining grounded, rather than making a high breakdown test by voltage from an external source. On tests of very high-tension apparatus, such as generators and transformers, no breakdown gap should be used in connection with the determination of voltage. Any error in the voltage of test, provided precautions as to the proper size of testing apparatus are used, will be comparatively unimportant. In some cases the voltage of the testing device may be determined by means of a spark-gap before the apparatus to be tested is connected to the circuit.

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THE DESIGN OF EXTRA HIGH TENSION SWITCHGEARS.

BY W. E. WARRILOW.

(Continued from page 196.)

The forgoing examples illustrate the assembly of boards in a comparatively small space, in spite of the voltage controlled, but such types are not actually suitable for dealing with circuits of any great power; they serve their purpose in small stations supplying scattered areas, but they are unable to cope with the enormous outputs which have to be controlled from power plants such as that installed at Niagara Falls. In these cases the tendency has been to adopt gears of the distance control type, the high-pressure sections being confined to isolated parts of the station, and all operating is carried out from a central table fitted with small switches closing low-pressure circuits connected to the actual gear itself. The high-tension switches are usually arranged on galleries above the control board, in the most convenient position for the leading in and out of the cables, a by no means unimportant problem in the assembly of the board. The energy for the operation of the switches can be derived from either a continuous or alternating current source, depending chiefly on the manner in which the switches are opened and closed. When motors are used the alternating type is employed, while for the direct actuation of the levers from pulling magnets continuous currents are found to be more suitable. In some instances pneumatic control of the switches is adopted, but the development of the electrically-operated device has now reached a degree of perfection which renders all mechanical methods obsolete.

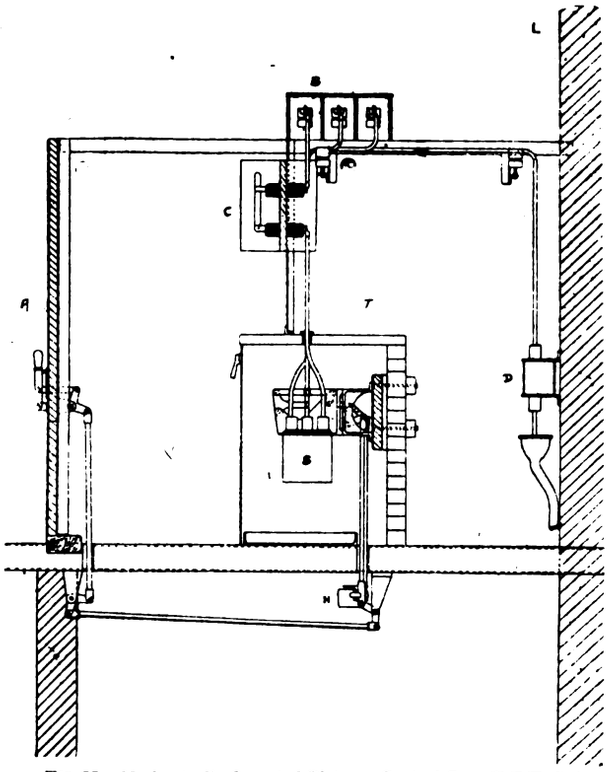

FIG. 18.—Mechanically Operated Distance Control Gear (B.T.H. Co.).

In certain instances, however, this form of gear with lever control can be adopted with advantage, and Fig. 18 will serve to illustrate the manner in which such a type of board can be assembled. An elevated gallery is preferable for the building up of the gear, as space is then allowable for the examination of the lever movements, bearings, etc. The working face of the board is comprised of marble panels mounted in an iron framework, the supporting stays of which serve the purpose of holding up the high-tension bars, B. For three-phase currents three separate switches are employed and mounted behind the marble slabs, in brick cells, fitted with an iron inspection door. The switch, one of which only can be seen, is shown by S, and each device is provided with a tripping solenoid, H, bolted under the platform, for releasing the mechanism on the passage of either an excess or reverse current; also a time-limit attachment can be introduced for the same purpose. In each instance the solenoid is connected to the secondary of the current transformer, D, fastened to the wall behind the entire gear. The interior of the switch can be seen in Fig. 19, though this design is suitable for bolting directly to a marble slab for operation with very

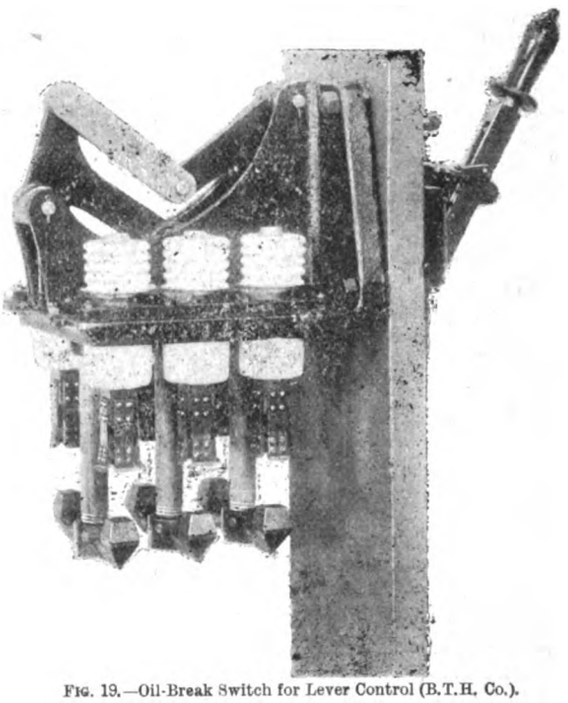

FIG. 19.—Oil-Break Switch for Lever Control (B.T.H. Co.).

short levers. The contacts are plainly visible, as well as the short-circuiting pieces, these being all coupled to one central operating rod attached directly to the link motion. The oil tank, of cast iron, has been removed to expose the contacts, but this receptacle can be easily raised into position, full of oil, without disturbing any portion of the gear in any way.

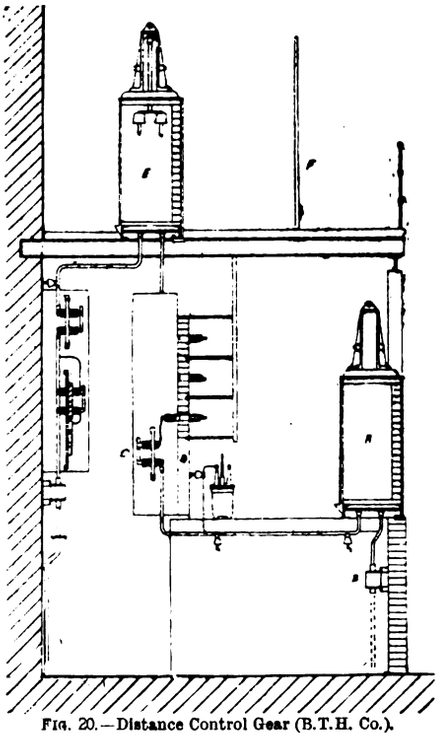

FIG. 20.—Distance Control Gear (B.T.H. Co.).

Referring, again, to Fig. 18, C is a switch which can be inserted for the purpose of isolating the main switches from the 'bus bars for cleaning or adjustment. Potential transformers for operating the shunts of the wattmeters (if there are any) can be mounted in the position shown at T, and if lightning arresters are used they are bolted to the wall above the main gear at L. The working face of the panels at A contains the fixings for the operating

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levers, and all instruments, as voltmeters, ammeters, or wattmeters, can also be mounted on this part of the board. The section of gear illustrated in Fig. 18 is suitable for controlling pressures up to 6,000 volts.

A sectional lay-out of a gear designed for the handling of currents at 10,000 volts is illustrated in Fig. 20, the switching devices in this case being all electrically operated. The cables from the generator enter a switch at A, after passing through a current transformer, B. Thence the conductors are laid on insulators as far as an isolating switch, C, from which they are connected directly to the 'bus bars mounted on insulators in the wall, D, erected for the purpose. Thence the cables pass to feeder switches fixed to the upper storey of the gallery at E, finally leaving the gear through another isolating switch and current transformer. The small control panels are mounted at F on the operating platform, all the low-tension switches, instruments, wattmeters, etc., being attached to this section of the board. The electrically-operated switch is shown in Fig. 21, the parts in question being fitted to a wooden framework, though when in actual use the device is mounted in a brick chamber with cast-iron top. The circuit is broken

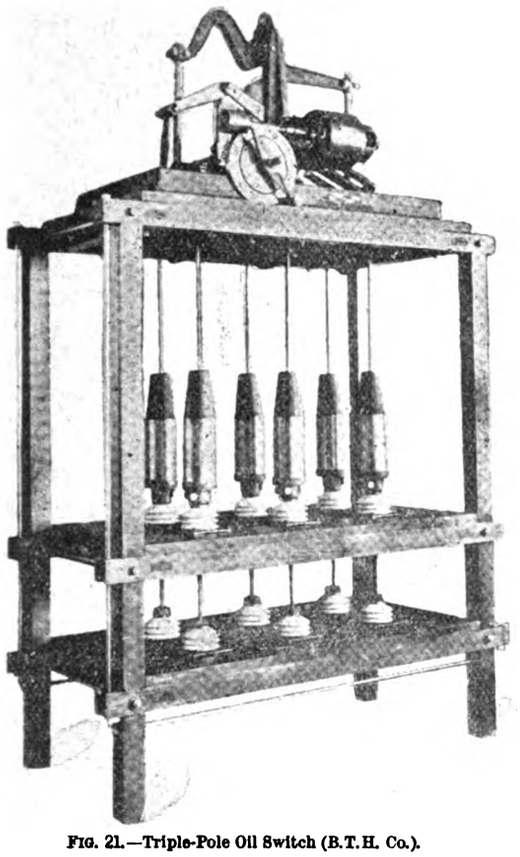

FIG. 21.—Triple-Pole Oil Switch (B.T.H. Co.).

in oil tubes cemented in insulators, the tubes containing contacts for the reception of the short-circuiting rods attached to the operating mechanism. It will be seen from the illustration that the switch is actuated entirely by an electromotor mounted on the top platform—that is, above the chamber containing the tubes; and this motor is of the series type, having an output of ½ h.p. The motor shaft carries a solenoid for connecting it to the operating mechanism through worm gearing, the magnet being energised when the motor switch is closed. A system of links and levers, coupled with a toggle motion, aided by powerful springs, enables the motor to wind up these latter, and also set the crank pins just off the dead centre, so that the slightest movement of the motor releases the toggle and allows the energy of the springs to be expended in either opening or closing the switch. Current for the motor is obtained from the secondaries of current transformers (these serve the purpose of providing low-tension circuits for the main ammeters), and small switches are fitted to the control board, which is mounted on a gallery some distance from the chamber accommodating the extra high tension gear. Signal lamps are included in this equipment to indicate to the switch hand that the motor has operated properly, and in some instances the main switches themselves are connected two in series, reliance being placed on one to open the circuit in case of failure with the other. The above-described switch is constructed for dealing with pressures up to 30,000 volts and currents to 50 amperes.

(To be continued.)

NOTES ON THE SPEED REGULATION OF CONTINUOUS-CURRENT MOTORS.

BY WALLACE ROGERS.

When a conductor carrying a current is placed in a magnetic field, it will be turned in such a direction that the E.M.F. induced in it by this motion will oppose the flow of current existing in the conductor. This law which gives us the theory of the motor states that under the conditions mentioned above there will be motion; it also gives the direction of motion. From this is derived the fact that the speed of a motor depends directly upon the impressed E.M.F. at its terminals, and inversely upon the strength of the magnetic field and the number of armature conductors. Hence any increase in the impressed E.M.F. will increase the speed, which is also increased by a decrease in the field strength. A motor always runs at a sufficient speed to generate a counter E.M.F., which is nearly equal to the impressed E.M.F., the difference between them increasing with load, the speed at any instant always satisfying the equation: counter E.M.F. + C R_a = impressed E.M.F., C R_a representing lost volts in the armature. Under no conditions could the counter E.M.F. equal the impressed voltage, seeing it is impossible to construct an armature having no resistance. The effect of putting load on a motor is to decrease the speed and lower the counter E.M.F., allowing a larger current to flow, and increasing the C R loss till the factors in the above equation are again balanced. The speed of any motor is proportional to its counter E.M.F., and if the armature and field resistances are low the speed may be said to vary directly as the impressed voltage. On the other hand, if these resistances are high, the speed will not vary directly as the impressed voltage, but as the difference between it and the C R loss (which is the counter E.M.F.). An example might simplify matters. Suppose that with an applied terminal voltage of 500 we get a speed of 200 revolutions per minute, it does not follow that we shall get a speed of 400 revolutions per minute if the applied voltage be raised to 1,000 volts, and to find out what speed we should have with the increased voltage it would be necessary to know the current value at which both tests were run, and also the internal resistance of the motor. We will suppose current = 30 amperes and R = 3⅓ ohms.

In first case C R loss = 30 × 3⅓ = 100 volts; ∴ speed of 200 revolutions per minute is given by (500 − 100) = 400 volts—*i.e.*, two volts give one revolution.

In second case 1,000 volts will give $\frac{1,000-100}{2}=450$ revolutions per minute.

Suppose R is lowered to one ohm, then C R loss = 30 volts; ∴ volts to cause motion = (500 − 30) = 470 volts.

Here 200 revolutions are given by 470 volts; ∴ one revolution is given by $\frac{470}{200}=2{\cdot}35$ volts; ∴ speed given by 1,000 volts $=\frac{1,000-30}{2{\cdot}35}=\frac{970}{2{\cdot}35}=412$ revolutions.

This example shows us that only when R is small is the speed proportional to the impressed voltage. Let n = speed, e = counter E.M.F., F = magnetic flux, c = number of armature conductors, then $n=\frac{e}{F\,C}$. This formula shows us that to increase the speed we must decrease the field strength (C being a constant quantity). This is because the armature when running in the weakened field cannot generate such a high counter E.M.F., hence a larger current flows through it, causing it to run at a higher speed. The speed of a shunt motor may be represented by $\frac{E-C\,R}{N\,F}$, where E = supply voltage, C = armature current, R = armature resist-

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ance, N = number of armature conductors, F = flux. It increases about 20 per cent. upon removal of load, but a series motor races badly if its load be removed, because any decrease in the armature current decreases the field strength.

So far we have only considered the effect of weakening the field as a means to speed regulation, which method has two disadvantages: firstly, as the motor field becomes weaker its electrical balance falls off; secondly, the torque disappears if the field is weakened below a certain point. We will now consider other methods of regulating the speed. To control the speed of a motor, it is necessary to apply to the armature terminals a voltage corresponding to the desired speed, and this may be done in several ways. One method is that known as rheostatic control. It consists in passing the applied voltage through a resistance before it reaches the motor, this resistance being varied to consume the excess of voltage over that required to produce any particular speed. The disadvantages of this method are: firstly, that it is very inefficient, seeing the voltage consumed in the resistance is a dead loss; secondly, if this voltage is large, it means that a large amount of heat has to be got rid of. Another method, known as the teaser system, consists in supplying the working motor with current from a small generator wound for large current capacity and low voltage, this small generator

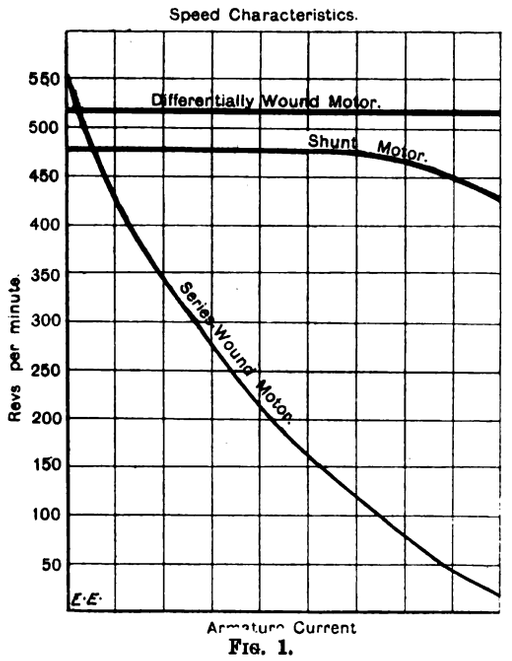

FIG. 1.

being driven by a motor which takes current at full voltage from the mains. The efficiency of this system is questionable, seeing it requires two auxiliary machines. If a motor be designed so that the loss of E.M.F. due to armature reaction is equal to the C R loss in the armature, it will run at constant speed with varying load. As this condition is not fulfilled in the design of present-day motors, we can only obtain constant speed with varying load by suitable regulation. As this is required in certain classes of work, it is usual to employ what is known as a differentially-connected compound-wound motor. In this type of motor the shunt and series coils are connected in opposition, the shunt winding being made strong enough to always control the polarity of the field. These motors maintain constant speed with varying load, owing to the fact that as the load increases a larger current flows through the series coils, whose demagnetising action over the shunt field increases, resulting in a weakening of the field and a corresponding rise in speed. The two windings must be so proportioned that the weakening effect of the series coils just compensates for the fall in speed due to increased load. The speed regulation is perfect only when the voltage across the mains is that for which the motor is designed, and also when the load varies between zero and a maximum, and not beyond the capabilities of the motor. Such a motor must be started up in the same way as a shunt motor, otherwise the strong initial series field will overpower the shunt, and reverse the direction of rotation. When starting up it is usual to short-circuit the series winding, and, in some cases, make it agree with the shunt, thus giving the motor a large starting torque, at the same time preventing it from starting in the wrong direction. After full speed is reached and the armature current falls to its normal value, the series coils are again short-circuited and reversed, restoring them to their normal condition of opposing the shunt winding. To obtain a constant speed at all loads, the series winding must be so proportioned that it is capable of reducing the counter E.M.F. sufficiently to allow a larger current corresponding to the increased load to flow through the armature. The curves in Fig. 1 show the difference between the speed characteristics of series, shunt, and differentially wound motors, from which it will be seen that where perfect speed regulation is required, it is necessary to use a motor having differential windings; but for most purposes the speed regulation of the shunt type is quite satisfactory. Although the differential compound-wound motor (when started up in

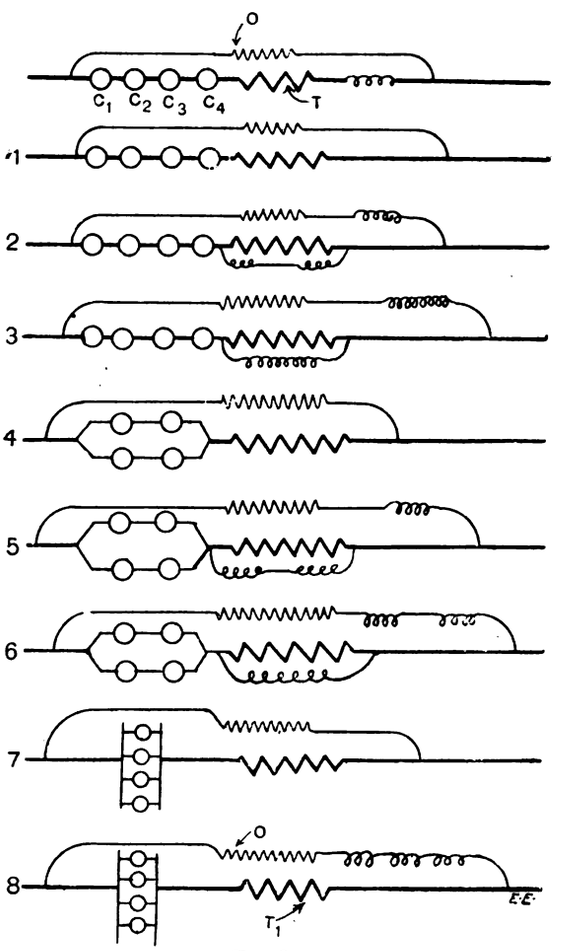

FIG. 2

the manner mentioned above) combines the large starting torque of the series motor with the good speed regulation of the shunt type, its efficiency is not very high, because more energy is expended in the field to produce a given magnetisation, as some of the lines of force are continuously being neutralised.

We have only considered speed regulation so far as it concerns motors used for stationary work. We will now consider it in connection with traction work, where this question is of equal importance. As regards traction motors (which are, of course, series wound), speed regulation is obtained by starting the motors in series with themselves and some external resistance, subsequently by steps putting them in parallel. A more efficient method is that due to Sprague, who made use of the counter E.M.F.'s of the motors as a means to speed regulation. His method was to divide the field windings into several sub-divisions and commuting them by means of a special controlling switch so as to change their influence upon the magnetic field, the result of this being a variation in strength of the counter E.M.F.'s of the motors. Although this method appreciably

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reduced the amount of external resistance necessary for wide variations of speed, it did not do away with its use altogether owing to the small variation in field strength it was possible to obtain.

The latest method of speed regulation in traction work is that introduced by Lundell. In this system the principle of series-paralleling from two armature circuits to four, is combined with the series and shunt methods of excitation, together with the Sprague method of varying the field strength. The whole combination gives complete control over current and speed over wide limits, relying solely upon the ohmic resistance and counter E.M.F.'s of the machines, external resistances in the armature circuits being completely done away with. This is brought about by furnishing each motor with two armature windings, two commutators, and a field magnet so constructed that it will be possible to run with a weak field without excessive sparking. Fig. 2 shows a diagram of the various circuit combinations for two railway motors constructed on the above principles. O represents the shunt windings, T the series windings, C^1 C^2 commutators for one motor, C^3 C^4 commutators for the other motor. As it is possible to obtain a varying field strength, each armature combination, excepting the parallel one, yields three different speeds. The first three combinations (first, second, and third) give 125 volts per commutator (with 500 volts on line), the motors working practically as shunt motors, owing to the very strong shunt and the weak series field. The next three speeds (fourth, fifth, and sixth) give 250 volts per commutator. The series fields have become stronger, and at the seventh position are four times as strong as at the first position. At the eighth position they are further strengthened by an increase in the current flowing through the armatures. When top speed is reached the motors are practically working as series motors, seeing the shunt field has been greatly reduced owing to the insertion of additional resistance in series with it. It will be seen that the speed of the motors depends upon their counter E.M.F.'s, which in turn depend upon the grouping of the armature windings and the field strength. This system has the following advantages: When the speed of the motors exceeds the speeds corresponding to a certain position of the controller, by reason of the car running down hill, the motors will become dynamos and restore energy to the line. Secondly, when any series-parallel changes are effected, the number of watts to be broken at the controller contacts is very small, being equal to the difference between the line voltage and the counter E.M.F. multiplied by the main current flowing at the time, or watts = (impressed E.M.F. – counter E.M.F.) × C. The great advantages which this system has over the older methods of speed regulation in traction work brings one to the conclusion that, although not impossible, it will be very difficult to improve upon it.

RADIUM AND OTHER RADIOACTIVE SUBSTANCES WITH A CONSIDERATION OF PHOSPHORESCENT AND FLUORESCENT SUBSTANCES. THE PROPERTIES AND APPLICATIONS OF SELENIUM AND THE TREATMENT OF DISEASE BY THE ULTRA-VIOLET LIGHT.*

BY WILLIAM J. HAMMER.

(Continued from page 197.)

Dolezalek has designed a very sensitive type of electrometer built by Bartels, of Göttingen, a description of which may be found in *Verk, der Deutsche Physik Ges.*, III. (1901). It is well known that the leaves of a gold or aluminium foil electroscope will hold their charge in dry air indefinitely, but the Becquerel rays are found to dissipate the charge by ionisation of the air, or rendering the air a conductor of electricity (the electroscope may also be discharged by Röntgen rays, cathode rays, and ultra-violet light). In Fig. 5 is shown a form of electroscope devised by the Curies for the study of radioactive substances. Referring to the diagram to the right, it will be noted that the electroscope consists of a single movable sheet of gold or aluminium foil attached to a stationary sheet of copper, L, being supported by the insulating piece, I. The radioactive substance to be tested is placed on the lower of the discs, P and P', preferably on a removable plate. The radiations make the air a conductor between these two plates. The electroscope is charged by means of a stick of ebonite rubbed briskly and placed near the rod, B. This deflects the sheet, L', from the vertical, and it so remains for a very long time. When radioactive substances are brought near it, the gold or aluminium leaf is caused to lose its charge, and the leakage is observed by means of a stationary telescope shown in the left-hand figure, which is provided with a micrometer scale. The time taken for the discharge of the electroscope is taken by means of a chronometer or watch. By suitable lighting the front edge of the foil may be made to appear as a very fine line, and its position noted with great precision. By examining the diagram it will be noted that the upper condenser plate is connected with the metallic case. Detachable metal cases are placed over the condenser plates and over the rod for charging the electroscope. Two of the sides of the case are of glass. I have here a simple form of electroscope with leaves of aluminium foil, which serves to show the ionisation of the air; when the radium is brought near, the divergent leaves

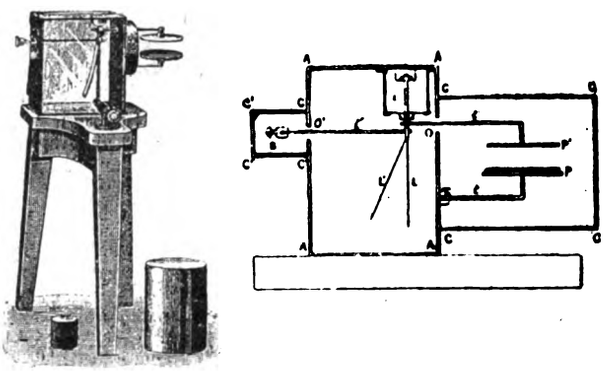

FIG. 5.—Curie's Electroscope for the Study of Radio-activity.

lose their charge of negative electricity and rapidly come together. It is of paramount importance that the radioactive substance should be kept in a room distant from the electroscope.

At the present moment the clothes of every person in this room and all the walls of the room are radioactive by reason of the presence of the nine preparations of radium which I have here this evening. Prof. Curie told the writer that it was often impossible for him to go near his instruments to make any measurements for hours, after being in the proximity of some radium, and those who have worked with this substance have found the greatest difficulty in keeping their tools and instruments and themselves free from the radioactivity imparted by the radium. The energy represented by radium is something enormous. Elster and Geitel have shown that a fine wire of any metal placed in the atmosphere and charged negatively from some source of current, say of 500 volts, causes the wire itself to become radioactive, and this radioactivity may be scraped off and will affect photograph plates, ionise the air, etc. It cannot, however, be washed off. It is stated that lightning rods and even the leaves of trees all become radioactive, and it has been shown that falling rain and snow are for a time quite powerfully radioactive; and after they have fallen, a wire negatively electrified in the atmosphere has only a small amount of radioactivity, apparently showing that the rain and snow have carried the radioactive particles in the atmosphere down to the ground. McLennan has made experiments with the negatively charged wire in Montreal, and subsequently at the foot of Niagara Falls, and has found the result about one-sixth as powerful in the latter place as in the former; and he has also shown that it was not necessary to electrify the wire used at Niagara Falls, as it received a sufficient charge from the electricity

*A lecture delivered at a meeting of the American Institute of Electrical Engineers and the American Electrochemical Society, New York, April 17, 1903.

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in the atmosphere. McLennan found that rain caught in a vessel and immediately evaporated to dryness imparted radioactivity to the vessel in which it was evaporated. Ordinary water when evaporated and rain-water which has stood for several hours before being boiled down do not yield any radioactivity.

As an evidence of radioactivity imparted to another substance by radium, I have here some pieces of cardboard which constituted the box which held my samples of radium for several months. The box becoming injured, I broke it up, fortunately saving the pieces; and six days after the radium had been removed I looked up the pieces, and was surprised to find them luminous in the dark. Subsequently I tried their effect on a photograph plate, but did not succeed in getting any impression. Three weeks later it occurred to me to try and stimulate the radioactivity of the cardboard, which had not been near radium for over a month, by burning magnesium wire, when I found I could make the cardboard brighter than it had been in the first place. I have also stimulated the radioactivity by sparks from a coil, especially when producing ultra-violet rays, by using a condenser bridged across the secondary and employing pure iron electrodes. I tried the burning magnesium with various samples of cardboard which had not been exposed to the radium, and there was no phosphorescence. It has already been stated that various substances which become radioactive retain that property for a short time only, and it is interesting to note its retention for such a long period of time, and to note this ability to stimulate and make visible the imparted radioactivity. This experiment suggests the discovery made by Prof. E Wiedemann that a mixture of sulphide of calcium with a little sulphate of manganese is not altered when exposed to cathode rays, but some time after its exposure it bursts into a vivid greenish glow when slightly heated, and to this phenomenon he has given the name "thermo-luminescence." Prof. S. P, Thompson also showed that fluorspar which by prolonged heating has lost its luminescing power, regains the power of thermo-luminescence on exposure to Röntgen rays when reheated. Prof. Trowbridge also finds that this restoration is also effected by exposure to the electric glow discharge, but not by exposure to ultra-violet light. It also stated that an object coated with calcium sulphide, and exposed to the sunlight, will phosphoresce about 10 hours, and even after it has lost its luminosity, it can be caused to again give light by heating first by the hand, then over a water-bath, and finally on a hot stove. McLennan has found a very large number of salts are brought into a condition by cathode rays, in which warming makes them radioactive for a short time, the supply of negatively-charged particles discharged from the surface coming to an end.

Prof. Rutherford, of Montreal, who has given a great deal of attention to radioactive substances, particularly to investigations into thorium, which next to radium is the most radioactive substance yet discovered, has found that by electrifying a wire negatively with a current of 500 volts connecting the positive pole to the ground, and by connecting a sample of thorium to the earth, that the thorium particles were attracted to the negatively-charged wire, producing a greater radioactivity than he had ever found in any thorium preparation which he had made. I have here a sample of oxide of thorium, the radioactivity of which was discovered independently by Schmidt and Curie. This sample is between 98 and 99 per cent. purity. From this body Prof. Rutherford has isolated a substance which he calls "ThX," and, extraordinary as it may seem, it has been found after separation of the active constituents represented by the ThX from the thorium, that the ThX loses its radioactivity, and this is taken up by the thorium in exactly the amount which the other loses. Sir William Crookes has also separated a non-uranium residue from uranium, leaving the matter without radioactivity. Whilst the whole of the radioactivity has been concentrated in the residue to which the name UrX was given, Crookes, as already stated, claims that actinium is but another name for his UrX. The only case of radioactivity induced by cathode rays in a neutral substance has been that of bismuth, discovered by Villari. Prof. Curie has discovered that radioactive gas emanates from radium, and Rutherford has discovered the gaseous emanations from thorium. Messrs. Rutherford and Soddy have investigated extensively these emanations, and they have succeeded in condensing them at the temperature of liquid air. A preliminary account appears in the *Proceedings* of the Chemical Society of London for December, and Prof. Rutherford writes me that the full paper will shortly appear in the *Philosophical Magazine*; and he states furthermore that in his opinion this proves beyond doubt the gaseous nature of the emanations.

The serious physiological effects of radium are well known, and Messrs. Giesel, Becquerel, the Curies, and others, have given important evidence thereof. As stated in the appendix of a paper read by the writer at the one hundred and fifty-ninth meeting of the institute on Jan. 3, 1902, dealing with the subject of radioactivity, Prof. Curie told the writer that he would not care to trust himself in a room with a kilo of pure radium, as it would burn all the skin off his body, destroy his eyesight, and probably kill him. The writer felt the effects for weeks of a slight burn from inadvertently carrying a wooden box containing eight tiny sealed glass tubes of radium under his arm for several hours. Mr. W. E. Hidden has called the attention of the writer to some phenomena which he has observed in a mine in Barringer's Hill, Llano County, Texas, which mine contains yttrium, thorium, and uranium. Pockets of ore have been found, ranging from a few ounces to a capacity of 70 kilos, which were the nuclei or focal points of rigid lines radiating in every possible direction. These lines penetrating great masses of quartz and orthoclase feldspar, and gigantic pegmatyt, to distances often of several feet—in some cases of from 5ft. to 8ft.—he has observed that these radial lines were fissures, and bore no relation to the natural cleavage or the crystalline form of the huge rock masses in which they existed. Easy parting took place along these radial lines, making the ore quickly available. It is Mr. Hidden's theory that, as these lines directed to ores rich in uranium and thorium, both well-known sources of radium, etc., the phenomenon is due to an electric or other effect of radioactivity; it being untenable, he believes, to explain this phenomenon on the basis of expansion or contraction. The slide which I will show on the screen shows clearly a pocket of ore with the lines radiating therefrom in all directions.

Eighteen years ago, while in Italy, the author visited the celebrated aquarium in Naples, which is probably the finest in the world; and while there was enabled to test the shocking abilities of the electric ray, or "torpedo Galvani," and was astonished at the tremendous shock which he received; and in this connection it is interesting to call attention to the fact that there are 50 or more fishes which are known to possess this property of giving powerful shocks. The "gymnotus," or electric eel, and the "torpedo Galvani," or electric ray, being the best known of these. It will be recollected that Faraday drew a powerful spark from a gymnotus at the Polytechnicum, London, and he estimated the shock to be equivalent to that given by a battery of Leyden jars of 3,500 square inches of surface. And many writers have referred to the ability of these electric fishes to give powerful shock for a long period of time. D'Arsonval has caused them to light incandescent lamps, and they have been known to magnetise needles and decompose water by the electricity they produce. These fishes doubtless using this faculty as a means of defence and also for procuring food. My object in mentioning this is to state that last fall I again visited Naples, and thinking that perhaps an electric torpedo was on exhibition, it occurred to me to take with me some half-dozen tubes of radium which I had in my bag, and see whether the radium had any effect upon the power of the fish to give powerful shocks. The fish, as at the time of my previous visit, was lying in a shallow wooden box containing wet sand and a small amount of water. By taking hold of the side of the fish and pressing with the thumb on one side and the fingers on the other, or by either pinching or tapping the fish, the cells with which the fish was equipped discharged themselves, and gave a shock sufficient to twist one's arm very badly. After the members of our party had each received a shock, and as soon as a few persons present had gone away, I laid the

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six tubes of radium on the fish (which is shaped very much like a flounder), leaving them there for about 20 minutes. I then replaced the tubes in the box, and taking hold of the fish tried for 15 minutes to get it to give me a shock by tapping or pinching in the same manner as previously done when the fish gave off shocks, and without receiving the slightest shock. Now, I am prepared to admit that the fish might have been "entirely out of shocks"; still, it is well known that these fishes will continue to give out shocks for a very long period of time, one authority reporting 360 shocks in seven minutes' time; but after exposing the fish to the radium I could get absolutely no manifestatien; and in this connection, it is to be remembered that the physiological effects of radium, such as burning, destroying microbic life, producing the sensation of light when a tube is held against the closed eye or temples (which is doubtless largely due to the phosphorescence of the pupil of the eye, but which may also affect the nerve centres), and also the electrical effects, where charged bodies are caused to give off their charge by the ionisation of the air; and one must also remember the very numerous chemical effects and the destruction of the germinating power of seeds, the changing of oxygen into ozone, and various other phenomena of radium which would lead one to wonder whether the radium did not affect the ability of the fish to give off electric shocks, perhaps producing a partial paralysis. The experiment is of some interest, and may be, perhaps, repeated by others who have better facilities than I to continue the investigation. I have sometimes wondered how that fish was getting along in Naples, though I believe the waters of the Mediterranean abound in them. *Note.*—Since writing the above description of his own experiments, the writer has learned of the recent experiments conducted by Prof. Curie, in which a few milligrammes of radium introduced beneath the skin of a mouse near the vertebral column produced death by paralysis in three hours; and tubes of radium placed in contact with the back of the necks of guinea pigs have killed or paralysed these animals in a few hours, according to the length of exposure to its fatal radiations.

As illustrating the action of radium rays upon bacteria, E. Aschkinass and W. Caspari speak of exposing cultures of *micrococus prodigiosus* to a radium preparation, and state that the rays killed the germs very effectively in about three hours. The work of Rutherford, the Curies, Becquerel, and others has demonstrated that there are three entirely distinct types of rays emanating from radium (Rutherford having first pointed out that uranium possessed two separate types of rays, α and β, the former easily absorbed even by gases, whilst the latter are very penetrating and but little absorbed by gas). Those which constitute by far the most important class are the α rays. They constitute the major proportion of the rays, and are those which produce the greatest portion of the ionisation of the gas, which has been observed under experimental conditions. These α rays possess in common certain characteristics of Röntgen rays, and by many have been thought to be Röntgen rays. I shall call your attention later to certain effects which are identical with those produced by Röntgen or X-rays. They have been considered absolutely non-deviable, as X-rays have been held to be. Rutherford has, however, recently shown that in a very powerful magnetic field he could deflect about 30 per cent. of the rays, and in experiments now being conducted with a strong electric field he has been able to deflect about 45 per cent. of the α rays. The α rays are readily absorbed, and a thin screen of metal will serve to cut off the greater portion of them. In this connection I would state that Mr. Tesla informed the writer recently of an experiment he had made in which he had succeeded in deflecting the X-rays themselves, and M. Blondelot has recently claimed as the result of his experiments that X-rays are susceptible of polarisation. If this is so, it is argued they may be shown to be ordinary light waves of extremely short wave-length. Strutt and Crookes have suggested that the α rays consist of positively electrified particles, and this view Rutherford supports, calling attention to the fact that they possess characteristics similar to the "Canal Strahlen" of Goldstein. These Goldstein rays have been shown by Wien to be positively charged particles, moving at high velocities. Rutherford, as a result of his most recent observations, considers that the α rays move at much higher velocity than the Goldstein rays, and he estimates that the energy of the α rays is a thousand times greater than that of the β rays. Rutherford says all the radioactive substances, including polonium, as well as excited bodies and the emanations, give out α rays. The β rays are much more penetrative and much longer, and in every particular correspond to the characteristics of cathode rays. They are readily deflected by a magnet. They discharge electrified bodies by ionisation of the air, affect photograph plates, etc.

M. Villard, in 1899, proved that the cathode rays are negatively electrified corpuscles or fragments of atomic hydrogen, and these corpuscles, as they were named by J. J. Thomson, which he has shown to be one one-thousandth of the mass of the hydrogen atom, are projected from the cathode at a speed approximating 70,000 miles per second. The γ rays are the rays possessing the greatest penetrative effect. They will excite or produce radioactivity through the air at a distance of 3ft. or 4ft. or more. Some recent experiments made by Rutherford show the relative penetration of the three classes of rays through aluminium sheets of varying thicknesses, before a loss is observed of half of the intensity, and this shows for the α rays a thickness of aluminium of ·0005cm., β rays a thickness of aluminium of ·05cm., γ rays a thickness of aluminium of 8cm. Mr. Rutherford, who has conducted most painstaking investigations into the penetrative character of the radiations from uranium, radium, thorium, etc., recently wrote the author, in answer to some questions on the subject, that he had found that the radium rays were reduced to half value after passing through 1cm. of lead, 1in. of iron, and about 8in. of water, the radiation being reduced to about 1 per cent. of its original value, after passing through 7cm. of lead, 7in. of iron, and 56in. of water.

In the lantern slide thrown on the screen is an interesting illustration of the effect of magnetism on the deflectable rays from radium. There are four large steel magnets, two being placed opposed to each other, and the other two so that unlike poles are opposite to each other, making a strong field of force between the two magnets. I have placed six tubes of radium a short distance above the magnets, and in a line running across and between the poles of the two pairs of magnets. It will be seen that the magnetic rays in the case of one pair of magnets have repelled the radium rays, so that the negative is but slightly affected; whereas, in the case of the other pair of magnets, the radium rays have been attracted by the magnets affecting considerably the negative around the pole pieces. Prof. Curie states that half of the induced radioactivity, when exposed to the air, is lost in certain substances in half an hour; but in a closed vessel where the air has been made radioactive, however, this radioactivity has not lost half its strength even after four days' time. It is desirable to keep radium free from moisture, preferably in sealed glass tubes. It readily takes up moisture, and then soon loses its luminosity, which may, however, be regained by dissolving and precipitating the substance and thoroughly drying it.

The luminosity may also be considerably heightened by subjecting the radium to high temperatures. Polonium like uranium, does not possess the power of exciting radioactivity, as it does not give off any emanations, whereas in the case of radium and thorium, there is an actual emanation, producing radioactivity in surrounding objects by the deposit of radioactive matter. When one considers the remarkable effects produced by radium it would almost seem that it is matter tearing itself into tiny pieces, and projecting these infinitesimally small particles through all matter at a speed from half to even the full speed of light, and rendering all substances about it radioactive, and still without appreciable loss in weight in the original substance, and, without disparagement of the accepted wave theory of light, one naturally "harks back" to Newton's corpuscular theory of light.

(To be continued.)

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APPRENTICESHIP IN ENGINEERING TRAINING.*

BY PROF. JOHN DEWAR CORMACK, B.SC., A.M.I.C.E.

The subject of this discussion is wide and complex, and as the scope of the title may be misunderstood it is well at the outset to make it clear, although it may seem, at the same time, to be extended and restricted. "Engineering" is to be understood as including all branches—to be, in fact, civil engineering in the wide meaning of the term. The use of the word "apprenticeship" may, to some, indicate that only one or two branches of engineering are to be considered, and to others it may seem that it is the training of the workman which is to be the subject of the discussion. But an apprentice is simply a "learner"; whatever be the branch of engineering, or whatever be the aim or the ultimate end of a young engineer—whether he is to be a workman, or whether he is to be an employer—during his apprenticeship he is a learner. The title therefore includes "pupil," although this term is sometimes used to distinguish a learner in certain branches, while in other branches it is used to distinguish the "paying" apprentice who aims at being an employer or designer, from the "paid" apprentice who becomes a workman. These extended definitions embrace too wide a field, and it is necessary to limit it by confining ourselves to the training of youths who are destined to be employers, manufacturers, or consulting engineers, designers, heads of departments, technical managers, and men in responsible positions. Whether or not such an apprentice should pay or be paid is a matter for the decision of individual engineers, or engineers in different branches, and this question may therefore be left out of the discussion.

Until the beginning of the last century, entrance into the trades and the professions could only be obtained by means of an apprenticeship extending over seven years, during which the apprentice was bound to serve a master, who, on his part, undertook to keep the apprentice and to teach him his work. The system, as it then was, led to many abuses, and the Act of 1814 was designed to counteract these. It opened wide the doors to all except a few professions, and no restriction was placed either on the manner in which a youth learned his future occupation or the duration of his training. At that time engineering, except in a few branches, was just emerging from its position among the crafts. The removal of the restrictions to entrance may have been harmful in some ways, but at all events it allowed free entrance to many men who, although trained for other purposes, became pioneers in different branches of engineering. Although the restrictions were removed, there still remained the idea that the proper way to become an engineer was to spend a period of five years or seven years in the workshop or office. Probably then, in the existing state of what we are now proud to call the profession, this was desirable, but now, after a century which has seen vast developments in engineering practice, and during which, with ever-increasing rapidity, scientific discovery is turned immediately to practical utility, it seems reasonable that some more generally recognised system of apprenticeship should be devised or recommended to suit the new conditions.

The inadequacy of the old system of apprenticeship has been realised for some time; so long ago as 1866, Sir John Fowler laid stress on the importance of combining the study of science and engineering theory with the ordinary apprenticeship. Since then it has become more generally recognised that the proper training for an engineer involves training both in theory and practice, and this has for the past seven years been emphasised by the institution in demanding a knowledge of theory from candidates for associate membership. When the technical education fever was at its height, opinion, to some extent, went to the other extreme, and it was thought by many that at last we had arrived at the solution of the problem. The numerous universities and technical colleges were expected to be able to turn out young engineers equipped not only with the necessary technical knowledge, but with experience gained in the college workshops. In the United States and on the Continent this system of training has been, to a large extent, adopted, but there are indications of an increasing tendency to diminish the workshop practice in the colleges, and to substitute a training in workshops under commercial conditions. Especially in the case of the United States does one see excuse for such a system, for the extraordinary rapidity of the increase of engineering business there has created a corresponding demand for young men possessed of scientific knowledge and some technical training, and capable of filling responsible positions. In this country, however, starting with a pre-eminent position in engineering, we have advanced with the times—perhaps at a less rapid rate than elsewhere, but still with sufficient prosperity. Interest in the training of young engineers has not been so generally aroused. Biassed as some were by the old traditions, infected as were others by the technical education fever, the advice given to our young engineers has been very varied, with the result that at present training is in some quarters found to be in a rather chaotic condition.

The ever-increasing keenness of international competition urges us to a solution of the problem, and this alone should be sufficient; but the call seems still more emphatic when we remember that the function of the engineer is "to direct the sources of power in nature to the use and convenience of man," and realise his cosmopolitan duties. The beneficial directing of the forces of nature implies a knowledge of the laws governing their behaviour. The definition of the title "civil engineer" demands from him both theoretical knowledge and practical experience, and in this discussion I think we may take as agreed that both are essential in the training of the engineer. The institution has for many years devoted most careful attention to the conditions of training which should be fulfilled by those coming under its purview. The "regular training" prescribed by its by-laws is defined by the council's rules to involve a *minimum* period of three years' pupilage or training as an assistant, where the standard of education is simply that required for admission as a student; and such *minimum* period of practical training may be reduced to two years where a recognised college course of study is taken. In each case the practical training must comprise both experience in the office and in or upon the works.

The institution clearly contemplates a scientific and a practical training for all, and, taking this as a matter of common agreement, the questions to be discussed are: (1) How should the knowledge and experience in each be acquired? (2) Is there any arrangement suitable for all branches of engineering, and if not, what modifications are required for the different branches? (3) Over what period of time should the complete training extend, and what is the best arrangement and division of the time?

Let us look for a moment at the raw material and the finished product, leaving out of account the genius who may achieve eminence in engineering without special training. The raw material is a youth of 17 or 18, fresh from school, educated, perhaps, to a standard below that which might be desired or expected, and supposed to be endowed with common-sense, natural aptitude for the profession, and sufficient physical strength; and the finished product is a blend of scientific and technical knowledge, practical experience, and business method. Our colleges should supply the first two requirements, but I venture to submit that the last two can only properly be acquired in the workshops and offices, and that no training can be considered efficient that does not include a considerable period of practical apprenticeship. Colleges may supply knowledge relating to the properties of materials, the theory and structure of machines, instruction in testing, and in the methods of attacking new problems; but it is only under actual commercial conditions that there can be acquired the proper type of practical experience, adequate knowledge of the design and construction of machines, experience of and sympathy with the workman. It is in the factory or office that there can be gained, by observation and imitation, some knowledge of routine, estimating, organisation and management, business methods and administration, the production of the maximum amount of work with the minimum friction and at the minimum cost. Imitation of good example

* Paper read before the Engineering Conference of the Institution of Civil Engineers.

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counts for much in engineering as in other professions, and to this, no doubt, can be largely traced the continuance of the success of our national engineering, despite our comparative slowness in advancing with the times. It is in this respect that Continental and American systems of training will be found deficient. There the young engineer is launched into his future occupation after a college training of four or five years with workshop experience gained, especially in America, only in the college, and with sometimes a total commercial experience of a year or less.

It is seldom that a youth when he enters the profession knows what special line he will eventually follow. The organisation of this engineering conference indicates at least seven important branches of the profession. He may be trained as a mechanical engineer and eventually end as a railway engineer, an electrical engineer, or a naval architect. There is no broad line of distinction, the branches being so closely related. The mechanical engineer must not build machines without considering the purposes for which they are intended. The dynamo manufacturer cannot look at a combined set solely from the commutator or collector end; the railway engineer cannot confine his knowledge to the finished girder or the finished locomotive, and the naval architect is not concerned simply with the lines or hull of a ship.

Underlying all branches there is to some extent the same practical foundation. All demand knowledge of the properties and uses of materials of construction, and of the methods and processes by which they are converted into structures and machines. In many of the branches it is generally realised that a man must go through the "shop," and after all, the processes in one "shop" do not greatly differ from those in another. Workshop experience is not, however, generally included in the training of all engineers, but surely it is desirable for all, and especially and increasingly so when steel has displaced to a large extent masonry and timber, when all types of motors bulk largely in their work, and when machines of all kinds are utilised to construct to their designs. If it is considered desirable that the training of all engineers should include experience in suitable workshops and factories, specialisation being confined more or less to the drawing office, the question under discussion is limited to the consideration of the time required, and the best division of that time between the college and the workshop. The duration of training depends to some extent upon the arrangement of the course; but probably it may be safely said that to produce the ideal young engineer the training should extend over five or six years, which might be about equally divided between the college and the workshop. Is there any one system that is the most desirable? I leave it to discussion chiefly by engineers in practice, as I feel certain that the colleges are anxious to have a solution of this problem, and to adapt their courses to any scheme or schemes that may be thought desirable.

In this country at the present time the systems in operation might be classed as (*a*) 1 and 2, "separate" systems; (*b*) 3 and 4, "combined" systems; (*c*) 5 and 6, "compromises."

1 *Workshop only.*—This is a survival of the old traditions. It demands physical exertion during the day and mental strain at night if theory is to be acquired. Many eminent men in the past have undergone the strain and emerged successfully, but in the future the ever-increasing demand upon the engineer will render it unpractical, and almost impossible. Many clever youths enter the shops on this system with limited opportunites but with great ability, and provision should be made for them in any scheme of training.

2. *College only.*—This has already been alluded to. Under exceptional circumstances, such as obtain in the United States, it may be expedient, but it is undesirable.

2. *Works before College.*—A youth entering college after, say, three years in the factory and office is in many respects a good type of student He has gone through the shops at the receptive and imitative age; he has ascertained whether engineering is still to his liking, and comes to college with a knowledge of processes, materials, and machinery. He has some idea of what he wants to know and what branch he wishes to enter, but has often wrong theories which are difficult to uproot. Teachers prefer this type, provided he has continued his studies during his apprenticeship, but this is not always or even generally the case. The youth may have forgotten much of his school training, and, what is worse, he may have forgotten how to study. If he has studied, it is under trying conditions, when he is physically tired, and he may wish to confine his studies to the more interesting technical subjects, the science underlying them being more or less neglected, and in consequence his progress is less rapid. He comes to college probably disinclined to begin again and gain the scientific knowledge which ought to precede all its applications.

4. *College before Works.*—A youth fresh from school and sufficiently educated is likely to make good progress in his scientific studies. In the technical work he is handicapped by his want of knowledge of manufacturing processes and the operation of machines, and is unable to associate his theoretical studies with practical examples of which he has had experience. Laboratories help to some extent to reduce the handicap. If this was to be the standard training there would be a greater plea for college workshops, which would supply some little practical experience, but which could not supplant, even partially, the workshop training under commercial conditions. Some may urge that this system produces a man disinclined to undergo what he calls the "drudgery" of the workshops, but others will be as ready to admit that the proper type of youth acquires his practical experience at a much more rapid rate after he has undergone a college training, and has no such disinclination. This system may be preferred by employers as distinguished from system (2), which may be preferred by teachers.

Other systems are in vogue, either by accident or design, whose object is to avoid the disadvantages connected with "separate" and "combined" systems, or to minimise the required period of training.

5. *Intermittent Systems.*—These include the works-college-works and the college-works-college systems. Many arguments can be advanced by the advocates of each. The first arrangement has to a lesser extent the disadvantages attached to system (3), and the latter system those of system (4). Both waste time, in so far as the usual college terms extend over only nine months of the year, and the remaining three months may be wasted, as few engineers care to take youths for three months in the year; but probably, on the whole, this system is preferable to (3) or (4). In the college-works-college system the youth fresh from school has an opportunity of acquiring a foundation of science on which to rest his works' experience, but if study is not continued his knowledge may evaporate in the works, and at the end of his training he is out of touch with his employers.

6. *Sandwich System.*—This system goes one step further. During a period of, say, five years' training, for four years, six months of each year are spent in the factory or office and six months in the workshops, and the additional year is spent in the workshops or office. It lessens the discontinuity between the two parts of the training, and effects a saving of time, inasmuch as the college long vacations are utilised. An objection which may be put forward is that the youth is always "on the move." He has no time to settle down to either the workshop or college work, and he may have difficulty and extra expense in arranging for lodgings. It must not be forgotten, however, that each part of his work forms a recreation for the other, and the student is likely to return to each with considerable keenness.

7. *Concurrent Systems.*—These either give time for study in classes in connection with workshops, or offer workshop training in connection with college. Both systems have already been alluded to. The objections to (1) and (2) may be applied here. Time taken off the workshops for study gives less time for the practical experience, and this is not acquired under strictly commercial conditions. Except in the very largest works, it is impossible to provide the requisite standard of teachers, and if it is necessary that the youth should breathe the atmosphere of the shops, probably it is perhaps equally necessary for him to breathe the atmosphere of the college.

The list may not comprise all the systems in vogue, and

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the arguments for and against them are merely indicated, but it serves to emphasise the diversity of the ways in which a youth may enter engineering. Is it not possible, at least to some extent, to standardise the training?

DISCUSSION.

Mr. Drummond, in opening the discussion, said that the system adopted on the London and South-Western Railway at Nine Elms was to take away from school a boy at the age of 15 or 16, give him three years' workshop training, and allow him to go to a class on three mornings in each week.

A lengthy discussion took place, and **Mr. A. F. Yarrow** (Poplar) was warmly applauded on rising to speak. He said that all those who had travelled abroad and concerned themselves in the training of engineers must be struck with the "chaotic state" in which the training here was carried on, as there seemed to be no system or policy. He thought it must be taken as admitted that for a man to occupy a leading position in an industrial undertaking, such as head of an engineering establishment, he must combine scientific knowledge with workshop experience. The question, therefore, arose as to which was the best system to adopt. Of late much attention had been paid to the subject, and they were in a position to form an opinion as to the comparative merits of the different systems, and possibly arrive at some plan which might be deemed the best, and perhaps better than that adopted elsewhere. He thought Prof. Cormack had made it quite clear that he was not dealing with the apprentice who desired simply to learn one branch of engineering, but with the young man who desired to attain a high position in his profession. That involved a more or less expensive education, but mechanics' sons, in consequence of scholarships which county councils and others had placed within their reach, had now an opportunity of pushing themselves to the front and securing an equally good training to that obtainable by those endowed with sufficient wealth. In any scheme that was adopted care should be taken to provide that the sons of poor men, so far as was practicable, were not shut out from the best educational advantages, otherwise the country would be deprived of the ability of the majority. It was desirable to select such a system as might be acceptable to the more industrious and the brighter lads. That was why he was such a strong advocate that all young men, during the period of serving their time in the shops, should start at six. In some works it had been attempted, with more or less success, to have a scientific course in connection with the works. That might be done in very large establishments, but it was evident that any such system would not give a young man the educational advantages that could be found at a universaity or technical school, where the most able professors were found and where various descriptions of apparatus to illustrate principles were available. He felt satisfied that to get the very best scientific training it was necessary to study in one of the leading colleges under the very best teachers. This could be done by a course of three years at a college, and it could be combined with workshop practice by three years in a workshop, either before or afterwards. It was the opinion of the majority of educational authorities that if the scientific and practical work could be proceeded with as far as possible side by side, it would be very much better than completing the one course of study and then taking up the other. They found very frequently in the universities and technical colleges large workshops, which he ventured to say was very undesirable, for he thought the use of machines should be learnt under "commercial conditions," because not only was the use of tools being acquired in the workshops, but the knowledge of the administration of works. He was strongly of opinion that money expended in increasing the number of workshops of technical colleges would be more wisely spent in other directions. The "sandwich" system seemed to offer many advantages for two classes of knowledge where acquired simultaneously. He thought they were very much indebted to Prof. Cormack for bringing it forward in so able a manner.

There was a great diversity of opinion as to what system should be used, some speakers objecting to any cut-and-dried system.

Sir Wm. White said they had had a great variety of opinions, some of which had been very strongly expressed. He noticed there was a universal agreement on one or two points; for instance, that no man could be an engineer unless he had had a large practical experience combined with scientific knowledge. How were they going to find some practical method of procedure out of all the diverse systems? There was not a single system mentioned in the paper which had not produced good men. That discussion would form the basis for considering a settled system, which, in any case, could not be made compulsory. It seemed to him that the Institution of Civil Engineers was naturally the body to take the initiative, but he did not suggest at present in what direction that movement should be made. He thought some members would like to know what had been the Admiralty system of training for nearly half a century. It was one of the oldest organised systems of the country, and it was exceedingly little known. It really embraced two stages, which applied distinctly to the training of officers of shipbuilding and engineering departments. The first stage was residence in a college attached to one of the dockyards. The students, for whom there was a competitive entrance examination, were concurrently studying and working in the shops and dockyards. Then there was a process of weeding. If the candidates did not prove capable of taking that training, they did not go further or went on in some other branch of the service; but those who had proved capable of taking the higher training were then passed on to the Naval College at Greenwich, and there the sandwich system prevailed—a certain number of months at colleges and a certain number of months in the dockyards. That system had been applied with complete success, and it was a system that should be placed on record.

A vote of thanks was accorded the author.

THE MANAGEMENT AND WORKING OF BOILERS.

BY HORACE BOOT.

The following is an abstract of Mr. Boot's paper read before the Municipal Electrical Association at Newcastle:

The author commenced by stating that every central-station engineer should be familiar with the construction, management, and the most economical way of working and maintaining steam-boilers in good repair. Nothing is more detrimental to the satisfactory running of a power station than neglect of this department, or leaving the supervision to leading foremen or workmen. There are few, if any, experienced engineers that, at some time or other, have not been short of the steam required owing to something having gone wrong in the boiler-house, which, perhaps, might have been avoided with clean boilers, proper draught, or more reliable boiler fittings. The author explains that the variable load of an electricity works is much more trying to boilers than that of a mill with regular hours of regular load. He advocates a combination of Lancashire and water-tube boilers, the latter being only used at peak load. To keep water-tube boilers in good order, the author recommends the following boiler-house regulations:

1. Never raise steam quickly; take about three hours from lighting up time for a cold boiler to get up steam.
2. Never allow cold air to blow on the front headers by opening the tube doors when the boiler is hot.
3. As soon as 50lb. of steam is showing on the gauge glass, blow down the boiler for a minute by opening the blow-down cock; test the boiler gauge glasses.
4. When letting down steam in a water-tube boiler, repeat No. 3.
5. Every boiler is to be blown down once in 24 hours. The safety valves tried, the gauge glasses tested every eight hours, the high and low water whistle alarms once every seven days. The soot blown and brushed off the tubes every morning. (It may be mentioned here that the fixed blowers usually fitted to water-tube boilers, when set in a battery, have not been found a success for this purpose, but it is very easy to have little doors built and use the ordinary lance cleaning tube. The objection to the fixed blowers has been that they are likely to only clean one portion of the tube, and cause outside corrosion of the tubes due to moisture dripping. For this reason, and their inefficiency, they have been removed from one of the author's boilers, and replaced by the ordinary type of blow-down lance, with inspection holes in its place among the tubes at the top of the boiler.)
6. The boiler is to be fed with water continuously and not intermittently; the regulation of the feed is to be performed by the speed of the feed pump, and not by throttling the boiler feed valves.
7. Before disturbing a banked fire, open the dampers and the cold-air doors on top of the fire in order to get rid of any accumulated gas; when sufficient time has been given to allow this to disperse, the dampers may be partly closed, and the fire raked up in the ordinary manner.
8. Anything abnormal noticed by the stokers to be at once reported to the engineer in charge.

The above are the regulations for keeping the boilers in good working order, and below are the cleaning and inspection regulations:

1. Every three months each boiler is to be carefully inspected inside and out. If necessary, all the front caps are to be taken off, the tubes scurfed, and valves ground in, if leaky.
2. Before taking down a boiler for inspection, about six to ten gallons of paraffin or soda is to be put in, and the boiler simmered for 60 hours, the steam pressure not being allowed to exceed 50lb.
3. On the completion of the above course, the hot water is to be let down gradually and the top caps removed one by one, so that the tubes are scurfed whilst the hot water is in them, in order to prevent the scale getting hard on the tube before the scraper reaches it.
4. After all the tubes have been scurfed, a careful inspection with a vat lamp—*i.e.*, a lamp to go right down the tube—is to be made.
5. Should any tubes look doubtful or not quite normal, they are to be submitted to a pressure test of about four times the working pressure.

The author then describes the apparatus he has designed and patented for testing a single tube *in situ*. This is illustrated in Fig. 1. This apparatus has been at Tunbridge Wells the means of saving tubes which certainly looked as if they ought to have come out, and other tubes which appeared perfect, after being tested, were found to be weak. There is no need to run any risk with doubtful tubes, as in a few minutes the pressure test can be applied, and the tube can be tested up to destruction if desirable. It also enables tubes to be tested up to higher pressures than the drum should be subjected to. The author has known scale in a tube resist 350lb. hydraulic pressure, and yet the moment that scale became loose the tube ripped open, owing to active corrosion taking place beneath the scale. He recommends a record of the dates of replacing tubes in boilers being kept, and such a record he illustrates by Fig. 2. A log of repairs is also advised to be kept. The author has tried various means of scurfing the tubes. On several occasions the tube turbine cleaner has been used, but it takes so long to do its work, and uses so much water, that he is not at all sure whether it is not cheaper in the end to put in a new tube. The importance of keeping the tubes in a water-tube boiler free from scale is shown by the following figures:

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Scale $\frac{1}{16}$in. thick, requires about 10 per cent. more fuel.
,, $\frac{3}{16}$in. ,, 25 ,, ,,
,, $\frac{1}{8}$in. ,, 125 ,, ,,
to evaporate the same quantity of water.

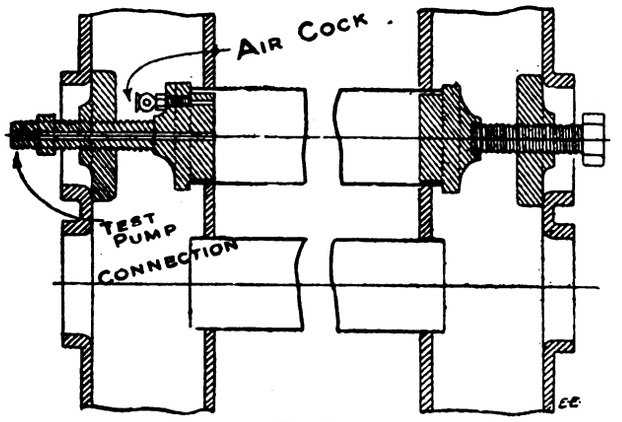

FIG. 1.

The costs of keeping up the five boilers at Tunbridge Wells for 1901 were as follows :

Year 1901.	Boiler I.	Boiler II.	Boiler III.	Boiler IV.	Boiler V.
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
Scurfing	1 10 1	4 17 0	4 6 8	3 19 6	1 12 3
Brickwork	3 13 6	4 9 0	4 9 0	4 9 0	1 15 0
Cost of renewing tubes	25 4 0	25 4 0	—	—	6 6 0
Labour on ditto	7 18 9	8 0 0	—	—	1 14 7
Firebars, including labour	8 4 0	8 4 0	8 4 0	8 4 0	4 2 0
Repairs to blow-down cocks	0 5 10	0 9 7	0 5 5	—	—
Gauge glasses, rings, and fittings	2 1 0	1 17 0	0 17 0	2 1 0	1 10 0
Total	48 17 2	53 0 7	18 2 1	18 13 6	16 19 10

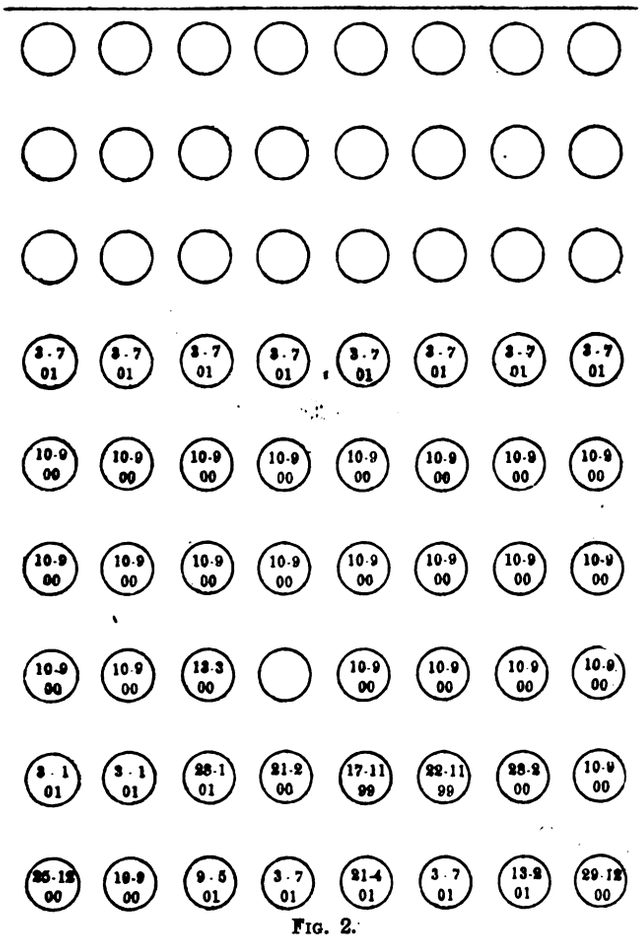

FIG. 2.

The figures for scurfing are not complete, as shift labour is also used for this work. The tube repairs on boilers Nos. 1 and 2 are abnormal, as 24 tubes were renewed in each. The author thinks a fair average with a medium class of water would be 10 tubes per boiler per annum. It has been found that the average cost of renewing a tube, including everything, is 26s. 6d.

It will be noticed that the wear and tear on firebars is high. The cost of the bars is 8s. per cwt. The author has tried all kinds of shaped bars, the air-space between the bars being regulated to suit the various kinds of fuel used. He has found it important to have a flat surface for clinkering, and is now using the dog-tooth bar, originally designed by a Nottingham firm, and from results these bars last longer than the ordinary straight bars, and there is less waste of fuel caused by unburned coal dropping through. The cost per set of ordinary bars was £7 per ton, and of the special design (which lasts half as long again) £8 per ton.

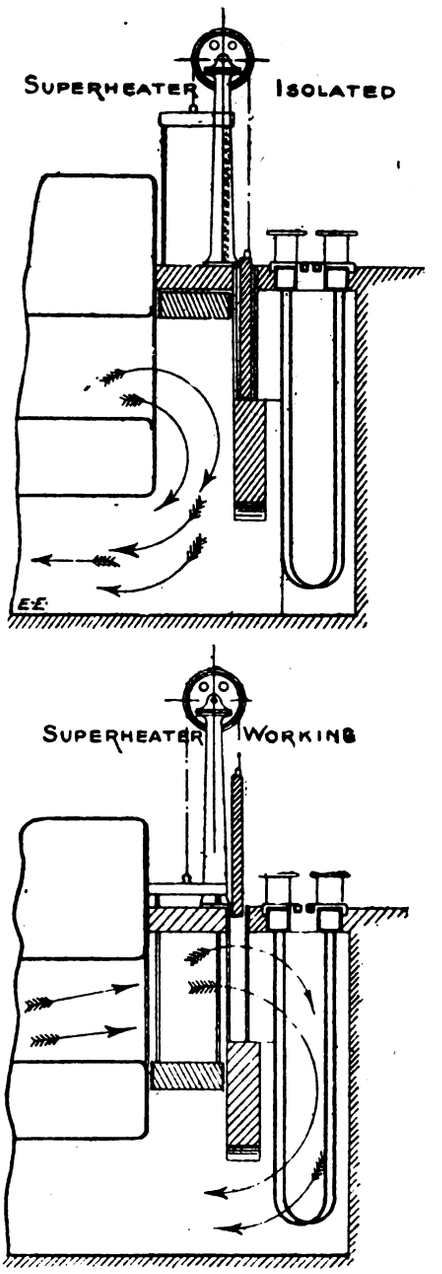

FIG. 3.

The author advises the use of a main isolating valve where several boilers are connected to a main steam range. The valve should be of the "mushroom" type, in preference to the "ball," which latter usually gives trouble when running large engines, owing to its continual knocking, thus damaging its seating. As regards the Lancashire boilers, the author has not found them more economical with regard to coal consumption, and he thinks the radiation losses are more than with the water-tube boilers. He has found the split bridge for the prevention of smoke a most efficient arrangement, although difficulty is experienced in making the stokers use it properly. Below is tabulated the cost of repairs over a period of 12 months to two Lancashire boilers :

	Boiler VI.	Boiler VII.
Brickwork	£1 11 7	£20 15 9
Firebars	5 19 7	6 0 0
Cleaning flues	0 12 1	0 12 0
Caulking seams	1 13 3	0 7 0
Blow-down cock	0 5 3	1 3 6
Repairing dead plates	1 3 8	1 3 6
Miscellaneous details, including labour	4 8 1	2 12 3
Totals	£15 13 6	£32 14 0

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The author then discusses superheaters, and states that tests at his works show that an economy of about 8 per cent. is obtained by their use. In the author's opinion, a superheater should be constructed and arranged in the flues of Lancashire boilers in such a manner as to comply with the following:

1. The gases must be entirely shut off, and go through a by-pass when the superheater is not in use.
2. It should not be necessary to flood the tubes under any circumstances, flooding being a most dangerous practice, although (unwisely) recommended by certain makers.
3. No cast metal, only boiler plate or forged steel, to be used for the headers or boxes into which the tubes are expanded.
4. Ample provision to be made for expansion and contraction, not only in the construction, but also the method of supporting.
5. Provision to be made for easily renewing defective tubes without an excessive amount of labour.
6. A dead-weight, and not a spring safety valve, to be fitted, of ample size, to relieve any excess pressure, and a lever provided for testing the efficiency of the safety valve from day to day.

It is an easy matter for the superheater flue to be so constructed that if it is desired to cut out the superheater the gases can pass through the by-pass, thus avoiding the necessity for flooding when getting up steam, and of having to withdraw the superheater when there is a defective tube until such be repaired. In Fig. 3 one way of doing this is shown.

In the concluding part of the paper, the author, in justice to boilermakers, states that the feed water at Tunbridge Wells is not desirable in quality, due to the presence of acids. The original water supply has now been abandoned, and the ordinary town water substituted.

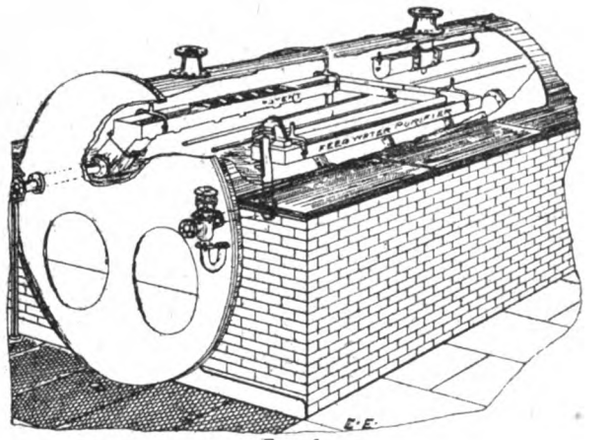

FIG. 4.

For the Lancashire boilers the author has tried a purifier—a sketch of which is given in Fig. 4, from which it will be seen that the comparatively cold water enters the trays, and flows round the steam space of the boiler, returning along the bottom of the zinc plates, dividing the two halves, and when it has deposited all its scale in these trays the water is delivered at *boiler temperature* into the boiler. A separate blow-down cock and pipe are fitted to the end of these trays, and by blowign down every 24 hours the purifier can be used for three montsh without cleaning, but after the boiler had been running three months the deposit was so thick in these trays that they had to be cleaned, because they were choked up.

Mr. T. P. Wilmshurst, of Derby, in opening the discussion, complimented the author on his practical paper. With respect to the renewal of tubes, he noticed that 50 had been renewed in two years. The tubes in the sixth or seventh row should not give any trouble, and he thought the total renewals was excessive. At Derby only the two bottom rows of tubes gave any trouble, and they had had to renew only from four to five tubes per boiler in the course of three years. At Exeter after 14 years' experience no tubes needed renewing. He thought that the lower rows gave out first because they did most work, and in consequence received more deposit. He had found that a chain-grate stoker practically stopped all smoke. It was difficult, however, to keep the fire well covered over the back of the grate at light loads. He had found that for the firebrick arches a much longer life could be obtained by using special key bricks from Stourbridge. These lasted twice as long as ordinary bricks. He thought that analyses should be made regularly of the flue gases, and was installing a carbon dioxide recorder in his station.

Mr. H. Talbot, of Nottingham, said that isolating valves should be used in the steam connections of all types of boilers.

Mr. J. H. Rosenthal, of Messrs. Babcock and Wilcox, pointed out that the water used at Tunbridge Wells contained acid which attacked the boiler tubes. He did not believe in the testing of individual tubes, which was apt to put strains on the headers. A simpler way was to plug the uptake and downtake pipe, and test whole sections together. Mr. Boot's average figure of their renewing 10 tubes per annum per boiler was much too high, and this would be confirmed by other users of the same water-tube boilers. He did not agree with Mr. Boot's remarks on the flooding of superheaters. It was in starting up that the superheaters were apt to be damaged, as then they contained neither water nor steam. As regards the addition of a valve between the boilers and the superheater, he thought the practice dangerous. Mr. Wilmshurst was correct as to the reason for the lower tubes going first. Practical experience, however, had shown that the work could not be equally divided between the tubes, and that if the number of rows was reduced, the boiler did not take the heat from the furnace gases as it should do. In fact, the addition of a superheater in retarding the gases on their way over the tubes improved the efficiency of the boiler. The difficulties of the early make of the chain-grate stoker as regards air leakage has now been got over.

Mr. A. G. Cooper, of Colne, agreed that the lower tubes alone should give trouble. Isolating valves were exceedingly useful if a stop-valve of a boiler was inadvertently opened before its pressure was high enough.

Mr. J. K. Bridges, of Eastbourne, remarked that there were other makes of water-tube boilers than the Babcock-Wilcox. He did not approve of frequent hydraulic testing of the tubes, and his experience of the turbine tube cleaner was much more favourable than the author's. There was no need to use a joint ring with the Babcock-Wilcox boiler, but with the Hornsby boiler they had to be used, and caused trouble. His experience had been that makers would not guarantee mushroom isolating valves with superheated steam.

Mr. Ruthven-Murray, of Willesden, advocated the use of glazed bricks to keep down air leakages through the brickwork. He had found, in consequence, that glazed bricks got hot because their surface did not radiate so well as a roughened surface of ordinary bricks. He also believed in the testing of flue gases regularly. For lagging he preferred a silicate cotton under a metal shield. The air imprisoned in the cotton acted as a good lagging. He thought that the economy from superheating should be considerably more than 8 per cent.

Mr. H. B. Maxwell, of Partick, had used the multiple firebars with satisfaction, both with ordinary boilers and with refuse destructors.

Mr. Robert Quin said that for removing oil a chemical process was the only one. Hydrated ferric oxide would serve, as would also aluminium sulphate. He thought the author's tube-testing arrangement was responsible for the header distortion he had referred to. He advocated gannister firebricks for boiler furnaces.

Mr. L. Robertson, of Hackney, gave a good record of the Babcock-Wilcox water purifier.

Mr. W. A. Vignoles, of Grimsby, advocated the undertype of stoker, which could be made quite smokeless.

Mr. H. L. P. Boot, in reply, said that everything depended on the feed water in the cost of boiler upkeep. He threw doubt on the small cost of repairs and few tube renewals which some engineers claimed. He found that firebrick arches lasted from eight to nine months. In spite of what had been said, he thought that the ordinary expansion and contraction would distort the headers. The Edmiston filter referred to was a marine type. The filtering medium was towel cloth, but the filter had not to deal with any considerable quantity of oil. He had not found much advantage from grouped firebars.

ECCLES ELECTRICITY ACCOUNTS.

Below we give an abstract of the accounts of the Eccles Corporation electric light works for the year ended March 31 last.

REVENUE ACCOUNT.

Dr. Expenditure.	£	s.	d.
Generation of electricity	1,438	10	2
Distribution of electricity	316	18	2
Public lamps	76	15	1
Rents, rates, and taxes	91	5	6
Salaries	262	14	9
Establishment charges	91	1	3
Insurances	22	5	0
Interest and repayment of loans	1,014	0	4
Interest and commission	58	7	3
	£3,371	17	6

Cr. Income.	£	s.	d.
Sale of electrical energy—Private lighting	2,028	16	0
Ditto public lighting	552	8	7
Meter rents	78	13	6
Sale of cinders, etc.	7	14	6
Fittings and repairs on consumers' premises	227	18	8
Balance, being deficit on revenue account	476	6	3
	£3,371	17	6

BALANCE-SHEET.

Dr. Liabilities.	£	s.	d.
Loans on mortgage	20,619	5	11
Sundry creditors	247	16	2
Treasurer	1,840	19	11
Sinking fund	38	15	2
Loan repayment account	1,640	14	1
	£24,387	11	3

Cr.	£	s.	d.
Capital outlay, assets, etc.	22,862	6	2
Sundry debtors	984	4	4
Stock on hand	20	19	4
Cash in hand	5	0	0
Sinking fund investments	38	15	2
Revenue account—balance	476	6	3
	£24,387	11	3

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CORRESPONDENCE.

WIRELESS FIRE-ALARM.

SIR,—With respect to the note headed "Wireless Fire-Alarms," on p. 187 of your issue of Aug. 8, I beg to offer the following observations on your remarks. I note that you are in favour of electric fire-alarms. Concerning my apparatus you say in the first place, "The most recent development of such an alarm is one patented by Mr. Guarini for doing without communicating wires Experiments in Brussels have shown that the system will work, but we are not hopeful of any system which depends on the Hertzian wave for giving such an alarm." This has need of explanation, because you make in it reproach on all wireless telegraphy by Hertzian waves. In the first place, I would say that I could make my system work equally well with ordinary alternating currents; secondly, I would refer you to the Hertzian-wave systems of Marconi, Slaby-Arco, Braun, De Forrest, Fessenden, Rochefort, etc, which are far from a myth, and which over short distances give perfect satisfaction. If wireless telegraphy over long distances is still open to fault, this does not apply to communications over small distances. I claim that over small distances wireless telegraphy leaves nothing to be desired, and has the following great advantages: it costs less to instal than connections with wires, and, secondly, is exempt from all those inconveniences which accompany overhead wires. It remains, then, to show that communications by wireless telegraphy over short distances are exempt from all those faults which signalling over great distances possess. These latter inconveniences are due to (1) the great sensitiveness which the receiver must have to avoid the employment of large power in the transmitters; (2) the space required for and height of the aerial wires which introduce disturbances due to earth currents and atmospheric electricity. Over small distances the vertical wires are short, and by the employment of condensers, connections with the earth can be avoided. It remains now to see if your remarks on my fire-alarm can be met. You say: "Quite apart from the difficulty of getting good distinctive signals from a large number of subscribers, there is the interference question, which is even more serious in a fire-alarm system than in ordinary telegraphy." The first difficulty can be got over easily in the way that is done with the May-Oatway fire-alarm, by transmitting Morse signals, each subscriber having a different signal. With regard to the interference being more serious, I think you would have to search in vain for two fires which commenced in the same town exactly at the same moment. Even then, by continuing to repeat the alarm, the signals can be divided out. At the end you say: "Up to the present we know of no experiment which gives that secrecy and freedom from interference with wireless telegraphy which can be obtained easily and cheaply when wires are employed." I would remind you that up to 4 km Hertzian reflectors have been employed with success by Marconi, which would be quite sufficient to avoid interference. Also in your issue of Aug. 7 you publish a letter of mine on the same subject. Then, again, by syntony secrecy can be assisted, but in my fire-alarm there is absolutely no necessity to avoid interference, or to take any precautions whatever against it. I freely admit that communications with wires can be easily made, but this is equally the case with wireless telegraphy, and the installation can be made in less time. It also avoids the overhead wires, which are objectionable. I am of the opinion that if one day the conditions laid down by Mr. Oatway are fulfilled completely, it will be done by means of wireless telegraphy.—Yours, etc.,

E. GUARINI.

[We regret to have had to condense the above letter, but think we have given the author's meaning fairly. He does not realise our point, that his wireless fire-alarm station would be receiving at odd times Morse code messages from other wireless telegraph systems in the neighbourhood or from casual experimenters. The essential feature of any system of electric fire-alarms is that it shall be quite distinct and apart from any other system which might give fictitious calls at any time. It is the fear of these fictitious calls, owing to defect in working, which has made the London County Council Fire Brigade refuse to recognise up to the present any automatic electrical fire-alarm system.—ED. *E. E.*]

JUDGING ELECTRICAL FIRE BRIGADE CALLS AT EARL'S COURT.

SIR,—I shall be glad if you will allow me space to call attention to the methods adopted by the executive of the British Fire Prevention Committee (is there such a thing as fire prevention?) in judging the exhibits entered under this class at the International Exhibition at Earl's Court.

My company is an exhibitor, and some time in June delivered at the request of the committee a descriptive schedule of the exhibit, which was acknowledged in due course. Some time subsequently we were notified to take our "hand machines" to the lake for examination by the jury on July 15, just as though the authorities in their wisdom did not know that a system of automatic fire-alarms did not indulge in hand machines, and was not a squirt, a diving bell, or other appliance in need of a lake. However, explanations passed, and in the end, classed as brigade calls, we were notified to be ready for the jury on the 7th inst. The writer came up from Scotland, expecting, as any other reasonable man would expect, that an electrical fire brigade device would be judged by electrical and fire brigade experts, and you can well imagine my surprise at finding the jury composed of two insurance surveyors (one an A.I.E.E.), a borough surveyor, an architect, and the respected chief of the Salvage Corps; but never, oh! never, a practising consulting or working electrician or fire brigade officer amongst them. Never imagining for a moment—original and anxious to glorify its members as the British Fire Prevention Committee is known to be—that that body would dare go to this length, the writer came to the conclusion that the only member of the jury unknown to him was the chief officer of a well-known brigade, and went ahead with the demonstration instead of withdrawing the exhibit from the investigation of such a group. So soon, however, as the identity of the fifth juror became known, and before any awards were made public, a protest was lodged with the executive, and it is to ask your readers to watch the result of this protest that I am now writing. I do not demur in the slightest to the integrity or status of the members of the jury, but just as no one in his senses would ask his Grace of Canterbury to judge the turnips at an agricultural show, or the president of the Royal Society the *lingerie* at Jay's, so the exhibitors in this class have a right to expect that the judges shall combine expert practical knowledge of the subject they are adjudicating upon with the necessary integrity, patience, and attention to detail. No awards are yet known, and I have asked the executive authorities to seek the assistance of the professional fire chiefs and National Fire Brigade Union committees in selecting brigade chiefs and electricians, and leaving them free to include lay members of their own committee, salvage experts, etc., so long as the practical element is in a preponderant majority. It now remains to be seen whether a common-sense suggestion of this kind commends itself to the authorities.—Yours, etc.,

GEO. W. OATWAY.

[We quite agree with Mr. Oatway that committees making awards at exhibitions should be composed of men expert in the branch of science involved.—ED. *E. E.*]

RE N. F. NALDER.

SIR,—Referring to your report of the proceedings under the failure of Noel Francis Nalder, of 19, Queen Victoria street, E.C., some confusion appears to have arisen between the name of the debtor and Mr. Francis Henry Nalder, one of our managing directors. We shall esteem it a favour, therefore, if you will kindly note in your next issue that our Mr. Francis Henry Nalder has not, nor ever has had, any connection, direct or indirect, whatsoever with Mr. Noel Francis Nalder, nor has he or our company of Nalder Bros. and Thompson, Limited, ever had any connection with any of the companies in which Mr. Noel Francis Nalder was interested.—Yours, etc.,

NALDER BROS. AND THOMPSON, LIMITED.
(E. Thompson, Managing Director.)

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THE

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TO CORRESPONDENTS.

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MUNICIPAL TRADING.

In our last issue we noticed briefly that a report by the joint committee appointed to consider this question had been published. The order of reference must be examined before any conclusion can be reached as to the value of the report. It was practically to "consider and report as to the principles which should govern powers given by Bills and provisional orders to municipal and other local authorities for industrial enterprise within or without the area of their jurisdiction." In 1900 a similar joint committee sat upon a similar order of reference. The 1903 committee in its report says of the 1900 committee:

"In consequence, however, of the great extent of ground to be covered, and the complexity of the subject, that committee were unable to make any report on the merits, but confined themselves to a recommendation of reappointment in the next session."

This proves that in 1900 there was no report on the merits of the case, nor is there in the present report one scrap of decision upon these merits, for paragraph 7 of the report says:

"Whatever view may be taken of the proper limits, if any, which can be set to municipal trading, it is clearly important that wherever it exists ratepayers should be not less fully and continuously informed of the success or failure of each undertaking than if they were shareholders in an ordinary trading company."

The importance of keeping a true and correct set of accounts admits of no discussion, but what has this to do with the merits or the limits of municipal trading? The fact is that the committee has deliberately ignored the order of reference, and spent its time and the public money upon a question of detail which did not concern it and with which it had nothing to do. What are the principles, and what are the limits, if any, that underlie municipal trading? These are the questions asked in the order of reference, but they are not answered in the report, nor has the committee taken any evidence that would assist in solving the questions. The whole thing has been a grotesque farce, and the result contemptible inanity. Reading between the lines, we come to the conclusion that neither the Government nor the committee care to tackle the main question. Tacitly they assume "What is, is right," that municipal trading exists and will continue to exist, that limits or principles are to be ignored, but some few petty suggestions about details may be embodied in a Bill. If that is done, the Government will have flouted the business men interested in the question, and the interference will irritate the municipal people, while doing no good. Either municipal trading is wholly good or wholly bad, or good within limits. There are few readers, or rather students, of history nowadays, otherwise it would be better known that municipal control of trading had been tried and failed. The current report deals mainly with the due keeping of accounts and having a proper audit, with a tail piece stating the advisability of continuing the investigation "into other branches of the subject." Here, again, we see inferentially the assumption that municipal trading has come to stay. The logic is, municipal trading exists; why trouble to enquire into the rights and wrongs of its existence? Just so, thieving exists; why enquire into the rights and wrongs of thieving? The present position of the matter is simple. Municipalities want to take all the plums of trading, and anybody can have the competitive trade. The plums are everything of the nature of a monopoly—no competition, and, therefore, little incentive to progress. Private enterprise may invent and improve. If

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it trades competitively, it must adopt the latest improvements in order to exist. The municipality, on the contrary, exists anyhow, and may or may not be "up to date." At the present moment, no doubt, the municipalities have done and are doing good work, and their concerns are mostly very up to date; but that is because the days are young. By-and-by, when fluctuations in business come, as they will and must come, what will be the position of a town heavily in debt, heavily rated, and retrogressing? We think its downfall will be hastened because of its being in business. It is a great pity that the Government and the committees have not had courage enough to make a thorough enquiry and give definite opinions. One word as to accounts. The report is to all intents and purposes a report condemning the accounts of local authorities, and, in our opinion, this is an absolutely incorrect view of the matter. The accounts of the local authorities on the whole are better kept, more in detail, and more understandable than those of companies. In the prominent cases which have led to complaint the items under controversy have been items that might with equal correctness be placed under either of one or two headings. We have never found any disposition by a local authority to falsify the exact final position of its financial affairs, though there have been differences of opinion as to how items should preferably be charged. The electors elect representatives upon the councils. Surely these men, who pay the money to be expended, are interested enough to see that their representatives are neither thieves nor rogues. This report infers that dishonesty is rampant, which we assert deliberately is wrong. Are mayors dishonest? Are they, usually the loyalist of loyal citizens, likely to nominate inefficient auditors, or auditors who will scamp their work? The report says little interest is taken by the ratepayers. Admit it. What does it mean but that those who do take an interest will see that the men elected are men who will take an interest in their work also? Altogether, in our opinion, a more contemptible report was never issued by a committee since this world began. It has left everything undone which it ought to have done, and done nothing it ought to have done.

THE PARIS METROPOLITAN RAILWAY DISASTER.

Our readers will have learned from the daily Press most of the details of the disastrous fire on the Metropolitan Railway of Paris on Monday last in which 84 passengers lost their lives. The following account may help to fix what little technical information is now available, and help in the formation of a just opinion as to how far such a fire is preventable. The stationmaster at the Rue des Couronnes Station is responsible for the statement in the *Daily Telegraph*, that "train No. 43, coming from the Porte Dauphine, and bound for the Place de la Nation, had been brought to a standstill at the Boulevard Barbes Station, owing to a mishap to the engine. The passengers were directed to leave the train. Train 52, following at a short distance, was also vacated, and was used to push on No. 43. The two trains ran through the Chapelle, Rue d'Allemagne, Rue d'Aubervilliers, Place du Combat, and Belleville Stations without stopping, so as to clear the line. When they passed the Rue des Coronnes Station flames were perceived at the bottom and up the sides of the cars. I cried to the guards who were standing at the open doors of the passing train, 'Stop, you will never reach the next station.' 'All right, all right,' the driver called back. 'We will get there safely,' and the two trains, already afire, disappeared at a terrific speed into the tunnel. Just before they reached the next station, that of Ménilmontant, a flame suddenly flashed out between the leading motor carriage and the car behind, and a violent explosion was heard. In a second flames enveloped all the eight cars of the two trains. The drivers and guards just had time to fly for their lives. The flames rose up to the roof of the tunnel and licked its sides. The electric light wires were melted and the whole tunnel was plunged in darkness, except for the glow of the conflagration. The current was immediately switched off, and train 48, which was coming up behind, stopped 300 yards before the Rue des Couronnes Station. A terrible panic occurred among the passengers of the train. Some rushed back to the Belleville Station, others went on to the Rue des Couronnes through the suffocating smoke and the luridly-lit darkness."

From this and other accounts it appears that the passengers in No. 48 train were never near the burning trains, but that in walking towards the Rue des Couronnes Station or in the station itself they were suffocated with smoke.

Naturally, the public wish to know if electric trains and electric railways are specially liable to the above type of accident. We would point out that from the above the following conclusions are derivable:

(*a*) That the locomotive on train No 43 was defective, and that it commenced the fire.

(*b*) That, instead of extinguishing the same, as could easily be done at first, the train was pushed over six sections and halfway over the seventh at express speed (over two miles of which the first portion was above ground).

(*c*) That this caused the flames to spread from the leading locomotive, which was defective, right down the two trains, and that the insulation round the conductors in the leading locomotive carriage was destroyed.

(*d*) That further short-circuiting then occurred, which apparently cut off the current from that section of the railway.

(*e*) The drivers then abandoned the trains, which they had so thoroughly set on fire, and saved themselves.

We have no wish to attribute blame to these drivers or to the officials, but trust that a full enquiry will be made as to the person responsible for the order to push a burning train over lines which were being used by the public. It must be remembered that the Paris Metropolitan Railway has two lines in one tunnel, or in cut and cover, and it is rather curious that more loss of life did not occur from the fire being conveyed to trains on the other parallel line. Considered with the Liverpool accident, the above tends to a general conclusion that no employé should be allowed to move a train, after defects have been found in the locomotive circuits, until every trace of fire has been put out. Also that independent lighting circuits should be used, so that short-circuits on the power mains will not throw both tunnels and stations into darkness. It was clearly sheer error in management which turned a trivial defect into a great disaster. The same error would have produced the same results with any system of driving.

REPORT ON MUNICIPAL TRADING.

The order of reference to the Joint Committee was practically to "consider and report as to the principles which should govern powers given by Bills and provisional orders to municipal and other local authorities for industrial enterprise within or without the area of their jurisdiction, and request that this House appoint an equal number of lords to be joined with the members of their House." And this is the report:

The Select Committee appointed to join with a Committee of the House of Commons to consider and report as to the principles which should govern powers given by Bills and provisional orders to municipal and other local authorities for industrial enterprise within or without the area of their jurisdiction. Ordered to report: that the committee have met and examined witnesses, and have agreed to the following report:

1. The present committee may be regarded as continuing the enquiry held by the Joint Committee on

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Municipal Trading appointed in 1900, an identical reference having been made in each case.

2. The evidence taken by the former committee was of a general character, beginning with a detailed examination of the limits and restrictions now imposed upon the undertakings of local authorities by different departments of State, by the authorities of both Houses entrusted with the regulation of private business, and by the practice of select committees. The former committee then proceeded to some consideration of the general arguments advanced by advocates and opponents of municipal trading.

3. In consequence, however, of the great extent of ground to be covered, and the complexity of the subject, that committee were unable to make any report on the merits, but confined themselves to a recommendation of reappointment in the next session.

4. The present committee, in view of the fact that they were not appointed until after Whitsuntide, and were unable to hold their first meeting before June 15, decided to take a different course.

5. The committee felt that any attempt to survey the general subject of municipal trading could only have led to a second postponement of the enquiry, as it would have been impossible for them in the short time available before the close of the session (when the existence of every committee is terminated) to issue a report upon the whole subject. They agreed, therefore, to devote their attention to one or more distinct aspects of the question, passing by others until Parliament should be pleased to direct further enquiry.

6. The first branch of the subject with which the committee decided to deal was that of municipal accounts, with regard both to the form in which they are prepared, the systems under which they are audited, and the right of access to them possessed by the ratepayers. The evidence taken has been mainly directed to these questions.

7. Whatever view may be taken of the proper limits, if any, which can be set to municipal trading, it is clearly important that wherever it exists ratepayers should be not less fully and continuously informed of the success or failure of each undertaking than if they were shareholders in an ordinary trading company.

8 In a large number of cases this is undoubtedly done. But there is in some instances evidence to a contrary effect, and in view of the ever-increasing number and magnitude of municipal undertakings, it is most desirable that a high and uniform standard of account-keeping should prevail throughout the country.

9. The committee are doubtful whether it would be possible to prescribe a standard form of keeping accounts for all municipal or other local authorities, having regard to the varying conditions existing in different districts. But they recommend that the Local Government departments should invite the Institute of Chartered Accountants, the Incorporated Society of Accountants and Auditors, and the Institute of Municipal Treasurers and Accountants of England and Wales, and the Society of Accountants in Edinburgh, and the Scottish Institute of Accountants, Glasgow, to confer and report upon the matter.

10. The committee have directed full attention to the question of audit.

11. The committee recommend that a uniform system of audit should be applied to all the major local authorities—viz., the councils of counties, cities, towns, burghs, and of urban districts.

12. At present municipal corporations in England and Wales, with a few exceptions, are only subject as regards audit to the provisions of the Municipal Corporations Act, 1882, by which one auditor, who must be a member of the town council, is nominated by the mayor, and two, who cannot be members of the town council, are elected by the ratepayers.

13. The evidence shows that no effective system of audit is thus supplied. The elective auditors are poorly paid, or are unpaid altogether, little interest is taken in their election, and although in some cases they are able to lay a finger on a particular irregularity, it is not clear that they could not make the same discovery in the capacity of active ratepayers. No complete or continuous audit is ever attempted by them.

14. All county councils, the London borough councils, and urban district councils are subject to the Local Government Board audit. This audit is carried out by district auditors, who as a rule are not accountants, and are not, in the opinion of the committee, properly qualified to discharge the duties which should devolve upon them. By special local Acts the Corporations of Tunbridge Wells, Bournemouth, and Southend-on-Sea must, and the Corporation of Folkestone may, adopt the Local Government Board system of audit. The duties of the auditors seem to be practically confined to certification of figures, and to the noting of illegal items of expenditure.

15. To apply this system of audit to municipal corporations would arouse strenuous opposition from them, and the course may be considered impracticable; but in addition to this the fact that district auditors are not accountants seems to unfit them as a class for the continuous and complicated task of auditing the accounts of what are really great commercial businesses.

16. The committee accordingly recommend that: (*a*) the existing systems of audit applicable to corporations, county councils, and urban district councils in England and Wales be abolished; (*b*) auditors, being members of the Institute of Chartered Accountants or of the Incorporated Society of Accountants and Auditors, should be appointed by the three classes of local authorities just mentioned; (*c*) in every case the appointment should be subject to the approval of the Local Government Board, after hearing any objections made by ratepayers, and the auditor, who should hold office for a term not exceeding five years, should be eligible for re-appointment, and should not be dismissed by the local authority without the sanction of the Board; (*d*) in the event of any disagreement between the local authority and the auditor as to his remuneration, the Local Government Board should have power to determine the matter; (*e*) the Scots practice of appointing auditors from a distance, in preference to local men, to audit the accounts of small burghs should in similar cases be adopted in England.

17. The committee are of opinion that it should be made clear by statute or regulation that the duties of those entrusted with the audit of local accounts are not confined to mere certification of figures. They therefore further recommend that (*a*) the auditor should have the right of access to all such papers, books, accounts, vouchers, sanctions for loans, and so forth as are necessary for his examination and certificate; (*b*) he should be entitled to require from officers of the authority such information and explanation as may be necessary for the performance of his duties; (*c*) he should certify (i.) that he has found the accounts in order, or otherwise, as the case may be; (ii.) that separate accounts of all trading undertakings have been kept, and that every charge which each ought to bear has been duly debited; (iii.) that in his opinion the accounts issued present a true and correct view of the transactions and results of trading (if any), for the period under investigation; (iv.) that due provision has been made out of revenue for the repayment of loans, that all items of receipts and expenditure and all known liabilities have been brought into account, and that the value of all assets has in all cases been fairly stated.

18. Auditors should be required to express an opinion upon the necessity of reserve funds, of amounts set aside to meet depreciation and obsolescence of plant in addition to the statutory sinking funds, and of the adequacy of such amounts.

19. The auditor should also be required to present a report to the local authority. Such report should include observations upon any matters as to which he has not been satisfied, or in which his judgment called for special notice, particularly with regard to the value of any assets taken into account.

20. The local authority should forward to the Local Government Board both the detailed accounts and the report of the auditor made upon them. It should be the duty of the auditor to report independently to the Board any case in which an authority declines to carry out any recommendation made by him.

21. A printed copy of the accounts, with the certificate and report of the auditor thereon should be supplied by

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the local authority to any ratepayer at a reasonable charge.

22. After careful consideration, the committee are of opinion that, in view of the thoroughness of the proposed audit, powers of surcharge and disallowance could be altogether dispensed with in the case of the major local authorities.

23. Those powers could not, it is believed, be applied to municipal corporations, in view of the strong objection expressed by them; and it is doubted whether their retention in the case of other authorities would compensate for the loss of uniformity which would result.

24. The power of disallowance, applying as it does only to illegal expenditure, and not to unwise undertakings and enterprises, does not afford any real safeguard to the ratepayers whose interests are affected.

25. With a continuous, vigilant, and thoroughly efficient system of inspection and audit, the surest guarantee to the ratepayers against extravagance is to be found in the deterrent effect of public exposure, in addition to the existing legal remedies.

26. The dispensing power possessed by the Local Government Board under the Local Authorities (Expenses) Act, 1887, throws on the department an amount of work often out of proportion to the importance of the issue involved.

27. The committee suggest that, in view of the large changes recommended by them, it might be advisable to create a new body, in the form of a Board of Commissioners of Local Audit, in some respects analogous to the Railway Commission. This body could be entrusted with the powers which the committee recommend in their report should be vested in the Local Government Board.

28. The committee recommend that if in the case of Scotland it is thought desirable that the existing statutory audit of accounts of county and borough councils should be maintained, at any rate the system of audit for the five large cities, which is at present regulated by private Acts, should be assimilated to that which is recommended for the major local authorities in England.

29. The committee are of opinion that it would be advisable to continue investigation into other branches of the subject of municipal trading in a future session of Parliament.

FORTHCOMING EVENTS.

Iron and Steel Institute.—Summer meeting, Barrow-in-Furness, September 1-4.

Institution of Civil Engineers.—Birmingham Students' visit: September to Rhayader.

Municipal and County Engineers.—Meetings: Aberdeen, Aug. 20, 21, and 22; Hastings, September 11 and 12.

Junior Institution of Engineers.—Summer meeting at Sheffield, Aug. 17 to 22. The proceedings will be opened at the Town Hall at 11 a.m., when the Lord Mayor of Sheffield will welcome the members.

British Association.—Seventy-third annual meeting, September 9, Southport.

APPOINTMENTS VACANT.

Chief Assistant Engineers, Hull Corporation, £200 per annum. See advertisement.—Ipswich, salary to commence at £160 per annum. See advertisement in last issue.

Assistant Electrical Engineer, Londonderry, £130 per annum. See advertisement.

Electrical Engineer, Hunslet Guardians, Leeds, Aug. 17.

Lecturer, Hull Municipal Technical School, £150 per annum. See advertisement.

Mains Superintendent, Bury, £120, rising to £150 per annum. See advertisement.

Pupil or Junior Draughtsman. See advertisement.

Canvassers. See advertisement.

Three Charge Engineers, Ipswich, salary to commence at £90 per annum. See advertisement in last issue.

Two Switchboard Attendants, Ipswich, salary to commence at £60 per annum. See advertisement in last issue.

Instructor in Mathematics, Governing Body of the Northampton Institute, Aug. 24.

QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any questions should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

609. Can anyone tell me which is the best contact breaker to use on a medical induction coil, giving their reasons for thinking so?—J. S.

610. Show diagrammatically the simplest method of controlling a single incandescent lamp from three places independently. Also give a sketch of the switches used for the purpose.—R. H. G.

ANSWERS.

Question No. 601.—It is desired to add condensing plant to an electric light station. It is proposed to draw the circulating water from the sea, which is at hand and is 25ft. below level of condenser at low water, by means of a pair of suction pumps. What precautions must be taken in putting down the pumps and piping? Is it the case that a U-bend in the pipe interferes appreciably with the suction?

Best Answer to No. 601 (*awarded* 10*s.*).—It is found in practice that 25ft. is too much for a suction pump to give a reliable performance. The best possible conditions can be readily calculated. We may take the weight of one cubic foot of sea-water as 64lb. and the barometric pressure as 14lb. per square inch. Although the average pressure of the atmosphere is about 14·75lb. per square inch, allowance must be made for the lowest depressions. Pressure due to the column of water in the suction pipe must be exactly equal to the barometric pressure. If x = height of the column of water in feet,

$$x \times 64 = 14 \times 144\,; \quad \therefore x = 31{\cdot}5.$$

This, however, gives the height when the vacuum is perfect, and to obtain this by means of a pump is utterly impossible. To take an example, suppose the stroke of the plunger is 9in., and that it has a clearance of 2in.

$$\frac{\frac{1}{6}}{\frac{3}{4}+\frac{1}{6}} = \frac{\frac{1}{6}}{\frac{11}{12}} = \frac{2}{11}\,;$$

that is, the air in the space of 2in. has filled 11in., and, therefore, exerts a pressure equal to $\frac{2}{11}$ of that due to the atmosphere. This must obviously be subtracted from our supposed pressure of 14lb.—31·5 − ($\frac{2}{11}$ of 31·5) = 25·8. By having a longer stroke for the plunger and reducing the clearance, these figures would be improved; it is, however, found impossible in practice to obtain such results, owing to the difficulty in keeping glands, joints, etc., airtight. Fifteen feet is a very usual limit for a suction pump in general work. If it should be decided to employ suction pumps, it will be well to have them fixed 8ft. or 10ft. below the level of the condenser; this will entail expense at first, but will greatly reduce trouble afterwards. Any bends, elbows, etc., in the suction pipe are detrimental, owing to the increased friction. This will be the more noticeable if the pumps are run at a high speed. If the U-bend gave any possible danger of air-locking, this would be another source of trouble. By all means let the suction pipes be large enough and be as straight as possible.—M. M.

Answer to No. 601 (*awarded* 5*s.*).—In laying down the proposed condensing plant, precaution should be taken to have the suction pipe for circulating water as straight as possible, as the effect of contour of pipes on the flow of water is important. It would appear from the query that it is necessary to have a bend in this pipe to pass some obstruction; if such be the case, care should be taken that no portion of the pipe rises above the hydraulic mean

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gradient. In Fig 1 an imaginary diagram shows the level of suction entry to pump, and the inlet end of suction pipe in the sea. If these are set out with the proper lineal distance and height to scale, a line drawn between the two points will give the hydraulic mean gradient, *a d* (Fig. 1).

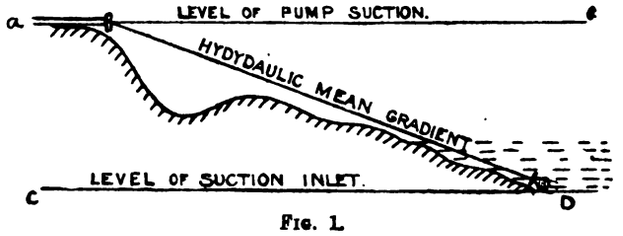

FIG. 1.

In this diagram the contour of the land is all below the mean gradient line, and the suction pipes may follow this contour without any loss of effect, but in Fig. 2 it will be observed that the portion of the contour, *a*, *b*, *c*, is above the mean gradient line, and a suction pipe following this contour would lose much in effect. The water flowing from *b* to *a* would cause a partial vacuum at *b*, and the air held in solution by the water would be liberated and would accumulate in the portion of the pipe *a* to *b*, causing a loss of suction.

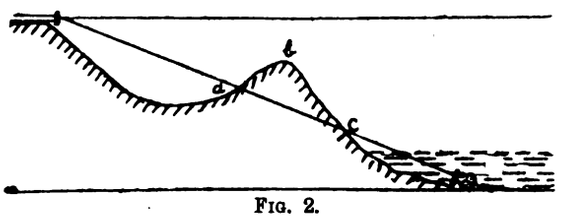

FIG. 2.

The worst arrangement of suction pipes is shown in Fig. 3, where the suction pipe not only rises above the hydraulic mean gradient, but also above the line of pump suction branch. This arrangement should be avoided if at all possible, but if really unavoidable, an air-vessel should be placed at the highest point of the suction pipe, with means for drawing off the accumulated air at intervals.

Precaution should also be taken that the suction pipes are of sufficient area not to cause undue loss by friction. It is not safe to take the size of suction branch as a guide for this, as pump-makers often calculate the suction diameter on the supposition of a short lift, and omit friction loss. The diameter of pipe required for a flow of a given quantity of water may be obtained by use of the formula—

$$d = \left(\frac{G^2 \times L}{H}\right)^{\frac{1}{5}} \div 3,$$

where d = diameter of pipe in inches;
G = gallons per minute;
L = length of suction pipe in yards;
H = height of suction lift in feet (head of water in feet).

It should be remembered, however, that the flow of water from and to a pump is not uniform in quantity and velocity owing to the intermittent action of the pump, and allowance should be made for this variation in calculating the size of the pipes required. The following table from Box's "Hydraulics" will serve to show the variation in flow from different classes of pumps:

TABLE OF VELOCITY OF DISCHARGE BY PUMPS WITHOUT AIR-VESSELS.

—	Velocity of discharge. Max.	Mean	Min.	Variation per cent.
One single-acting pump, worked by a crank	314·16	100	000	314·16
Two ditto, worked by cranks at right angles	222·00	100	000	222·00
One double-acting pump	157·08	100	000	157·08
Three-throw single-acting	104·76	100	90·69	14·07
Four single-acting or two double-acting	111·00	100	78·79	32·21

An air-vessel would partially equalise the flow of water, and one should be fitted at the highest part of the suction pipe, and near to the pump. The inlet, or sea end of the pipe, should be fitted with a retaining valve to prevent air accumulating in the suction pipe. If the level of the pump could be lowered without introducing the conditions shown in Fig. 3, it would be advantageous, as 25ft. is a deep lift, and would require the pump to be kept in thorough good

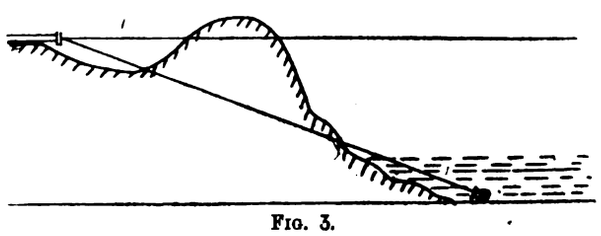

FIG. 3.

repair to maintain it. The condenser should have the cooling surface sufficiently large that the circulating water is not raised in temperature to the point at which it will precipitate salt, or the condenser will prove troublesome from scale formation.—STOW.

Answer to No. 601 (*awarded* 5*s.*).—A much fuller discussion of this question would have been possible had "D. R." given a few more details, such as the types of condensers and pumps proposed, the approximate amount of steam to be condensed per hour, etc. As the available supply of condensing water is plentiful, the choice of condenser will probably lie between the jet, surface, and ejector types, the final decision depending on amount of space available and the inclinations of the engineer.

The ejector condenser requires the largest quantity of water for a given quantity of steam, so we will first assume that this type will be used, and then modify conditions somewhat for other types. For satisfactory working the ejector type should be fed with water under a head of about 15ft., giving in the present case a required lift of 40ft. The most economical way to obtain this would be by using centrifugal pumps direct-coupled to electric motors. The centrifugal pump has its maximum efficiency when pumping to a height of about 20ft., the efficiency then being about 70 per cent., gradually falling as the head is increased; at a head of 40ft. the efficiency would be somewhere between 54 and 60 per cent. The flow through pump for a lift of H feet should be $\cdot 25 \sqrt{2\,g\,H}$; $g = 32{\cdot}2$, or about 4ft. per second in case under consideration. The velocity of delivery and suction should not exceed 6ft. per second. The mouth of the delivery pipe to tank should be submerged so as to keep the pump flooded.

If the jet or surface types are used, a smaller quantity of water is required, and the water could, especially with the latter type, be circulated straight through the condenser without using a storage tank, thus obtaining a greater efficiency of the pump due to decreased head. But this method cannot be recommended, as it is much more preferable to have a reservoir, which could go on feeding condensers in case of breakdown of pumps or pipes while the latter were being temporarily repaired, which would be a distinct advantage if the breakdown occurred in time of heavy load, as the engines could still be run condensing. And, again, at very light loads the tank could feed the condenser without continuously running the pump. We see that with the two latter types less water per pound of steam is required than with the ejector type. This would allow the use of smaller pumps and motors and diminished first cost, but against this must be set off the necessity of air-pumps, which are required with the jet and surface types, but not with the ejector type, a decided advantage in favour of the latter. It is quite common practice now to use centrifugal circulating pumps and steam-driven air-pumps. The use of steam or electrically-driven reciprocating pumps for circulating water is quite practicable, but cannot compare with the former arrangement either for economy or simplicity (owing to the entire absence of valves and their consequent troubles, in the centrifugal type). For particulars of pipes see answers to Question 596 in the issue of *Electrical Engineer* for July 24, 1903. A U-bend in a pipe causes a distinct loss of head, but not so great a loss as an ⌒ bend, as the loss at the second bend is less than that at the first. The pipe should have

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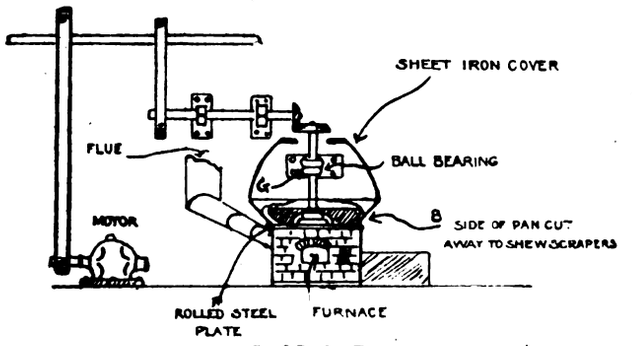
as few bends as possible, the bends having as large a radius as possible. Provision should be made at the mouth of suction pipe for keeping out pebbles and as much sand as possible; and the outlet from tank to condensers may with advantage be kept a few inches from bottom of tank, so that any sand or sediment which gets into tank may settle at bottom, and will not be led into condensers. Wash-outs and overflows should be provided for tanks. Automatic regulation of water-level can readily be supplied, and should depend on conditions and position of tanks, pumps, etc.—ERG.

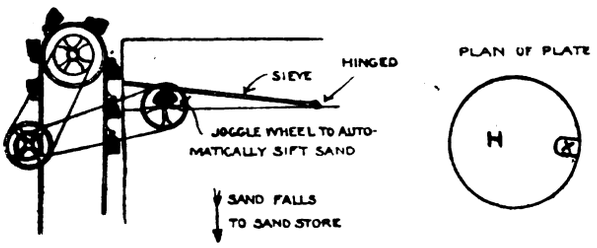
Question No. 602.—Describe a suitable form of sand-drying stove capable of delivering one ton of dry sand per day for use in car hoppers. The car-shed does not adjoin the power-house, so that flue gases are not available. Discuss the relative advantages of hand and mechanical feeding in such an apparatus.

Best Answer to No. 602 (*awarded* 10*s.*).—The best method of mechanically drying sand for use on tram tracks is illustrated below, with a description of the method of working. The part A is built up of firebrick, and on top is laid a rolled-steel plate about 1in. thick. The firebricks should be dipped in a thick solution of fireclay, so as to get close contact between bricks. The furnace brickwork is about 6ft. square. B is ordinary sheet iron forming the sides, it being kept in position by being riveted through small knee-pieces to the base-plate. There is a saddle bolted in the centre of the plate, forming a guide for the shaft, but it should be noticed that the shaft should not rest in this



Sand-Drying Pan.

saddle, as the heat would cause it to seize. The bearing at the top marked G is a cupped ball bearing, and the weight of the shaft should be taken at this point. In setting the bevel wheels, care should be taken to see that the teeth do not engage closely; about ½in. should be allowed for expansion when the fire is on. Sketch H shows plan of plate, X being a piece cut out with door fixed to slide underneath so as not to foul scrapers when revolving. This door is opened when a charge of sand is sufficiently dried, and the sand falls into a hopper, where it is picked up by a chain-bucket conveyor, and is dropped



at the top into a sieve, which is constantly kept in motion by a joggle wheel worked from the same shaft. This sifts all the stones from the sand, so that there is no danger of the outlet of the sand-boxes on the cars being stopped up, which might lead to serious consequences should the braking action on the car fail on a greasy rail. The sand is then ready for use. The furnace should be started with coal and kept up with damp coke.

There is no question as to this mechanical method of sand drying being far superior to the manual method, as from experience it is proved that in the latter case it takes about four or five men to do the work of the one man necessary to attend to the apparatus in the former method, besides which it is about 200 per cent. more economical from a fuel consumption point of view.—O. H M.

SHIPLEY ELECTRICITY WORKS.

Mr. S. D. Schofield, resident electrical engineer to the Shipley Urban District Council, has forwarded us a copy of the balance-sheet, analyses of costs, summary of expenditure, and return of units sold in connection with the Council's electrical undertaking for the year ending March 31 last, and also comparative costs for the part of year ending March 31, 1902. Supply was first given for lighting and power on July 26, 1901, there being three consumers connected up, with a total connection equivalent to 100 8-c.p. lamps; the total connections at the end of March, 1903, were equivalent to 8,147 8-c.p. lamps. This includes an equivalent of 4,237 8-c.p. lamps for 26 motors on hire in the town, the total brake horse-power being 169½. Traction supply was commenced on May 5, 1902, and the load factor has been calculated out from that date on, the running hours per day. These works are combined with the destructor and sewage works, and no charge is made by the Sanitary Committee for steam generated by the destructor boiler. On the other hand, the Electricity Committee bear the cost of management and superintendence of the destructor, sewage pumping, and sewage treatment, providing the current for the sewage pumps, clinker breaking and screening machinery, works lighting, and various small motors at the works, free of charge. The units used on works, including the above, last year were 92,542, and are not included with the units sold. Appended we give an abstract of the accounts. The amount of capital expenditure on March 31 last was £30,738. 5s. 1d.

REVENUE ACCOUNT.

Dr. Expenditure.	£	s.	d.
Coal or other fuel	467	9	0
Engine-room stores, etc.	183	4	10
Wages at generating stations	279	6	11
Repairs and maintenance of generating plant, etc.	185	4	5
Wages to linesmen, etc.	37	3	2
Repairs of mains, etc.	11	8	7
Repairs of transformers, meters, etc.	208	4	4
Attending and repairs to public lamps	67	3	1
Rents, rates, and taxes	25	7	6
Management expenses	395	3	7
Special charges—street accidents	49	10	6
Total expenditure	1,909	5	11
Amount carried to net revenue account	814	2	5
	£2,723	8	4

Cr. Income.	£	s.	d.
Sale of current per meter	2,050	18	11
Rental of meters	157	7	1
Public lighting	281	12	9
Sale and repairs of lamps	39	17	7
Sale and repairs of other apparatus	217	13	2
	2,749	9	6
Less discounts and allowances	24	1	2
	£2,723	8	4

GENERAL BALANCE-SHEET.

Dr. Liabilities.	£	s.	d.
Capital account—amount received	27,000	0	0
Sinking fund account	802	18	2
General district fund balance-sheet—amount credited to electricity revenue account, but remaining unpaid	1,120	17	1
Amount owing to treasurer on capital account	3,738	5	1
	£32,662	0	4

Cr. Assets.	£	s.	d.
Capital account	30,738	5	1
Sundry debtors for current	1,012	15	7
Other debtors	108	1	6
Loans repaid from sinking fund	800	0	0
Cash	2	18	2
	£32,662	0	4

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T. units			470,530
Quantity sold	Public lamps	41,295	
	Traction	169,294	301,369
	Private consumers by meter	90,780	
Quantity used on works			92,542
Total quantity accounted for			393,911
Quantity not accounted for			76,619
Total maximum supply demanded (kilowatts)			402

Number of public lamps, 30 arcs.

PERSONAL.

Mr. F. W. Hewitt, the chief assistant of the electrical engineer, has gained a first prize offered by the Municipal Electrical Association for a paper on "Fuses."

The first annual outing of the Dartmouth staff of the Urban Electric Supply Company, Limited, took place on Saturday, Aug. 1. The party proceeded by train to Paignton, drove to Haytor Rocks *via* Totnes and Asberton. Dinner was served at the Rock Hotel, Haytor.

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Leaving Haytor and proceeding over the moors, the next stop was made at Beeky Falls, and Bovey Tracey (where tea was provided) was reached at 5.30. Leaving at 7.30, the 9.10 train for Dartmouth was met at Torre, ending a most successful and enjoyable day.

We understand that the tramways department, with that of the Electricity Committee, is to be under one manager, and that the salary of Mr. C. J. Spencer, the tramways manager, is to be increased from £500 to £700 per annum, with annual increases of £100 up to a maximum of £1,000.

The Hoylake and West Kirby Urban District Council have appointed Mr, Chas. J. Turner, one of the mains assistants from the electricity department of the metropolitan borough of Islington, chief assistant to Mr. H. G. M'Haffie, the resident electrical engineer.

Messrs. Gent and Co., Faraday Works, Leicester, have appointed Mr. Harold Elliot, of 30, Bootle-street, Manchester, to represent them in Lancashire, Cheshire, North Wales, and West Riding of Yorkshire.

Mr. J. C. Vaudrey, M.I.C.E., M.I.E.E., who is retiring from the position of city electrical engineer at Birmingham, has been presented with a silver salver from the staff and employés of the electric supply department as a token of their esteem. Unfortunately the state of Mr. Vaudrey's health rendered a public presentation impossible. The salver was presented privately by the works manager.

The Hull Council have appointed Mr. Joseph Wilkinson to the post of tramway electrical engineer at a salary of £300 a year, and they appointed Mr. Herbert Bell to be the city electrical engineer, and devote himself exclusively to the electric lighting undertaking at a salary of £400 a year.

Mr. R. L. Horsfield, the chief clerk at the Bradford city tramways office, takes up his new duties as manager of the Walsall tramways on Sept. 1 at a salary of £200 per annum, rising £25 a year for meritorious service to £250 a year. Altogether there were close on 60 applicants.

We understand Mr. Frederick Groves, the tramways manager at Reading under the horse system (whose present appointment ceases on Oct. 31 next), is to be continued in the service of the Corporation as traffic superintendent under Mr. Binns, the engineer and manager, at a salary of £200 per annum.

Mr. Frank Ayton, who has been engaged since October last as resident engineer at Ipswich, representing Messrs. Kennedy and Jenkin, has been appointed engineer and manager of the electric light and power station and tramways undertaking, at a salary of £400 per annum, with an understanding that his salary would be increased by £40 per annum for three years.

LEGAL INTELLIGENCE.

ELECTRICITY METERS.

In the House of Lords judgment has been given in the appeal of the plaintiffs in the action Chamberlain and Hookham, Limited *v.* the Corporation of Bradford. The action was brought by the appellants to obtain an injunction to restrain the Corporation from infringing letters patent in respect of an invention of improvements in electricity meters, parts of which improvements are applicable to dynamo-electric generators and motors, and for damages on account of profits. The respondents denied the infringement, and said the letters patent were invalid. Mr. Justice Farwell found in favour of the respondents, and the Court of Appeal affirmed his decision. The House of Lords now dismissed the appeal, with costs.

HIRAM MAXIM ELECTRICAL CORPORATION.

In the Chancery Division on Thursday, Mr. Justice Farwell heard the case of Pulsford *v.* Devenish. The plaintiffs, Emile Pulsford and the Société Centrale d'Electricité et de Lampes, claimed damages against Mr. M. Devenish, of 44, Gillingham-street, London, the liquidator of the Hiram S. Maxim Electrical Corporation, Limited, for wrongfully distributing the assets without providing for the claims of the plaintiffs. The hearing was adjourned.

THE USE OF HIGHWAYS.

In the Chancery Division of the High Court on Tuesday (before Mr. Justice Swinfen Eady), Mr. Eve, K.C., applied on behalf of Mr. Morgan, of 72, Chepstow-road, Newport, a hay and corn dealer, for an injunction against the Corporation of Newport restraining them from unlawfully interfering with the plaintiff's user of the highway in front of his premises by the tramways of the defendants. There was a cross motion to restrain the plaintiff from interfering or obstructing the passage of the trams through the streets of Newport. The Corporation tramways ran in front of the plaintiff's shop and premises. At the part of the road where plaintiff's house stood the roadway was only 29ft. Notwithstanding this fact, the Corporation had proceeded to lay a double line of tramway at that spot, though the plaintiff's advisers had pointed out to the Town Council that it would be better to have what were called interlacing lines. The result was that when the trams came along they found the plaintiff's carts standing in front of his premises, loading or unloading, and there was not room for the tram to pass. The drivers stood and clanged their bells, and occasionally used opprobrious epithets to plaintiff's customers, whose carts were blocking the road. Sometimes they went so far that the Corporation officials took the names and addresses of plaintiff's customers, and even threatened prosecution, in one case the aid of the police being sought. There was no case where the obstruction of the tram had lasted more than five minutes, and yet the Corporation had gone to a Mr. Frost, who supplied plaintiff with goods, and warned him, with the result that he had declined to supply more goods.

Mr. Eve said the evidence was that frequently two or three trams passed together, owing to blocks at other places. Sometimes the tram men removed the carts, and then there was trouble. The plaintiff had as much right to use the road as the Corporation if he did not unduly occupy it. Owing to these difficulties the plaintiff's business in the last few months had gone down some 50 per cent.

The **Judge** said no doubt the Corporation wished to use the trams, and it was very irritating to them to be obstructed; but on the other hand he could quite see that plaintiff wished to make reasonable use of the highway. A man was entitled to earn his living by unloading or loading his goods at the shop door; but it must be done reasonably and without obstructing others. He thought it was unreasonable when there was a cart at plaintiff's door for the tram drivers to sound their gongs unreasonably. He did not think that Mr. Micklem had satisfied the Court that there had been unreasonable obstruction on plaintiff's part.

After further discussion, it was arranged that the Corporation should reduce the pathway to 4ft., so as to throw enough space into the roadway as to enable the plaintiff's carts to stand in front of his house, and at the same time to allow the trams to pass. On the Corporation undertaking to do that there would be no order made on the motion.

RIGHTS OF TELEPHONE COMPANIES.

Mr. Justice Buckley on Wednesday had before him the case of the National Telephone Company, Limited *v.* the Corporation of Hull, upon a motion to vary the minutes of the order as drawn by the registrar.

Mr. J. M. Astbury, K.C., for the plaintiffs, said that the motion was with regard to the question of costs of the action, and the simple question was whether the plaintiff had to pay the costs as between solicitor and client. The action involved the short point of whether the company was, under the latest Telephone Act, entitled to a renewal of their license from the Postmaster-General, or whether a notice given by the Corporation determining an agreement of 1899, by which the company maintained a telephone system in Hull, deprived them of that right. By the agreement of 1899 the Telephone Company had power to lay underground works in Hull. There was a provision in the agreement that by a certain notice given by the Corporation, they could determine the agreement. The Corporation gave that notice, and when the new Act of Parliament came into force the question arose of whether the Hull Corporation would have their own system and deprive the Telephone Company of the expenditure they had incurred in laying down and maintaining their system. The court had held against the plaintiffs, and they were ordered to pay the costs. He contended that as the defendants had given notice under the terms of the agreement, and not under any Act or in the exercise of any public authority, the question turned upon the agreement between the parties. The question had nothing to do with the Public Authorities' Protection Act, and therefore the defendants were only entitled to party-and-party costs.

Mr. Otto Danckwerts (for the Corporation) submitted that the question turned upon the statute, and in defending the action the Corporation were defending a public right, and were, therefore, entitled to the protection of the Act.

His Lordship said that, in his opinion, the Public Authorities' Protection Act did not apply. There was no duty on the part of the Corporation to determine the contracts with the plaintiffs, nor were they in so determining it acting as a public authority. They thought it right to determine it under a clause of revocation which they had reserved to themselves, and under the circumstances they were not entitled to the benefit of the Act. He, therefore, struck out of the minutes of the order the words "as between solicitor and client," and ordered the defendants to pay the costs of the motion.

DAMAGES FOR COLLISION.

At the Nottingham County Court last week £28. 18s. were obtained from the driver of a conveyance as damages for personal injuries. It appeared that on August Bank Holiday of last year a collision occurred between a tramcar in which plaintiff was riding and a dray, the shafts of which penetrated one of the windows. Plaintiff was injured by the broken glass and her child also, and she fainted. She was removed to her home and was under medical treatment for some time, and her health had suffered. The driver of the car stated that he was travelling at the rate of four miles an hour. After the accident he asked the defendant's man why he did not look where he was going, and he replied that he did not know about the cars. He admitted that he heard the bell, but said that he wanted to get to market. Defendant saw the driver and asked him to say that it was a pure accident, but he declined.

INTERFERING WITH THE TROLLEY POLES.

At the Spelthorne Petty Sessions, held at Sunbury on Wednesday, George Lush, 25, a carpenter, of Parkside, Windmill-road, Hamptonhill, was summoned for wilfully endangering the safety of passengers on an electric car of the London United Tramways Company by removing the trolley pole by means of which the electric current is communicated to the car. Defendant went into the box and swore that he never pulled down the trolley pole. He said he helped to put it back. The magistrates imposed a fine of £3 and 15s. costs, or a month's imprisonment.

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COMPANIES' MEETINGS AND REPORTS.

LIVERPOOL OVERHEAD RAILWAY.

The half-yearly meeting of the Liverpool Overhead Railway Company was held on Tuesday, Sir Wm. B. Forwood, chairman of directors, presiding.

The **Chairman** said the report abundantly justified their recent expenditure of capital upon accelerating the service. The passengers carried during the half-year ended June 30 last numbered 5,514,000, an increase in round figures of half a million. Moreover, it was only 100,000 fewer than the record half-year. He pointed out that they were now putting aside for renewals and for the tramway sinking fund, to which they had contributed £500, a sum of £4,000 a year. The fund, he was glad to say, now amounted £26,200, which he considered was a very handsome sum. They proposed, with the shareholders' approval, to pay dividends at the rate of 5 per cent. per annum on the preferred shares, which would amount to £3 000, and 1¼ per cent. upon the ordinary shares, amounting to £3,125. This would leave a balance of £3,747. 5s. 10d. to be carried forward. During the half-year two Bills had passed through Parliament and received the Royal assent, in which they would be considerably interested. The first was the Bill of the Cheshire Lines Company to make a line connecting St. Michael's Station on the Cheshire Lines with the Overhead Railway at the Herculaneum Dock, thus forming a link with the Cheshire Lines, and enabling them to run their trains from their suburban stations, and also from Manchester and Warrington, along the Overhead Railway. The other was the Bill of the Seaforth and Sefton Junction Railway, and it was proposed to join the line running from the Central Station, Liverpool, to Southport at Aintree, and to form a junction with the Overhead Railway at Seaforth Sands, thus effecting a connection between the Overhead Railway and Southport, and forming a very important link or circle round the outside of Liverpool. They had arranged to work the trains that might run upon that line electrically off the Overhead system upon terms which had yet to be negotiated. The agreement with the Lancashire and Yorkshire Railway, which he mentioned at the last meeting, was expected to be concluded within the next few weeks. By that agreement they would connect with the Lancashire and Yorkshire Railway at their Seaforth Station. The system to Southport was at present being electrified, and he could not but think that when these arrangements were completed with their new line of railway very great advantage must result to the Liverpool Overhead Railway Company. Their structure and equipment had always been well maintained, and he believed it was in as good a condition to-day as on the day it was laid down. The service had been continued with great regularity. He was sorry to say they had not yet been able to institute a regular five minutes' service, as they were still short of some of the equipment necessary to do that, but he hoped in the course of a few weeks they would have a five minutes' service throughout the day. While they gave their shareholders this half-year £3,125, they had practically to pay the same amount in rates. This railway was really constructed more for the good of the trade of the port than for the shareholders - because they were all more or less philanthropists in the matter—and he did think they were unduly taxed when they had to pay to the local authority a sum exceeding £6,000 a year for rates and taxes.

The report (which appeared in our last issue) was adopted.

On the proposition of the **Chairman**, seconded by **Sir Edward Lawrence**, dividends were declared at the rate of 5 per cent. per annum on the preference shares and 1¼ per cent. per annum on the ordinary shares.

A vote of thanks to the chairman for presiding terminated the meeting.

LEYLAND AND BIRMINGHAM RUBBER.

The ordinary general meeting of the shareholders was held last week at Leyland, near Preston.

Mr. Jas. E. Baxter, who presided, congratulated the shareholders on the property. They had started in 1899 under the new form of the Leyland and Birmingham Company. They paid 6¼ per cent. in the first two years, 7½ in 1901 and 1902, and 8¾ in 1903. Since the end of the year which ended on June 30 the sales had very materially increased. They had increased up to July 18 to £3,345, or more than £1,000 per week. They had opened new markets with very considerable success. The tyre trade was bound to improve. The motorcar had come to stay, and was bound to be a very large and profitable business. The directors were looking upon that side of the question with great hopes, but they were not dependent in any case on specialities for realising this profit. They were building large new offices and warehouses necessary for the extension of the business, and it would also be necessary, before the year was out, to spend money in providing electrical power, engines, boilers, and further buildings.

The report was adopted, and the dividend was agreed to. Mr. S. Whitehead, the retiring director, was re-elected, and a special vote of thanks was accorded to Mr. Shutt, the secretary, and the managers.

WIDNES AND RUNCORN ELECTRICAL BRIDGE.

The sixth ordinary general meeting of the shareholders of the Widnes and Runcorn Bridge Company was held on Tuesday.

The **Deputy-Chairman** (Sir Henry Seton-Karr, M.P.), who presided, said the towers on each side had been erected to a height of about 160ft., the total being 190ft. The masonry was almost complete, and the wires for the cables were undergoing satisfactory tests. The final contract, that for the electrical installation and equipment, had been let to Messrs. Mather and Platt, of Manchester, who undertook to have the work completed within six months. The engines, dynamos, etc., were being made in duplicate, so that in the event of a breakdown the traffic would not be suspended. This contract included the machinery for driving the transporter car and for the lighting of the bridge. Having drawn attention to a pamphlet, prepared by the engineers, setting forth the history and features of the scheme in detail, Sir Henry said he hoped the bridge would be completed before the next half-yearly meeting.

The report was adopted, and the suggestion that the Prince of Wales, or, failing H.R.H., then some other member of the Royal family or other important personage, should be invited to ceremonially declare the bridge open was received with enthusiasm. The whole of the capital of the Company (£100,000) has been subscribed, £70,000 being called up. Only £500 of the calls are in arrear. The amount expended to date of report was £56,004, there being £13,700 balance in the bank. The bridge has a clear span over the Mersey of 1,000ft. The parliamentary powers to construct was obtained, after considerable opposition, in 1900.

METROPOLITAN DISTRICT RAILWAY.

Mr. R. W. Perks, M.P., at the half-yearly meeting on Thursday, said the work of electrification upon the railway was proceeding very rapidly. There were at present 1,000 men employed on this important work. Six hundred men were engaged constantly in laying the conductor railways carrying the ducts under the platforms, and doing general constructive work, which had already been completed on the Ealing and Harrow line. The Ealing and Harrow Railway was working under difficulties, but the effect of their running had already been to throw open for building purposes various estates both on the Harrow and the Hounslow line. At Whitechapel and Bow they had done an enormous business in the morning and evening, but, unfortunately, they could not get a sufficient number of trains through at present on the Tilbury Railway to show an adequate return upon the Whitechapel and Bow line. He did not see any reason why, if the Board of Trade sanctioned their automatic signalling apparatus, they should not run 40 to 50 trains per hour. Their electrical engineers proposed to run a five minutes' service of trains from Wimbledon, Richmond, Hounslow, Ealing, and from Harrow—five services of five minutes' interval. The Metropolitan Company were urging them to increase the number of trains running upon the Inner Circle. At the present time they ran six in the hour. It was possible that by arrangement they might increase that service to 10 in the hour. It was a matter they would have to consider with the Metropolitan Company. The rolling-stock which was now being ordered for the whole of the District Railway would provide a carrying capacity of from 100,000,000 to 120,000,000 passengers per annum. It might be necessary to ask Parliament to sanction a uniform fare of 2d. all over their railway without reference to class. That was the principle accepted by nearly every civilised country but our own. They carried at the present time from 45,000,000 to 50,000,000 people a year, and their passengers should bear in mind that the 10,000,000 or 11,000,000 of the working classes whom they carried at an abnormally low rate were practically being carried at the expense of the other travellers. It might be necessary to ask Parliament to sanction a uniform rate for rich and poor alike, regardless of place of booking and destination, and the time at which they might book. That was a democratic sort of proposition, which he thought ought to commend itself to Parliament and to the municipal governors of London, who seemed to think that they had a right to express an opinion as to the terms upon which London railways carried their passengers. As large ratepayers they were entitled to protest against the extravagant and wasteful expenditure of the County Council upon their abortive propositions which were from time to time, with strange insistence, brought before Parliament and almost invariably rejected. The report was adopted, and an extraordinary general meeting of the Company was subsequently held, at which resolutions were passed for the raising of additional capital.

NORTH METROPOLITAN TRAMWAYS.

The half-yearly general meeting of this Company was held at the Cannon-street Hotel on Wednesday under the presidency of Mr. George Richardson.

The **Chairman** said their receipts had fallen £34,613, the chief reason which accounted for these decreases being that the traffic on the Middlesex lines, which were sold to the Metropolitan Electric Tramways Company, was included in the corresponding period, and on this account there could be no fair comparison with the half-year ended June, 1902. The London County Council had not yet finally decided what system of electric traction was to be adopted on the tramways which they at present leased from them, but unfortunately their inclination seemed to be in favour of the more costly conduit system. This would mean about three times the cost of the overhead system. With regard to the West Ham scheme, it was in 1899 the Corporation of West Ham served notices upon the Company requiring them to sell the lines authorised by the Acts of 1869 and 1870. The Company lodged objection, and after lengthy negotiations an agreement was entered into with the West Ham Corporation, by which the Corporation agreed to buy the whole of the lines within their district, and also the two depôts situated at Stratford. The purchase money of the lines was fixed by agreement at £5,000 per mile of single line for the lines authorised by the Act of 1870, and at £5,500 per mile of single line for the remaining line. The value of the depôts was to be referred to arbitration in the event of the Company being unable to agree with the Corporation. The sale of lines was carried into effect as from June 30 last, and since that date the Company had by arrangement with the Corporation continued to work the line on behalf of the Corporation as part of the through system from Aldgate to Stratford.

The report was adopted, and it was further agreed that out of the £11,499 standing at the credit of net revenue account a dividend be

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declared at the rate of 2½ per cent. per annum on the fully paid-up shares, and that the directors be authorised to enter into an agreement for the sale to the Metropolitan Electric Tramways, Limited (subject to the consent of the Board of Trade), of certain portions of tramway belonging to the Company, and situated in Stoke Newington and Hackney.

GREAT NORTHERN RAILWAY.

At the meeting on Tuesday **Lord Allerton,** who presided, said to some extent the decision as between steam and electric power would depend on whether a steam locomotive could be designed and constructed which would give much greater acceleration, coupled with more tractive power, without unduly increasing and concentrating the weight. At present—and it was the crux of the whole question—electric power appeared to have a decided advantage as regarded acceleration; but he had no doubt that the locomotive builders of the country realised how important this point was in connection with the future of their industry. The directors did not feel in a position at present to make any announcement on merits as between steam and electric traction, but meantime they were taking in hand improvements and enlargements which were common advantages under either or both systems. He hoped that they would be able to find some solution of a most difficult problem. The receipts on capital account in the half-year had amounted to £220,877, the whole amount practically being for the purposes of the Great Northern and City and the Great Northern, Piccadilly, and Brompton Railways. The opening for traffic of the Great Northern and City and the Great Northern, Piccadilly, and Brompton Railways was, it was hoped, approaching. Some persons, apparently, were sanguine enough to think that one of the lines would be open this year.

WATERLOO AND CITY RAILWAY.

Lieut.-Colonel the Hon. H. W. Campbell, deputy-chairman of this Company, presiding at the nineteenth half-yearly general meeting last week, said the traffic during the past half-year was greater than in the corresponding six months of 1902, although less than in the intermediate half-year ended last December. They carried 41,739 more passengers than in the half-year to June, 1902, and there was an increase of 47 in the number of season-ticket holders. A dividend at the rate of 3¼ per cent. per annum was proposed, which absorbed £8,775, and left £170 to be carried forward. At present the working Company ran as many trains as they could. If the storage accommodation for trains was enlarged they might be able to run more, and they would perhaps see this carried out in the near future.

The report was adopted.

LANCASHIRE ELECTRIC POWER.

Mr. F. E. Gripper, chairman of the Lancashire Electric Power Company, at the ordinary meeting of shareholders held on the 8th inst., said the Company having now raised the necessary capital for the equipment of their first station, which would be situate near Radcliffe, a contract has been entered into with the Lancashire Power Construction Company, Limited, to carry out the whole of the work for a plant with a total generating capacity of 6,000 kw., with substations and 60 miles of mains and cables, and as the local authorities with whom they had been negotiating were anxious for a supply of electricity in bulk, every effort was being made to expedite the work of construction, and by the end of 1904 or early in 1905 they expected to be in a position to afford such supply.

TAFF VALE RAILWAY.

At the half-yearly meeting at Bristol on the 11th inst., the **Chairman** mentioned that parliamentary powers had been obtained for the electrification of their railway, although the dreadful accident on a Paris railway would not encourage railways to proceed in that direction. They had intended to introduce on their line carriages with self-contained electric power, and with that object they obtained tenders from several electrical contractors. None of these tenders was, however, accepted, as from an inspection of the steam motor carriages now being used by the London and South-Western Railway it was concluded that it was better to adopt that mode of coach rather than a coach moved by electric power. They were now building, and it was nearly completed in their own sheds, a self-contained motor carriage as an experiment.

BELFAST STREET TRAMWAYS.

The report for the half-year ended June 30 last shows a credit balance of revenue account (after setting aside £1,400 to the credit of the sinking fund account) of £8,651, and from this the directors recommend a dividend upon the ordinary shares at the rate of 5½ per cent. per annum. This will leave £1,336 to be carried forward. Since the close of the half-year the Company has completed the purchase of the Sydenham District tramways and the Ligoniel tramways in accordance with the authority conferred upon the directors at the meeting held in February last. The Corporation will promote a Bill next session for the purchase of the Company's undertaking. This action of the Corporation, says the report, is a breach of the contract scheduled to and confirmed by the Act of 1893, whereby the date for the Corporation giving notice to purchase is postponed to 1907. In pursuance of this policy the Corporation has submitted to the Company a draft agreement for purchase. The directors regard this agreement as unfair, and in some respects even confiscatory in its terms, and they have informed the Corporation that, while the Company is now, as they have always been, willing on fair and reasonable terms to come to a voluntary agreement with the Corporation, so that electric traction may be established either by the Corporation or by the Company, they will resist to the utmost any attempt to force them into an agreement such as that of which the draft has been submitted.

BAKER STREET AND WATERLOO RAILWAY.

The report for the half-year ended June 30 last gives the capital expenditure for the half-year as £143,513; the estimated expenditure for the current half-year is £250,000. Satisfactory progress has been made with the construction of the works. The Company's Bills have now passed both Houses of Parliament, and await the Royal assent.

DUBLIN AND LUCAN ELECTRIC RAILWAY.

The report for the half-year ended June 30 last shows an increase of £61 in the total receipts. The expenditure shows a net increase of £167, including £137 for rebuilding a boundary wall, and £50 for repairs due to the great storm of Feb. 26. After providing for debenture interest there is a balance available of £837, out of which it is proposed that a dividend at the rate of 5 per cent. per annum be paid on the preference shares, that £300 be placed to reserve account, leaving £62 to be carried forward.

ELECTRIC WELDING.

A meeting of the Electric Welding Company, Limited, was held on Friday at the offices, 28, Basinghall-street, E.C. The Press was not admitted.

NEW COMPANIES REGISTERED.

Alexandra Simplex Motor Company, Limited.—Capital, £1,000. Objects: to manufacture, buy, sell, let on hire, and otherwise deal in motorcars and vehicles of every description and their component parts, fittings, and accessories; to adopt an agreement with C. Heyermans and A. Bluhm; and to carry on the business of automobile store and garage keepers, suppliers of electricity and motive power, electrical engineers, electricians, etc.

South-Western Electrical Company, Limited (78,230).—Capital, £5,000. Object: to carry on the business of electrical engineers, contractors, merchants, etc.

A. H. Miles, Limited (78201).—Capital, £1,000. Objects: to carry on the business of cycle and motorcar manufacturers, gun and ammunition makers, suppliers of electric light installations, manufacturers of phonographs, electric wiring, and bell fittings, etc.

Fabry Automobile Company, Limited (78,265).—Capital, £5,000. Objects: to adopt an agreement with M. Fabry, to cause to be manufactured, buy, sell, let on hire, and generally deal in motors and motor carriages and their parts, fittings, and accessories, to carry on the business of automobile store and garage keepers, motorcar repairers and cleaners, suppliers of electricity and motive power, electrical engineers, manufacturers of electrical apparatus, etc.

COMPANY LIENS REGISTERED.

Auckland Electric Tramways Company, Limited, London, W.C.—Trust deed registered July 31, for £200,000 debenture stock. Trustee: Electric and General Investment Company, Limited. Specifically charged on the concession, lands, and buildings, and generally, on the entire property, undertakings, and assets.

Ferranti Limited, Hollinwood.—Lien registered on Aug. 1 for £30,000 5 per cent. debenture. Holder: Parr's Bank, Limited. Charged on the undertaking and all the assets and property, including the uncalled capital, but subject to a first mortgage debenture for £10,000.

Wilson's (St. James's-square, Manchester), Limited (Ironmongers and Electricians).—Issue on July 28 of £4,250 debentures, part of a series created on July 23, 1903, to secure £4,500, charged on the company's undertaking and property, present and future, including uncalled capital. No trustees. No previous issue of same series.

Bright's Light and Power, Limited.—A debenture for £2,000, created July 31, 1903, charged on the company's concessions, freehold and leasehold property, works, and plant in England or elsewhere, and (as a floating security) all its other assets, including uncalled capital, has been registered. Holder: C. Owles, 16-17, Russell-street, W.C.

CONTRACTS FOR ELECTRICAL SUPPLIES.

Aranjuez.—The Municipality invite tenders for public and private lighting of the town. Tenders by Aug. 20.

Hackney.—The Borough Council invite tenders for arc lamps and pillars and distributing mains. Tenders by 31st inst.

Lisbon.—The Public Works Department require tenders for the public electric lighting of Macao. Tenders by Oct. 21.

Edinburgh.—The Corporation invite tenders for the supply of arc lamps for public lighting by Aug. 26. See advertisement.

Canea.—The Mayor of Canea invites tenders for the lighting by electricity of part or the whole of the town of Canea. Tenders by Aug. 28.

Beszterczebanya (Neusohl, Austria).—Tenders are required by the municipality for installation, buildings, etc., of a central station of a minimum capacity of 600 h.p. Tenders by Aug. 31.

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West Ham.—The Borough Council invite tenders for traction switchboard, etc. Particulars from Borough Electrical Engineer, Abbey Mills, West Ham. Tenders by 4 p.m. on Aug. 21. See advertisement.

Avila.—The Department of the Interior, Madrid, require tenders for an electric light installation for public and private lighting. The latter will require about 6,000 lamps. Particulars from the above. Tenders by Aug. 22.

Madrid.—The Post and Telegraph Department require tenders for a telephone system in communication with the principal central station in San Lorenzo del Escorial and sub-central stations in Cercedilla. Tenders by Sept. 6.

West Ham.—The Town Council invite tenders for traction switchboard, etc. Further particulars may be obtained from Mr. James K. Bock, Abbey Mills, West Ham. Tenders may be sent to Mr. Fred E. Hilleary, Town Hall, West Ham, by 4 p.m. on 21st inst.

Madrid.—The Posts and Telegraph Department require tenders for installation and working of a telephone system in Gerona for twenty years, and also for installation of telephone between Gijon and Pola de Siero. Tenders by Aug. 25. Specification may seen at this office.

Shanghai.—The French Colony propose to instal motor-propelled tramways. Tenders may be sent by Oct. 31, 1903, to Secrétariat de la Municipalité Française de Shanghai. Particulars may be obtained from l'Office National du Commerce Extérieur, Rue Feydeau, 3, Paris.

Utrecht.—The Town Council will receive tenders for supply and erection of a central electric establishment for lighting, power supply, and working tramways. Contract, conditions, etc., to be obtained at the "Gemeente Secretaire" of Utrecht, on payment of 5fl. (8s. 4d.). Tenders by Oct. 1.

Swindon.—The Corporation invite tenders for the supply, delivery, and laying of all the rails, points, crossings, and accessories for the permanent way of the Corporation's tramways. Particulars from the engineers, Messrs. Lacey and Sillar, Manchester and Westminster. Tenders by Aug. 26. See advertisement.

Launceston (Tasmania).—The Mayor and Aldermen invite tenders for the supply of 500 or more electric meters. Particulars may be obtained on application to Mr. William Corin, city electrical engineer, Launceston, Tasmania, or to Messrs. John Terry and Co., 7, Great Winchester-street, London, E.C. Tenders by Sept. 28.

North Shields.—The Tynemouth Corporation invite tenders for the erection of an accumulator house at the electrical power station, North Shields. Plans and specifications may be seen at the office of Mr. John F. Smillie, borough surveyor, Tynemouth, to whom sealed tenders, endorsed "Tender for Accumulator House," are to be sent by 10 a.m. on 18th inst.

London, S.E.—The London County Council invite tenders for the supply, delivery, and erection in the electricity generating station to be established by the Council at Greenwich of four 5,000-h.p. vertical-horizontal steam-engines, each suitable for driving a three-phase generator. Particulars, etc., may be obtained at the County Hall, Spring-gardens, S.W. Tenders by 10 a.m. on Oct. 6.

Portugal.—The "Diaro de Governo" of Aug. 5 contains a notice granting to the Conde de Vizella for 15 years the exclusive concession for automobile service on various roads in the districts of Loanda and Lunda, in Portuguese West Africa, with a preference, under equal conditions, of the establishment of other automobile services in the same districts upon conditions which are stated in the "Diario.""

Madrid.—The Posts and Telegraphs Department require tenders for the supply of 25 telegraph apparatus of the Hughes system and 25 motors with weight elevators for the same, for the service of the telegraph stations of the State, at the upset price of 2,530 pesetas, or about £73, for each apparatus with its accessories as detailed, and 408 pesetas, or about £12, for each motor with its corresponding elevator. Tenders by 22nd inst.

Batley.—The Corporation invite tenders for the mason, joiner, plumber, plasterer, slater, painter, heating engineer, and electric lighting engineer's work respectively, in erection and completion of additions to the present town hall. Plans and specifications, etc., can be seen, and bills of quantities obtained at the offices of Messrs. Walter Hanstock and Son, architects, Branch-road, Batley. Tenders to be sent to Mr. J. H. Craik, town clerk, by noon on Sept. 4.

Birmingham.—The Tramways Committee require the names of contractors who are desirous of tendering for the supply and delivery of materials and fittings as follows: (Section A) manganese steel points and crossings; (B) tapered steel side poles and bracket arms; (C) suspension ears, pull-offs, section insulators, and other overhead materials; (D) hard-drawn copper trolley wire and stranded steel span wire. Mr. John Price, city engineer, Council House, Birmingham.

Cardiff.—Tenders are required for new electrical department for lupus treatment, etc., at the Cardiff Infirmary. Plans, etc., may be seen at the office of the architect, Mr. Edwin Seward, F.R.I.B.A., from whom bills of quantities may be obtained on payment of cheque for £1. 1s., to be returned on receipt of a bona fide tender. Tenders, endorsed "Electrical and X-Ray Department," to be delivered to Mr. Leonard D. Rea, secretary and general superintendent, by 12 noon on 18th inst.

RESULTS OF TENDERS.

Colchester.—The Council have accepted the tender of Statter and Co. to supply a traction switchboard for £408.

Sleaford.—The Urban District Council have accepted the tender of Messrs. Parker and Co. for engine, at £754, and Messrs. Babcock and Wilcox's tender for a boiler, at £625.

Dewsbury.—The Joint Hospital Board have accepted a tender of Robb and Mitchell, Ossett, for electric mains, switchboards, etc., at the hospital in course of construction, at the cost of £634. 17s. 4d.

Derby.—The Electric Lighting Committee have, subject to the approval of the Council, accepted the tender of Messrs. Radford and Greaves, amounting to £1,328. 17s. 6d., for the erection of a battery house.

Baltinglass (Ireland).—The Guardians have accepted the tender of Mr. J. O'Gorman, Hacketstown, for supplying and erecting electric bells throughout the workhouse, amounting to about 12 in all, at £1. 7s. 6d. and £2. 2s. each.

Lifts.—Messrs. Wm. Aug's Gibson, Limited, Temple Bar House, 28, Fleet-street, E.C., have obtained the contract for four electric lifts and two hydraulic lifts in the new premises of Messrs. Robinson and Cleaver, Regent-street, W.

Bradford.—The Corporation have accepted the tender of G. H. Woods, Slacke, and Co., Corporation-street, Blackburn, for the works and materials necessary for the electric lighting at the Cartwright Memorial Hall, Lister Park, Bradford.

Admiralty.—Messrs. W. T. Henley's Telegraph Works Company, Limited, have obtained from the Admiralty a contract for the electric lighting of the Gibraltar Dockyard, the contract including supplying and laying of cables, conduits, arc lamps, joint-boxes, etc.

Penang.—The contractors for the arc lighting of Penang, Messrs. Crompton and Co., have accepted the tender of Messrs. Rowland Carr and Co., 6 and 8, Lime-street-square, London, E.C., for the supply of the whole of the arc-lamp pillars and brackets in connection with their contract.

Wednesbury.—The Corporation have received the following tenders for erection of a sub-station in connection with the electricity supply undertaking: Hammond Bros., Darlaston, £1,147; W. T. Lees, Darlaston, £1,140; G. Summerhill, Limited, Wednesbury, £1,135; F. J. Smith, Wednesbury, £948.

Kettering.—The Urban District Council have received the following tenders, ranging from £1,205. 12s. 3d. to £560. 17s. (Messrs. Lees and Harrison, Leeds), for providing and erecting the steel trusses and other work required for 2,000 yards super of roofing on the buildings for the electricity and destructor works.

Ealing.—The Town Council have accepted the following tenders in connection with the electricity works: Wiggins and Co., Castlehill Wharf, Ealing, stoneware pipes; W. Ashby and Sons, Cement Works, East Greenwich, cement; W. H. Willcox and Co., 23, Southwark-street, S.E., cylinder and other oils, waste, etc.

Kingston.—The Town Council have accepted the tender of Bennis and Co., Limited, for fitting one of their machine stokers, fitted with patent pneumatic gear and self-cleaning compressed-air furnaces, to the No. 2 Lancashire boiler, at £107. 10s., and the tender of the Wheeler Condenser and Engineering Company for supplying a horizontal combined air and circulating pump, inclusive of suction and delivery pipes and valves, at £130.

Newcastle.—Messrs. Falconar, Cross, and Co., 4, St. Nicholas-buildings, Newcastle-on-Tyne, report an order for the electrical work at the Newcastle-on-Tyne Royal Victoria Infirmary, which is now in course of erection. The contract includes the whole of the lighting and power distribution, and also electric bells, telephones, fire-alarms, fans, and motors. The work is being carried out to the specification of Messrs. Dolby and Williamson, of London.

Ipswich.—The Council have ordered from the British Westinghouse Electric and Manufacturing Company a combined motor watering and track-cleaning car complete at £864. 6s., and a telescopic car and breakdown wagon complete at £70. Eleven firms tendered for the supply of meters, and the tender of the Reason Manufacturing Company, at £273. 5s., has been accepted for the four smaller ones, and that of Ferranti Limited, at £96. 5s., for the larger ones.

Bracebridge Asylum.—The following tenders have been accepted in connection with the proposed plant for the supply of electric light and power to the asylum: Chloride Electric Storage Company, Limited, Clifton, supply and erection of a storage battery, £559; W. Foster and Co., Limited, Lincoln, supply and erection of two engines and dynamos, one motor-generator, main switchboard, meters, etc., £1,211; H. T. Hazzledine, Lincoln, supply and fixing of electric wires, switches, etc., £2,250.

Engines.—Messrs. W. H. Allen, Son, and Co., Limited, Queen's Engineering Works, Bedford, report the following recent orders: One 750-i.h.p. engine and surface-condensing plant for the Fairfield Shipbuilding Company; one 105-b.h.p. engine for Messrs. Mather and Platt; one 30-b.h.p. engine for Messrs. Parkers; one 30-b.h.p. engine for the Lahmeyer Electric Company for the Chelsea Polytechnic; nine 24-b.h.p. engines for the Union Castle Company; one 133-b.h.p. engine for the British Schuckert Company; three 900-i.h.p. triple-expansion engines and surface-condensing plants for the Cardiff Railway Company; two 10-b.h.p. engines for the Adelaide Steamship Company.

Aberdeen.—The Tramways Committee have received the following tenders for the electrical equipment of their Torry route of tramways, comprising the supply and laying of cables and erection of overhead gear: British Insulated and Helsby Cables Limited, Prescot, Lancs. (accepted); W. T. Glover and Co., Limited, Manchester; G. Hill and Co., Limited, Manchester; W. T. Henley's Telegraph Works Co., Limited, London; St. Helens Cable Company, Warrington; Callender's Cable and Construction Company, Limited, London; Anchor Cable Company, Limited, Leigh; Western Electric Company, London; Land-und-Sekabelwerke Aktiengesellschaft, Coln-Nippes, Germany.

Bootle.—The following tenders have been accepted: J. Riddock, Bootle, construction of foundations for extension of boiler-house, £1,033, and construction of foundations for engines at a schedule of prices; Yates and Thom, Blackburn, supply and fixing of four Lancashire boilers with superheaters £2,569, supply and fixing of one fuel economiser and fittings £425, and supply and fixing of

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coal conveyor and overhead bunkers £954; Ferranti Limited, Hollinwood, supply and delivery of two steam dynamos, spare parts and switchboard, £8,711; Fawcett, Preston, and Co., Limited, Liverpool, supply and erection of an iron bridge over the Leeds and Liverpool Canal, to carry cables, subject to agreement with the canal company, £180.

Heston and Isleworth.—The following tenders have been received by the Urban District Council for electric lighting:

Section 2.—Engines and dynamos, boosters and balancers switchboard and connections, condensers, pumps and accessories, with cooling plant, water softener, travelling crane, tools, etc.

Bruce Peebles and Co.	£5,359
Davey, Paxman, and Co. (accepted)	5,550
General Electric Company	5,571
Witting-Eborall	5,645
Lahmeyer Electrical Company	5,649
Crompton and Co.	5,729
International Electric Engineering Company	5,777
Mather and Platt, Limited	5,991
British Westinghouse Company	6,020
Siemens Bros.	6,048
Reavell and Co.	6,075
Johnson and Phillips	6,140
Dick, Kerr, and Co.	6,186
F. Suter and Co.	6,177
Brush Electrical Engineering Company	6,199
Electrical Construction Company	6,252
R. Blackwell and Co.	6,301
T. Parker, Limited	6,337

Section 4.—Cables.

Western Electric Company, Limited	9,555
W. T. Henley and Co., Limited (accepted)	9,852
British Insulated Wire Company, Limited	10,356
W. T. Glover and Co., Limited	10,924
F. Suter and Co., Limited	11,169
Callender's Cable and Construction Company, Limited	11,187
Anchor Cable Company, Limited	11,412
St. Helens Cable Company, Limited	11,759
Johnson and Phillips	12,954
Siemens Bros. and Co.	13,856

Section 5.—Arc lamps and standards.

Johnson and Phillips	713
Brockie-Pell Company	802
Crompton and Co.	811
Improved Electric Glow Lamp Company	813
British Westinghouse	821
W. T. Henley and Co.	854
Oliver and Co.	893
Electrical Company	904
Gilbert Arc Lamp Company	926
F. Suter and Co.	1,018
Drake and Gorham	1,402

BUSINESS NOTES.

TRACTION.

Perth.—The Tramways Order Confirmation Bill has received the Royal assent.

Bristol.—The tramways carried nearly a quarter of a million passengers on Bank Holiday.

Fleetwood.—Record business has been done on the Fleetwood trams during the holidays.

Ipswich.—The Corporation have received a deputation against the running of trams on Sunday.

Glasgow Corporation Tramways Order.—This Bill has been read a third time in the House of Commons.

Mexico.—The Mexican Electric Vehicle Company has given up business, as there was not sufficient local demand for motors and garage.

Crewe.—The Corporation have adopted the agreement with the Crewe and Nantwich Tramways Company, as revised by Messrs. Hewitt and Rhodes.

Newcastle.—The Corporation tramways carried 764,660 passengers in the week ended Aug. 1; 76,152 miles were run for £3,485, giving 10·98d. per car mile.

Wednesbury.—Terms have been agreed to by which the electrification of the tramway connecting Wednesbury and West Bromwich will be commenced forthwith.

Oldham.—The Town Council have obtained sanction to borrow £62,000 for tramway plant and street widening, and £17,000 for electrical equipment of the lines.

Leicester.—The permanent way on the chief trunk line of the new tramways—that is to say, the London-road and the Belgrave-road—will be probably completed by the end of October.

Barrowford.—The first trial trip on the new length between Foulds-street and Higherford Bridge has been made. The journey only occupied about 10 minutes, and was performed without a hitch.

Aberdeen.—A sub-committee of the Corporation Tramway Committee have resolved to recommend that ½d. fares be introduced. The question will come before the Council next Monday for confirmation.

Italy.—The Mediterranean Railroad Company has presented to the Italian Government a plan for an electric line from Rome to Naples of 210 km. The cost of constructing this line would exceed £4,000,000.

Newport (Mon.).—The tramways receipts for the month of June were £1,956. 6s. 8½d., the number of passengers carried being 465,333, against £1,424. 14s. 8d. receipts from horse cars for the corresponding month of last year.

Yardley.—The Tramway Committee intend to commence the construction of the lines on the two main roads, while the work on the Coventry-road route, from Small Heath to the Swan Inn at Yardley, is to be proceeded with at once.

Hillingdon.—The London United Tramways, Limited, are applying to the Board of Trade for a 12 months' extension of time in which to complete their light railway to Uxbridge under an order of 1898. The Parish Council have asked the company to widen the roads.

Burton.—The question of the running of trams on Sundays in Burton has caused the Wesleyans of Burton to issue a notice, in which the ratepayers belonging to the church and congregation are earnestly entreated to record their votes against such a measure.

Dundee.—The returns for the city tramways for the week just ended show receipts amounting to £872. 17s. 4½d., representing 224,799 passengers—increases of £82. 10s. 6d. in receipts and 21,284 in passengers as compared with the corresponding week of last year.

Cardiff.—Application is to be made to the Board of Trade for a loan of £4,000 for the construction of a new tramway section in Meteor-street from Planet-street to the junction in Constellation-street. In the week ending Aug. 8, 682,261 passengers were carried.

Portsmouth.—On Bank Holiday the trams earned a record amount. During the day no less than £812 was taken, or an average of about £10 per car. The previous best day was Whit Monday, when £797 was taken. On August Bank Holiday a year ago the cars earned £600.

Birkenhead.—The trams showed a fairly substantial increase for the last Bank Holiday. An increased service was run all day. The following are the returns for the three days: 1903—passengers 120,294, receipts £586. 9s. 0½d.; 1902—passengers 116,688, receipts £592. 7s. 5½d.

Beddgelert Light Railway.—In a letter to the Glaslyn Council, read at the last monthly meeting, the secretary of the North Wales Narrow-Gauge Railway Company stated that the company intended to proceed with the proposed railway from Rhyd-ddu to Beddgelert as soon as possible.

Sheffield.—At the last meeting of the City Council it was proposed that a sum of £5,000 be contributed out of the surplus of the tramways undertaking towards the new university buildings, conditional on a grant of a charter being made and the amount being spread over a period of five years.

Colne and Trawden Light Railway.—An extension of time has been granted in which to construct railways No. 2 and No. 3 (part of) on the express understanding that railway No. 4 was completed by June 17, 1904, in accordance with the arrangement made at the enquiry before the Board of Trade.

Elland.—The Elland Council recently sent in an application to the Huddersfield Corporation that that body should extend their tramway service to Elland. We understand that a reply has been received by the Elland Council stating that at present the Corporation cannot see their way to effect the desired extension.

Dunfermline.—Now that the Fife Electric Power Bill has been passed, and only awaits the Royal assent, consideration has been turned to the proposal of forming a company in Dunfermline, with the object of making a tramway from Dunfermline to St. Margaret's Hope. Probably other districts will be opened up.

Reading.—Up to Tuesday night, Aug. 4, 347,319 passengers had been carried, and up to Wednesday night £1,655. 12s. 3d. has been taken in fares. On Bank Holiday the persons carried numbered 51,310, and the money taken amounted to £247. 0s. 10d. During the first 10 days only about 20 cars were in use.

Doncaster.—Major Druitt, inspector for the Board of Trade, on Tuesday inspected the new tramway lines at Doncaster, from Station-road to Beckett-road, Wheatley, and the loop line from Station-road by Printing Office-street to High-street. The Priory-place loop is 1 furlong 3½ chains in length, and the Beckett-road route 3 furlongs 4 chains.

Chile.—The Government have appointed a special commission for the consideration of the question of applying electric traction to that part of the State railways between Santiago and Talca, taking into account the hydraulic power that might be available, and also for the work of affording additional power for working the line between Lhai-Lhai and Las Chilcas.

Leeds and Wakefield Tramway.—At a recent meeting of the Stanley District Council it was announced that the tramway syndicate had decided to commence work on the construction of the Leeds and Wakefield tramway on Aug. 13. A start was to be made at the Stanley and Wakefield boundary (opposite the Vine Tree Inn, Newton), working towards Leeds.

Wandsworth.—The Council have informed the London County Council that they regret that it is not apparently intended to apply for powers in the ensuing session of Parliament for the extension of the tramways along East-hill and High-street, Wandsworth, and asking the London County Council to consider the desirability of including such powers in their Bill.

Prestwich.—The Urban District Council have decided to apply to the Board of Trade for sanction to the borrowing of £24,125 for the construction of the electric tramway line in Bury Old-road, and the costs incurred in the construction of the tramways. The new line will connect the Manchester and Salford lines. It will run from

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Heaton Park main entrance to Besses-o'-th'-Barn, where it will join the Salford tramway line, which ends at Whitefield.

Wolverhampton.—A letter from the Tradesmen's Association, urging the Council to have the tramways constructed along the Dudley-road, Willenhall-road, and Wednesfield-road, to end the isolation of the town and the outside districts, has been referred to the Tramways Committee, asking them to proceed without delay in establishing communication with the outside districts. A special meeting of the Council is to be held next month to direct the work to be carried out.

Colchester.—Application is to be made for a further prolongation for three months of the time for the commencement of the tram works, "though in the sub-committee's view it may not be needful to take advantage of the extension." The Board of Trade sanction had been received to the borrowing of £61,164 for the purposes and periods undermentioned: permanent way, buildings, lands, etc., 30 years, £39,933; electrical equipment, with contingencies, 20 years, £10,831; cars, £10,400.

Coatbridge and Airdrie.—The Tramway Confirmation of Order Bill for these burghs has passed the third reading in the Commons, and may be expected to reach that stage shortly in the Lords. The tramways are to be driven by electricity generated at the works of the Scottish House-to-House Electricity Company, Limited, in Dundyvan, the company who are at present supplying the burghs with current for electric lighting. The contractors expect to start work on the 15th inst.

Hull.—About 300 of the drivers and conductors of the Hull Corporation tramways, through the kindness of Councillor Peter Atkinson and Mr. John Tapp and numerous friends, last week enjoyed a cruise on the River Humber. Breakfast and dinner were served aboard, and with music and dancing the time passed pleasantly. The party arrived at the pier about one o'clock, and before the men left the ship to take up their customary Sunday duty some speechmaking took place in the saloon cabin.

Poole and District Light Railway.—The petitions of all parties with reference to the Bournemouth Light Railway Bill have been withdrawn, and the Bill will now proceed as an unopposed measure. The agreement mentions that the Bournemouth Corporation should not accept a lease or enter into a contract with respect to the working of any tramlines in the county of Dorset (except the borough of Poole and the urban district of Branksome), unless they obtain the consent of the County Council of Dorset.

Blackpool.—Last week a cable was run from one of the Fleetwood Tramroad Company's feeders to one of the Corporation Promenade tramway poles at the Gynn Inn junction. The heavy Bank Holiday traffic on the Promenade and Lytham and St. Annes section of the Corporation line having strained the electrical energy at the municipal works, application was made for assistance from the Fleetwood Company's power station at Bispham. Mr. Cameron, the secretary and manager, at once complied with the request.

Manchester.—It appears that the refusal to carry passengers on the Manchester Corporation electric cars up the steep gradient from Chestergate into St. Peter's-square led to a threat to legally enforce the terms of the agreement between the Stockport and Manchester Corporation. The general manager of the Manchester tramways has recently placed an order for a number of cars to be equipped with the Westinghouse magnetic brake, by means of which he expects to be able to safely negotiate the heavy gradient and run through St. Peter's-square.

Douglas.—The purchase by the Town Council of the tramway system within the borough has turned out a great success. The first year's working was very satisfactory from a financial point of view, and ever since the receipts have been growing. Last week they exceeded those of the corresponding week of 1902 by over £200, while the increase in regard to the portion of the year up to the end of last week is nearly £1,000. It is expected that the result of the current year's working will enable a handsome contribution to be made in relief of the rates.

Halifax.—At the meeting of the Corporation last week it was agreed that the borough engineer be instructed to proceed with the extension of the tramways from Hove Edge to Brighouse (George Hotel), at an estimated cost of £10,378. 13s. 9d. (of this amount £2,103. 10s. having been already spent), on the terms set forth in the resolution of the Tramways Committee of July 23—namely, that the Brighouse Corporation excavate and pay the value of the granite, dross, and rolling where rails are laid in Upper Green-lane, Well Green-lane, and Laverack-lane.

Carlisle.—The Electricity Sub-Committee of the Corporation have had under consideration a letter from the tramway company with reference to a proposal by the company to run a 10 minutes' service of cars throughout the year, provided the Corporation would meet them by reducing the price charged for the current required for traction purposes. The sub-committee have passed a resolution recommending the Town Council to make a uniform charge of 1·6d. per unit on condition that the company guarantee a 10 minutes' service, and take a minimum of 350,000 units of electrical energy per annum.

Manchester.—The Tramways Committee are extending their lines in the direction of Middleton. At the present time workmen are constructing a new line in Middleton-road from White Smithy Bar to the city boundary. In continuation of this line the Salford Corporation will lay down rails from the city boundary up to the Three Arrows, where the lines will join the system of the British Electric Traction Company, which runs through the borough of Middleton. It has been suggested that a tramway line might be laid from the Middleton-road side of Heaton Park to a point in the park not far from the hall.

Yeadon.—At the last meeting of the Yeadon District Council the tramways question came up for discussion on an enquiry as to the exact position the Leeds and Guiseley scheme occupied. The clerk (Mr. H. Walmesley) was instructed to call a special meeting of the Council as soon as he had obtained any reliable information as to the position of affairs, the feeling on the part of the Yeadon councillors being that, if the present scheme collapsed, the construction of the tramways should be taken in hand by the joint Councils of Guiseley, Rawdon, and Yeadon, or the Leeds City Council be asked to carry out the scheme.

Brighton.—The following figures give the number of passengers carried on the Corporation trams for each of the first four days of last week, together with the receipts. Monday was Bank Holiday, and the other days those of the Brighton races. Out of the total number, 33,277 passengers paid the special 2d. fare during certain hours for the Race-hill trams. Monday proved a record for a day's passengers, and it is expected that the week will surpass any previous week's total: Monday, passengers 84,343, receipts £351; Tuesday, 56,144 and £283; Wednesday, 71,464 and £297; Thursday, 56,389 and £277—totals, 268,340 and £1,210.

Highgate Tramways.—The Middlesex County Council have in hand a scheme for the extension and construction of tramways at Highgate, N. For this purpose the Council have compulsorily acquired certain land and property in Archway-road, Highgate, amounting to nearly 3 000ft., and an enquiry was held at Westminster recently before Mr. Ralph Clutton, F.S.I., as sole arbitrator, to assess the compensation in a claim brought by the owners of the property. For the claimants £3,100 was asked for, but the Middlesex County Council, through their expert witnesses, put the value at about £600 to £800. The arbitrator reserved his award.

Rotherham.—The returns for the week ending Aug. 6 were as under: Tinsley, passengers 60,255, receipts £436; Kimberworth and Fitzwilliam-road, 54,428 and £201; Canklow and Rawmarsh-road, 39,869 and £129—totals, 154,552 and £769. These returns again greatly exceed all previous records. The figures for the preceding week were: passengers, 132 693; receipts, £600. The best day this week was Bank Holiday, when 39,871 passengers were carried and £207 in fares received. Since the opening of the first section on Jan. 31 the total number of passengers up to and including Thursday was 1,789,078, and the total receipts amounted to £6,450.

Perth.—At the last Council meeting a letter was read from the parliamentary agents intimating that the tramway provisional order had now passed the Commons, and awaited the formal Royal assent. The convener submitted the financial report by the tramway company directors for the month of June, 1903. The number of passengers carried during the month was 68,000, and the credit balance of assets over expenditure amounted to the satisfactory sum of £233 10s. 3d. The committee considered this extremely satisfactory, and they were strongly of opinion that the tramway directors should be asked to continue the management of the concern until the conversion to electric traction takes place.

Sunderland.—The Tramways Committee have determined to join the rails on the new Laurence-street route in the same manner as the rest of the system, with the addition of the scarphed or Dicker joints with anchor bolts, in preference to a new system of welding which was tested recently at Roker. At the last meeting a circular letter was read from the Board of Trade, in which it was recommended that in view of the fact that many people who had been knocked down by cars had been injured by the protruding step, folding steps should be adopted. Mr. H. England (manager) and Mr. J. F. C. Snell (electrical engineer) pointed out that such steps were impracticable and dangerous, and had not been successful in places where they had been tried. The committee agreed with the report of their officials.

Devonport.—The secretary to the Light Railway Commission has forwarded the following letter to the parties interested in the application of the Corporation to construct an electric tramway to Crownhill: "Sir,—With reference to the enquiry held by the Light Railway Commissioners at Devonport on Feb. 26 last, I am directed by them to inform you that they are satisfied that the preamble of the order to authorise the above-named light railway is proved, but that the submission by them of an order to the Board of Trade will depend upon the settlement of satisfactory clauses in particular as to road widenings, etc., if possible to be agreed between the Devonport Corporation and the Devon County Council, or in default of agreement settled by the Commissioners.—I am, Sir, your obedient servant, (Signed) ALAN D. ERSKINE."

Heywood.—The understanding which has been arrived at between Heywood and the Corporations of Bury and Rochdale for the Heywood tramways is, briefly, that the Corporations of the two adjoining boroughs should each run their cars to Heywood Market-place. They would purchase the tramways from the present company, Heywood would reconstruct the lines within the borough boundary, and then would lease them for 21 years to Bury and Rochdale at a rent equal to 10 per cent. on the capital outlay, Heywood to keep the line in repair. Latterly, however, the neighbouring Corporations have agreed that if they hold by this understanding they will lose by it, and an amended scheme has been submitted to the Heywood committee. The committee have decided that they could not accept the amendments; they could not see their way to depart from the original agreement.

Walsall.—At Tuesday's meeting of the Town Council the chairman of the Tramways Committee, Mr. Cope, said it had been stated that when the Corporation took over the tramways Walsall would be isolated from Wednesbury and Darlaston, as the British Electric Traction lines would break the connection. The committee knew there would be a difficulty, but it would have to be arranged mutually. He believed the borough surveyor and electrical engineer had had an interview with Mr. Lycett, but the committee had entered into no arrangement. The Town Clerk said the British Electric Traction Company could not construct a loop line to connect the existing Wednesbury

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and Darlaston lines without the consent of the Council, who were quite masters of the situation. The Tramways Committee, however, did not wish to act dog-in-the-manger like, and he believed a spirit of conciliation would be manifested.

North Wales.—Messrs. Bruce Peebles and Co., Limited, of Tay Works, Bonnington, have secured the contract for the construction of the new electric railway being promoted by the North Wales Power and Traction Company, Limited. The scheme is for the harnessing of the immense watershed comprised in the lakes of Snowdon. The initial contract, amounting to £180,000, will supply approximately 10,000 h.p., and includes about 13 miles of electric railway, constructed on the Ganz high-tension system. The line will pass through some of the finest scenery in North Wales. It passes through the village of Croesor and amongst the numerous slate quarries in active operation in that district, and only awaiting railway communication with Portmadoc, where the slates can be shipped direct. At present, owing to the heavy cost of cartage, amounting to as much as 10s. per ton for a distance of 12 miles, several of the quarries have had to shut down.

Parliament.—After six months' sittings the Royal Commission on London Locomotion have adjourned for the summer recess, and will not meet again until the first week in October. While metropolitan tube schemes are thus stopped for the moment, work has been proceeding with those schemes which have passed the ordeal of Parliament. The line from Baker-street to Waterloo is being pushed on as rapidly as possible, and there is every probability that the new tube from Finsbury Park to Moorgate-street will be ready for the public about the end of the year. It does not appear that the restriction will apply to tramway extension schemes. During the session the London County Council have obtained legislative sanction to their proposed electric lines from Hammersmith to Harlesden in the west, and from Garratt-lane to the county boundary at Wimbledon in the south. Several other schemes have been adopted, and it is understood that these will be proceeded with.

Derby.—At the last meeting of the Council it was mentioned that the Brush Company had obtained the contract for the tramway cars through the contractors (Messrs. White). Some time ago three names were given by the contractors, and the committee were asked whether they would be satisfied with these firms—viz., the Brush Company, the Electric Contract Company, and G. F. Milnes and Co. The committee intimated that they would be satisfied with any of these, and the contractors then had the selection, and they nominated the Brush Company. The receipts of the Corporation tramways during the five weeks ended July 26 were £2,000. 19s. 11d., being an increase of £20. 13s. 8d. as compared with the corresponding period last year. The Board of Trade have approved the plans of the rail and substructure of the electric tramways, subject to certain minor conditions. The committee have visited Loughborough, Nottingham, and Halifax for the purpose of inspecting tramcars.

Eastbourne.—The Electricity Committee of the Town Council have decided to discard the German motor omnibus which has for the second time been given a trial. The car has its good points, the arrangement of the body being particularly ingenious and of considerable convenience to the passengers, but its eccentricities were too marked to allow the committee to recommend a definite purchase. One of its little originalities was an impromptu pyrotechnic display, accompanied by a terrific report, which occurred whenever the vapour in the cylinders failed to ignite and the succeeding spark exploded a double charge. One of these performances was given about nine o'clock the other evening just opposite the railway station, and the time in which the passengers vacated their seats and the vehicle is quoted as a record. The crowd which had collected was worthy of the Metropolis, and their remarks were vitriolic. So the committee have determined that the 'bus is too exciting a luxury for staid Eastbourne.

Wallasey.—A tramways extension scheme, estimated to cost £169,100, was adopted by the Wallasey District Council last week. The various routes to be proceeded with were the Poulton-road and Breck-road route, so long asked for, which would cost £14,300; from Breck-road west of St. Luke's Church to School-lane, Wallasey, £8,300; Wallasey village from School-lane to Sandy-lane, £7,100; and Grove-road from Sandy-lane to Warren-drive, £6,600, this completing the Poulton-Wallasey route. In addition to this, there was a doubling in Wheatland-lane, in Victoria-road, New Brighton, a single line along Egerton-street and Grosvenor-road, which would enable some of the cars to go *via* Virginia-road, and would give a double system from New Brighton Ferry to Seabank-road. Also doublings along part of Warren-drive, in Seaview-road, in Hose-side, and along Seabank-road; a single line along Falkland-road, and an extension of the Church-street line along Tobin-street, with a return by a turn-out into Brighton-street, so that a connection with Liscard and Tobin-street could be had for Egremont Ferry.

Lowestoft.—The electric trams, which were only opened on July 22, took as much as £64 and £63 last Saturday and Sunday respectively, which were up to that time record receipts. These figures were far exceeded on Bank Holiday, when, although actually all the cars were not in use, as many as 22,570 passengers were carried (and then hundreds were unable to obtain a ride), and the earnings reached £111. 7s. 4d. The cars were also well filled on Tuesday. The earnings of the cars during the first 12 days (three of which, by the way, were only half days), including about the wettest week of the season, were £729—an average of about £60. 10s. per day. Tuesday night completed the second week's working. In the 14 days the cars have carried 165,900 passengers, a number representing the population of the borough 5½ times over. The takings amounted to £792. 0s. 3d. In the first week, which began after one o'clock on the opening day, and in which there were several rainy days, the number of passengers was 72,434. The number for the second week, which, of course, included the exceptional holiday traffic, was, therefore, 93,466.

Aberdeen.—The traffic receipts for the week ending Saturday, Aug. 1, show that the receipts amounted to £1,251. 1s., a decrease of £68. 9s. 7d. compared with the corresponding week last year. The expenditure for the week, which totalled £490. 3s. 8d., shows an increase of £118. 8s. 8d. compared with the corresponding period last year. There were 33 cars and 210 men employed, as against 31 cars and 142 men in the same week last year, while the number of car miles run was 25,012, compared with 19,758. The passengers carried numbered 285,448, the figures for the corresponding week last year being 292,579. For the nine weeks of the financial year the receipts amount to £11,691. 7s. 10d., an increase of £1 355. 15s. 1d., and as the expenditure for the same period shows an increase of £1,253. 5s. 4d., the net advantage is £102. 9s. 9d. At a meeting of the Lands and Fishings Committee of the Harbour Board an application from the Tramways Committee of the Town Council for a piece of ground for the purpose of providing shed accommodation for the cars to be run on the Torry tramway system was agreed to.

Bury.—At the quarterly meeting of the Town Council Mr. Alderman Sykes, in moving the adoption of the minutes of the Tramway Committee, referred to a hitch which had occurred in the negotiations between the Bury, Rochdale, and other local authorities, and the Bury, Rochdale, and Oldham Tramway Company, by which the understanding that the local authorities should take over the control of the tramway undertaking on July 31 had not come into effect. The hitch, he said, arose through the company springing upon them what the local authorities thought were pettifogging details. He also stated that at a conference between representatives of Bury and Salford on the question of a through service of cars an understanding had been arrived at. During the conference the chairman of the Salford Tramway Committee stated that it had been agreed between Manchester and Salford that any revenue raised by one authority in the other's territory should go into the coffers of that authority after deducting wages, etc. The Salford representatives agreed that the Salford cars should be run on to Bury on conditions similar to those existing between Salford and Manchester. Salford also agreed to run their cars into the centre of Radcliffe provided a double set of rails were laid, Bury to take the revenue. The minutes were confirmed.

Peru.—Two syndicates have recently been formed in Lima for the construction of overhead trolley tramways. One is La Compañia Anónima Tranvia Eléctrico de Lima y Chorrillos. This company proposes to build an electric tramway from Lima to Chorrillos, a distance of about eight miles. The line will be double-tracked and the cars will run at intervals of about 10 minutes. The capital is 389,320dol., divided into shares of 4·86dol. each. The other company is called Ferrocarril Eléctrico de Lima y Callao. This line is also to be double-tracked, and will run from Lima to Callao, about eight miles distant. This company also intends to construct tramways in the city of Callao. Its capital is 486,650dol., and it intends to compete with the existing railways for the carrying of freight as well as passengers between Callao and Lima. The passenger trains are intended to be run, like those of the other company, every 10 minutes. The Government gives to these two syndicates a privilege for 66 years. The two companies are to be free of taxes and are to import free of duty for the term of two years all material for their own use. At the end of 66 years the tramways, rolling-stock, and all material become the property of the Government free of cost. Both the electric tramway companies have made arrangements with American manufacturers for the supply of plant and material to equip the lines, which are to be finished and in working order within two years from the date of contract with the Government.

Tramway Competition.—The Midland Railway, owing to the competition of electric trams, lost 123,000 short-journey passengers during the past half-year. The same cause was answerable on the North-Eastern Railway, in Newcastle, Tynemouth, and Wallsend districts, for a deficiency of 1,000,000 passengers in the same period. At the half-yearly meeting of the Lancashire and Yorkshire Railway Company Sir George Armytage, the chairman, explained the decrease of over half a million passengers carried by the company's trains to be due to the competition of tramways in short journeys. At the half-yearly meeting of the London and South-Western Railway Company Lord Frederick Hamilton, speaking as a shareholder, raised the subject of municipal tramway competition. It was high time, he said, they were protecting their interests. The Chairman, in reply, said the question was under consideration by the Board. He thought their best chance of getting rid of competitive tramways was by fighting them "tooth and nail" when their Bills came before the Houses of Parliament. Tramway competition was also the subject of complaint by Sir Alexander Henderson, M.P., in presiding over a meeting of the Great Central Railway Company at Manchester yesterday. By this competition in the Manchester district alone the company had lost no fewer than 330,000 passengers, but as the majority of these travelled very short distances, and the fares were very low, the actual decrease in receipts would not exceed £2,000 or £3,000.

East Molesey.—At the last District Council meeting the following enquiries were made: (1) whether the London United Tramways Company recently sought to acquire powers to supply electrical energy to private consumers, and electric light for other purposes; (2) whether the Council opposed the application upon the ground that they might at some remote date desire to undertake similar services; (3) whether the powers sought by the tramways company were in any sense exclusive, or whether, on the contrary, they would have left the local authority free to undertake such work whenever they felt so disposed; (4) whether the company were willing to bind themselves not to supply electrical power to any person in the district without the written consent of the local authority; (5) whether opposition of the local authority was prompted not by the consideration that they would be debarred from undertaking work of that kind, but that if they at any time undertook it, they would have to do so in competition with the tramways company. The Clerk explained that it was

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a fact that they had objected to the tramways company supplying electricity without the consent of the Council in writing, which the company were willing to adopt, but in the passage of the Bill through the House of Commons the whole clause relating to the supply of electricity was withdrawn. It was mentioned that it was the desire of the Council to protect the inhabitants of the district to the fullest extent, and to see that they had a supply of current at the lowest possible price. It must be their policy to come to some arrangement with a company, as they had decided not to provide the supply themselves.

Leeds.—Councillor R. A. Smithson has written to the Lord Mayor of Leeds (Mr. John Ward) resigning his position as chairman of the Tramways Committee. He feels, he says, that no other course is open to him, as it was mainly upon his advice that the Tramways Committee put forward the recommendation in regard to Mr. Hamilton's salary, fully dealt with in our last issue. A special meeting of the Tramways Committee was held on Saturday, at which it was decided to ask the Lord Mayor to write to Mr. Smithson, conveying to him their regret that he should have thought it necessary to send in his resignation. The committee expressed the confidence they have always felt in Mr. Smithson as their chairman. Further consideration of the matter was left over until the monthly meeting of the Tramways Committee next Monday, and a hope was expressed that in the meantime Mr. Smithson would reconsider the position and withdraw his resignation. The Corporation tramway men have been been granted concessions which represent an increased expenditure of £4,600 a year, but it seems in every way likely that they will demand still more, as the minimum, for which they have been agitating has not yet been reached. The tramwaymen connected with the Gas-workers' and General Labourers' Union are not yet satisfied with the new conditions. A meeting was held on the 10th, when it was urged that the whole of their original application to the committee might be granted. The great stumbling block in the way of any final settlement is the bonus system, which, while condemned by the men, is, in the opinion of the committee, the best possible way in which to prevent accidents. They point to the very small number of accidents in the city, contending that if it were not for the bonus system there would not be such a clean sheet in regard to accidents as there is at the present time.

Inquests.—The Salford coroner, Mr. A. Holmes, has held an inquest with regard to the death of the little boy William Pearson, who was killed by an electric car on Wednesday last week. Thomas Griggs, deputy superintendent of the car depôt, stated that the car, which belonged to the Manchester Corporation, was slowing down when he first saw the child. The boy was only some four yards away and he applied the emergency brake and pulled up in 30 yards. With that type of car he could not pull up under about 20 yards. A foreman fitter named Talbot stated that he and Griggs were standing side by side, and the latter was driving the car in a careful manner. The hand brake was applied when the boy was some 20 yards away. The boy was three yards clear of the track, and when the vehicle was about four yards away the boy ran straight in front of it. The car was a big weight—about 15 tons—and going down a decline the weight would carry the car forward. The jury found that death was accidental, and added that they considered the authorities were to blame for entrusting an inexperienced man with the driving of the car.—Mr. Coroner Hoyle held an inquest at the Newcastle Infirmary last week on Mary Etta Rutherford, 20 years old, who was killed by colliding with an electric tramcar whilst riding a bicycle on Monday. The evidence showed that at the point where the accident occurred a large hoarding prevented the driver of the car from seeing traffic approaching from a side street or other traffic from seeing the approach of the cars. It also appeared that the space between the tramlines and the kerb was too narrow for the young woman to turn along it, and therefore compelled her to attempt to cross the road. The coroner commented strongly on the small space that was left between the tramlines and kerbs in various parts of the city. The jury found that deceased had died from injuries accidentally received.

London United Electric Tramways.—The number of passengers carried during the Bank Holiday period was as follows: Saturday, 178,000; Sunday, 200,000; Monday, 330,000; and Tuesday, 170,000—a total of 878,000. For the week ended on Saturday the figures would probably reach 1,100,000 passengers. On Tuesday, on the confirmation of the order for the making of several miles of tramways in the neighbourhood of the Thames Valley, recently passed by the Light Railway Commissioners, the Middlesex County Council asked for amendments by which they should become the purchasing authority in the place of the local authorities through which the tramway passes; that they should have the power to make the by-laws; that all plans of works to be constructed should be submitted to them for approval as well as to the local authorities; and, further, they objected to any light railway being laid unless the roads were 32ft. in width for a single line and 50ft. for a double line. Colonel Yorke, on behalf of the Board of Trade, recommended that the single line should be 32ft. instead of 24ft., as passed by the Light Railway Commissioners. He said that these narrow roads were not suitable for the speeds now attained on tramways; and if the roads were not widened the promoters would have to be satisfied with lesser speeds. Mr. Lewis Coward, K.C., for the tramways company, said if they were saddled with the cost of widening to 32ft., and in some parts to 50ft., they might have to abandon the scheme. The widenings of the London United Tramways route had cost them over £200,000, and it was proposed to make them pay another £100,000. Sir H. Jekyll and the Board would go carefully over that question, and that concerning the change in the purchasing authority, before coming to a decision. The directors of the company have declared an interim dividend of 8 per cent. per annum on the £10 ordinary shares for the half-year ended June 30 last. The divided warrants will be posted on the 14th inst.

North-Eastern Railway.—We have already referred to the proposal of the North-Eastern Railway Company to electrify a portion of their system, notably on the north bank of the River Tyne. The line is at present operated by steam locomotives with the exception of the line from Gosforth to Ponteland, which is under construction. The *Stockton and Darlington Reporter* says the Quayside branch line, which is used for goods traffic only, is also being equipped for electrical operation, the object in this case being to overcome the ventilation difficulties which now prevent the line from being fully utilised owing to it being for the most part in tunnel and on a heavy gradient. The various lines to be so electrified run from Newcastle Central Station in all cases to Manors, Byker, Heaton, Walkergate, Wallsend, Haydon, Percy Main, North Shields, Tynemouth, then up the coast to Monk Seaton, and inland again to Benton, Gosforth, West Jesmond, and completing the circular route. The Quayside line leaves the first route at Byker, and running close to the river, touches the first route again near Percy Main. A third line leaves the original rails at Heaton, and running to Benton, again comes into the circle. The line to be put down runs out west from Gosforth to Ponteland, into what is acknowledged to be pretty country. The current to drive the electric trams will be supplied to the collector rail, from which the cars will collect their power, from sub-stations located at Pandon Dene, Wallsend, Cullercoats, Benton, and Kenton, the largest of these being Pandon Dene. The stations will be lighted with electricity, but the manner in which it will be done has not yet been decided. The new rolling-stock which will be used will comprise motor and trailer coaches, the bodies of which will be built by the railway company at their works at York from the designs of Mr. William Worsdell. They will be of the open-corridor type, lighted and heated with electricity. The unit train will be composed of two motor coaches, with one trailer coach between them, this being strengthened when necessary by the addition of another unit train. The motor coaches will have driver's compartments at one end only, but a master controller will be fitted at the other end also, so that the coach may be driven from this end also. The coaches will be fitted with the Westinghouse air-brake, a motor-driven air-compressor being provided for this purpose. The ordinary stopping train will take about 23 minutes for the journey from Newcastle to Tynemouth, the average speed being 22 miles per hour, including stops. Quick trains, running through without stops, will reduce this time to 15 minutes. Instead of constructing a generating station of their own, the railway company will purchase their current from the Newcastle-on-Tyne Electric Supply Company, Limited. Already many of the contracts have been placed.

LIGHTING AND GENERAL.

Felixstowe.—We understand that the electric lighting is to be started on the 17th inst.

Clydebank.—The new Corporation telephones between Duntocher and Clydebank have been opened.

Friern Barnet.—The Council have decided to apply for an extension of their electric lighting order.

Wednesbury.—The Council have obtained sanction to a loan of £11,000 for electric lighting purposes.

Shropshire and Worcestershire Electric Power Bill.—This Bill has been ordered for third reading.

Morpeth.—The electric supply company will begin to lay the cables in the main streets within a month's time.

Yorkshire College, Leeds.—The next session will begin on Monday, Oct. 5. Details in another column.

Walton-le-Dale.—The District Council have applied for powers to generate and supply electricity in the district.

Scottish Electric Power Bill.—This Bill has passed the Committee on Unopposed Bills of the House of Commons.

Horsham.—An enquiry is to be held into the Council's application for sanction to borrow £9,500 for electric lighting.

Stafford.—The Town Council intend to apply for power to borrow £6,000 for the extension of the electric lighting cables.

Business for Sale.—A well-known electrical plant and accessory supply business is for sale. Details in another column.

Thirsk.—The Parish Council are negotiating with the Northern Counties Electricity Supply Company for public lighting.

Derby.—The Town Council have agreed to pay £3,400 for property in Full-street for the extension of the electric light works.

Kingston.—The appointment of Messrs. Burstall and Monkhouse as advising engineers to the Corporation has been confirmed.

Colyton.—The Parochial Sanitary Committee have decided to at once invite tenders for the lighting of Colyton and Colyford.

Leicester.—The engineer to the Corporation has advised a considerable extension of the distributing plant at a cost of £69,223.

Cardiff.—The work in connection with the electric lighting of Clare-street is expected to be begun in about a week or fortnight.

Whitby.—The Urban District Council have decided to borrow a further sum of £2,500 for extending their electric lighting system.

Conway.—The electric light is to be installed in Deganwy. The Council will consider the question of applying for a Board of Trade order.

Stroud.—The draft agreement with the National Telephone Company for the laying of underground wires within the urban area has been approved.

Malling.—The Kent Electric Power Syndicate and Kent Electric Power Company will apply for orders to embrace the Council's district in the autumn.

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Bootle.—Mr. W. O. E. Meade-King has held an enquiry into the application of the Council for sanction to borrow £40,000 for purposes of electric lighting.

Redditch.—The Urban District Council are considering a supplementary report from Messrs. Burstall and Monkhouse, London, upon the town's electric supply undertaking.

Carlisle.—The Electricity Committee have appointed a sub-committee to consider the charges at present made to private consumers for the electric current for lighting purposes.

Farnham.—The Urban District Council are corresponding with the Sir Hiram Maxim Electrical and Engineering Company, Limited, with regard to their electric lighting provisional order.

Begnor.—The Local Government Board having given their sanction to the borrowing of £16,000 for the purpose of lighting the town with electricity, the Council are advertising for a loan.

Woolwich.—As the result of the audit by Messrs. W. H. Pannell and Co. of the accounts of the Woolwich Electric Light Company, the Borough Council have benefited by £664. 17s. 7d.

Ludlow.—The Town Council have resolved to apply for sanction to borrow £8,250 for the purpose of carrying out a system of electric lighting for the borough and erecting a refuse destructor.

Mutford and Lothingland.—The Council have asked Messrs. Barber and Croft, of Oulton, to give an estimate for fitting the hospital for the use of electric light, and for the supply of the light.

West Hartlepool.—The Electric Lighting Committee's last report states that 91,581 units of current had been supplied during the quarter ended June 30 against 50,423 for the corresponding quarter of last year.

Walsall.—The Council have entered into an agreement with Messrs. Whittaker Bros., Limited, Dudley, who propose to apply for a provisional order to enable them to supply electricity in the Cannock Urban Council area.

Saltburn.—The work of wiring the parish church for the installation of the electric light is approaching completion, and arrangements have been made for having it switched on on Aug. 30, when special services are to be held.

Fire.—A small fire occurred last Saturday in an outlying store and auxiliary serving shed at Messrs. W. T. Glover's works, Trafford Park, but not of sufficient consequence to affect the output. The damage is only slight, and is covered by insurance.

Spalding.—The Urban District Council have referred to a committee the proposed application of a company to apply for powers to supply the town with electricity, and the question whether the Council d take action to secure the powers for themselves.

Burgess Hill.—The Electric Lighting Committee will, before proceeding further in the matter of electric lighting, enquire as to the probable number of consumers which might be obtained in that portion of the district to be served by the proposed works.

Huntingdon.—We understand that the Town Council will not avail themselves of the offer of the Hiram Maxim Electrical and Engineering Company, Limited, who intend to apply for a provisional order authorising the supply of electricity in the borough.

Northwich.—An offer from the Northwich Electric Light Company as to a suggested fixed price for supplying light for the district is before a sub-committee empowered to confer with either company as to the preparation of a scheme to be submitted by the Council.

Buckfastleigh.—The District Council have accepted an offer from Messrs. Noblett for public electric lighting at 37s. per lamp. The same firm will undertake to light Buckfast on the same terms. They have commenced operations, and the town will be lighted by Oct. 1.

Belfast.—Mr. Moneypenny (most appropriate name in connection with accounts) last week presented the electric accounts, which amounted to £60. 18s. 3d., and stated that the banking account showed a balance of £9,552. 9s. 8d. to the credit of the department.

Wakefield.—The last report of the electrical engineer shows that the income for the year has been £6,669 and the cost £2,846, leaving a gross profit of £3,823. Interest and sinking fund absorbed £2,874, leaving a net profit of £948, a considerable advance on any previous year.

Abersychan.—At Tuesday's meeting of the District Council it was reported that the Empire Electric Light Company were not likely to be successful in their application to supply electric light to the Abersychan district, as the Abersychan Council had already obtained powers.

Lytham.—At a meeting of the Ratepayers' Committee appointed to report upon the question of an electricity installation for the town, on Thursday, it was decided to ask the Council for more definite particulars, so that they may arrive at a conclusion as to what the approximate cost will be.

Peru.—According to the reports of Joseph C. Cree, American vice-consul at Callao, the city of Lima is now lighted throughout by electricity, and in many establishments the machinery is driven by electrical power. A number of the cities in the interior also enjoy the benefits of electric lighting.

Edinburgh.—The number of lamps applied for from July 16 to Aug. 6 was as follows: lighting, 3,559; power, 438; heating, 1,240—total, 5,237; compared with 4,532, 768, and 416—total, 5,716—for the corresponding period of last year. The total for the year from May 15, 1902, was 25,032, and for the year 1983, 23,704.

St. Annes.—Of the £2,866 received from the sale of electric current last year, £1,541. 14s. was from private consumption and £1,324. 15s. 2d. from public lighting. The Council are negotiating a loan of £12,023 for electric lighting extensions. The Electric Light Committee have decided to lay a distributing main in Chapel-street for a distance of 115 yards.

Dorchester.—The Town Council again considered the question of electric lighting on Tuesday. Messrs. E. Wright, the electrical engineers, had informed the Council that they were prepared to submit a modified scheme to serve the compulsory area at an expenditure of from £12,000 to £14,000 in place of the more expensive scheme they had already submitted.

London Gazette.—The partnership heretofore subsisting between Ralph Ball and Sidney Alfred Hunter, carrying on business as dealers in electrical accessories, at 9 and 10, Wells-street, Oxford-street, in the county of London, under the style or firm of the Accessories Manufacturing Company, has been dissolved by mutual consent as and from July 31, 1903.

New Book.—We have received from the Directory Publishing Company, Limited, 3, Ludgate-circus-buildings, E.C., the ninth issue of the "Universal Directory of Railway Officials," compiled from official sources under the direction of S. Richardson Blundstone, editor of the *Railway Engineer*. The volume is, like its predecessors, well compiled and handy for reference.

Ludlow.—At the last Town Council meeting it was decided to apply for sanction to borrow £8,250 for carrying out a scheme of electric lighting and for the purpose of a refuse destructor. The scheme has been prepared by Mr. John Parker, Hereford, and the Corporation has already consulted an expert upon the details, his opinion being entirely favourable.

Swinton and Pendlebury.—The clerk (Mr. Postlethwaite) has been instructed to write to the Lancashire Electric Power Company and the South Lancashire Tramways Company enquiring when these companies would be prepared to enter into an agreement to supply electricity in bulk for the lighting of the district, and on what terms, if different from the offers already made.

Clacton.—At the last meeting of the Urban District Council a letter was considered from Messrs. Ainslie Bros., Electric Works, Pier-avenue, undertaking to supply electrical energy and a business premises, etc., in the centre of the town, by arrangement with the Council, on the understanding that the Council should take over the installation at the end of seven years at cost price.

Battersea.—Tenants of the Borough Council's new workmen's dwellings on the Latchmere estate will be able to use electric light at a charge less than the price of gas which rules in the disirict. The electric light will be provided on the "penny-in-the-slot" system at the rate of 4d. per unit. The arrangement means that about 7½ hours' light from one ordinary 8-c.p. lamp can be obtained for 1d.

Bexley.—We understand that Messrs. Mordey and Dawbarn have been appointed the Council's consulting engineers with regard to the electric lighting of the newly-added East Wickham ward. It further recommends the Council to instruct the engineers to prepare plans and detailed estimates of the cost of lighting of that ward, in order that same may be submitted to the Local Government Board with application for loan.

Beverley.—The Beverley Corporation and Mr Baker, the engineer employed in connection with the scheme for installing the electric light in the borough, have agreed to refer the payment of Mr. Baker's account to the president of the Law Society, or someone he may appoint. This means the abandonment of the scheme by the Corporation, and the settling of the electric lighting question for some years to come.

Sowerby Bridge.—A circular is to be sent to the various mill-owners, tradespeople, etc., within the area covered by the electric lighting order, asking if they would be prepared to take a supply of electricity from the Council, and also what quantity they would be likely to require. A sub-committee has been appointed to consider generally matters connected with electric lighting and the carrying out of the order.

The King's Electric Motor-Launch.—On Thursday last week the King and the Prince of Wales left the Royal yacht in his Majesty's new electric motor-launch, used for the first time on this occasion, and landed at Kingston Quay. A visit was then paid to Barton Manor, a large residence on the Osborne Estate, where alterations have been in progress with a view, it is believed, to its being utilised by members of the Royal family.

Accrington.—The Electricity Committee have adopted a new scale of electricity charges both for lighting and power, commencing on Oct. 1 next—viz.: Lighting—4d. per unit, with 1¼ per cent. discount for 251 up to 500 units per quarter, rising by 1¼ per cent. for each additional 250 units up to 3,000, over 3,000 units 15 per cent. Power—3d. per unit for the first hour per day of normal full-load running, and 1d. per unit after. No demand indicator is to be used.

Accidents.—On Wednesday an accident occurred on the tramway route near the centre of the town, by which about 16 persons were injured, 12 of which required medical treatment. It appears that a car proceeding from Margate had reached the top of the hill in Bellevue-road, when an overhead rod became detached from the cable and the driver lost control of the vehicle. It ran down hill at a most alarming rate, and would possibly have stopped without mishap had not another car been on the rails at a point where the lines converged. The cars collided with violence, and all the outside passengers were thrown off. From the evidence at the enquiry into the accident which occurred in Elswick-road, Newcastle, last week, it appears that no blame could possibly be put on the driver of the car, who did the best he could under the circumstances. Some excitement was caused in Church-street, Liverpool, near the Pro-Cathedral, on Monday through one of the electric tram wires falling into the roadway. No one was injured, and the Corporation repairing wagon, which arrived in quick time repaired the damage within half an hour.

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South Staffordshire Mines Drainage.—At the last meeting of the South Staffordshire Mines Drainage Commission, Mr. E. B. Marten, surface engineer, reported that the electric pump at Doebank had worked continuously during the last month. We understand that further electric pumps are to be installed.

West Bromwich.—The loss for the year on the electric lighting account amounts to £1,045. 5s. 2d. The sum of £760 will be transferred from district fund to credit of profit and loss account, which at March last stood at £1,195. 1s. 2d. The Council have adopted the report on street-lighting to which we referred in our last issue.

Rochester.—The surveyor has been instructed to build a boundary wall and iron fence to enclose the yard adjoining the central station at a cost of £107. The electrical engineer (Mr. A. R. Sillar) in his last report gives the following figures: output of electricity in units during June—1903, 13,113; 1902, 8,266; 1901, 4,464; number of consumers at end of June—1903, 362; 1902, 279; 1901, 177; total number of 8-c.p. lamps connected—1903, 22,819; 1902, 16,483; 1901, 12,691.

Glasgow.—The accounts of the Corporation Electricity Committee show a revenue of £127,000, an increase on the 12 months of £24,000. Generating and distribution cost £57,500, and provision was made for interest and statutory sinking fund to the extent of £45,000, leaving a balance of £24,500. For depreciation applicable to the year the committee have, however, written off £37,700, thereby bringing out a net debit balance of £13,200. No alteration will be made in the charges to consumers.

Perth.—Mr. John Lambert, electrical engineer, has just issued his report on the working of the electrical department for the month of July, giving the following figures: units generated during month, 23,764; units generated during same month last year, 8,434; consumers connected, 4; lamps connected (equivalent), 154; lamps disconnected (equivalent), nil; total lamps connected since June 1, 1901, 24,461; coal and coke used during month, 112 tons 3cwt.; coal, etc., per unit generated, 10·57lb.

Wakefield.—The city electrical engineer (Mr. C. M. Shaw) in his report upon the electric light shows a net profit for the past year of £948, compared with £187 in 1902, £463 in 1901, and £129 in 1900, while in 1903 there has been an increased consumption of 47 per cent. over that of the preceding year, and an addition of 48 per cent. to the lamp connection of 1902. The increased profit is owing to economies effected and improvements made at the works, as well as to an increase of the output, while there is no appreciable increase in the expenses for buildings, salaries, and so forth.

Sunderland.—The electric lighting account shows a total borrowing of £226,635 and an expenditure of £225,997 on capital works, £26,214 of which had been spent during the year. The income on the revenue account was £31,325, and the working expenses were £18,509, leaving a gross profit of £12,816 to carry to net revenue, out of which there has been paid in interest £6,755, and £6,460 has been set aside for the depreciation and sinking fund account. The total amount repaid to mortgages was £20,025, and £1,346 has been set aside for reserve purposes.

Worthing.—Electricity equivalent to 11,955 lamps of 8 c.p. is now supplied by the Corporation to private consumers, who number some 230, and there are still connections to be made. There was a recommendation to the Town Council on Tuesday to acquire the land and premises on the east side of the electricity works, "on the ground that it would be a material advantage to extend the frontage of the works to Park-road, and admit of the shutting off of that part of the present premises which is in use for other purposes." The proposal to purchase was, however, rejected.

Lowestoft.—The Electric Lighting Committee's estimate for the half-year ending Dec. 31 shows that they will probably require £894 from the rates to meet expenses, which includes £2,350 repayment of loans and interest and £1,700 for coal. The electrical engineer reports that 10 new consumers for the last month, representing 507 8-c.p. lamps, had been connected to the mains. The total lamps connected aggregate 20,218 8-c.p. lamps. Cables for public lighting are being laid in Essex-street and Norfolk-road to enable the surveyor to complete the making-up of these roads.

Ayr.—The burgh electrical engineer (Mr. Roland Marshall) in his last report says the sub-station at Craigie-road is now completed and equipped, and so far is working satisfactorily. The erection of a sub-station is in hand. The following figures were appended: Number of consumers as per last report, 707; number of consumers connected during month, 6—total, 713. Number of lamps connected as per last report, 27,243; number of lamps connected during month, 391—total, 27,634. Units generated as per last report, 104,476; units generated during month, 62,752—total, 167,228; units generated for corresponding period of last year, 164,819—increase, 2,409.

Sheffield.—The chief constable recently interviewed the general manager of the electric light department and the cleansing superintendent with reference to the utilisation of the spare steam at the Penistone-road destructor for the purpose of generating electricity for lighting streets in the neighbourhood of the destructor. The estimated cost of the installation of the necessary plant, lights, etc., for lighting 100 lamps would be £3,000—not including the annual cost of maintenance. A deputation from the Watch Committee will meet the Cleansing Sub-Committee of the Health Committee with reference to the utilisation of the spare steam for the purpose named.

Chesterfield.—Application is to be made for sanction to borrow £15,000 for the extension of the electricity works. The consumers and the plant have increased from time to time, and the major part of the proposed loan is to be used for paying work already sanctioned by the Council, leaving a margin for further extensions. In June, 1903, there were 262 consumers, as compared with 146 in 1902; an equivalent of 21,132 8-c.p. lamps, as against 11,676; 161 h.p. in motors, as against 30; 16 radiators, as against 10; and 43,313 units sold, a compared with 22,919. The revenue from current sold for the quarter ended June, 1903, was £802, being an increase of £319. 15s. 10d.

Water Power in the States.—In the United States 43 companies, having a total capacity of 177,300 h.p., transmit power over a line distance of 1,549 miles, on an average 36 miles, with a voltage which ranges from 10,000 to 60 000 volts. The maximum distance over which power is transmitted is from Colgate to San Francisco, 220 miles, with a loss of 25 per cent. Waterfalls are made use of under the most varied conditions as regards volume and fall. At Niagara the body of water is large, and the fall is between 150ft. and 200ft.; at Sault Ste. Marie, between Lakes Superior and Huron, the body of water is also large, but the fall is small—namely, 24ft.; at Colgate the body of water is small, but the fall is 1,500ft.

Tonbridge.—The Electric Lighting Committee in their last report state that the total amount of charges to private consumers for the quarter ending June 30 were £107. 11s. 1d. The resident engineer reported that five applications for light had been received during the month, and that the total to date was 72, equal to 2,395 8-c.p. lamps. The number of units supplied to private consumers for the quarter ended June 30 (summer quarter) was 5,280, against 5,546 for the quarter ended March 31, 1903 (winter quarter). The consumption for a winter quarter was usually double that for a summer quarter, and the resident engineer therefore estimated that at least 12,000 units would be sold for private consumption during the next Christmas quarter.

Brighton.—The following proceedings of the Lighting Committee have been confirmed: "This committee, at their meeting on July 27, had before them a letter from the British Westinghouse Electric and Manufacturing Company, Limited, stating that they made a mistake when they quoted the sum of £580 for electrically-driven condensers, instead of steam-driven, in the works at Southwick, and that the price should be £1,400, as quoted in their letter of June 6, 1903, forwarding their tender for the generating plant The consulting engineer having reported thereon, the committee were satisfied that the smaller sum was quoted in error, and they recommended the Council to agree to pay £1,400 as the addition for electrically-driven condensers."

Broughty Ferry.—The Town Council have adopted the following charges for current: for motive power, 4d. per unit; for lighting, 6d. per unit. The accounts of the electricity department show receipts amounting to £706. 9s. 7d. and expenditure to £887. 13s. 7d., a deficit of £181. 4s. The sale of current realised £688. 10s. 6d., the amount derived at 6d. per unit being £485. 5s. The expenditure consisted chiefly of the cost of generation, £351. 18s. 11d., and management expenses, £228. 12s. From the estimates it appeared that the sale of current was expected to yield £1,673. 13s. 4d., and that the total income would be £1,694. 8s. 4d. The generation, it was anticipated, would cost £402. 7s.; management expenses, £241; while interest and sinking fund would absorb £421. 17s. 6d. and £443. 11s. 3d. respectively, the total outlay being estimated at £1,628. 13s. 11d., exclusive of the debit balance at the beginning of the year.

Longton.—The last report shows that the electric lighting undertaking is more satisfactory, even at this early stage in its career, than was anticipated, though it does not pay the whole of the charges to be brought against it. There is a "working profit" of £704 for the year ended March last, but the interest on capital and the proportion of sinking fund not only swallow up the whole of the working profit, but also leave a deficiency of £719. This, with a similar deficiency of £426 on the previous year, leaves a net deficiency of £1,145 on the 18 months' working. There was an item of £870 for bank interest. It will probably be three or four years before the profit from this department will be sufficient to meet the whole of the current capital charges, and in the meantime there will be an increased deficiency in the sinking fund account. the debit balance at the present time being (as stated before) £1,145, and probably nearly £3,000 before the committee can make ends meet.

Siberian Telegraphs.—The *Globe* St. Petersburg correspondent says the recent decision of the Imperial authorities to establish direct telegraphic communication between St. Petersburg and Vladivostock may be ascribed, doubtless, to the following incident. A few days ago there arrived here a very important telegram consisting of 1,600 words, and sent from Japan to the Czar by means of the Siberian telegraph system. Not only did the telegram take three days to reach the Russian capital after it had been dispatched, but on its arrival it was found to be so greatly mutilated that its meaning was altogether unintelligible, and the dispatch was valueless. The Czar at once gave orders that the chief officials employed in the postal and telegraphic offices at Irkutsk, Blagovestshensk, Vladivostock, and Samara should be dismissed. Nor will the matter rest there; it is reported that the chief officials of the Siberian telegraphic system as far as Kazan, in European Russia, are to be removed from office.

Hull.—The last report by the city treasurer and Mr. Bell (acting engineer) shows the position of the electric light undertaking. The value of the useful plant is estimated at £220,000, after deducting the cost of plant disposed of, the depreciation set aside on meters, and the proportion of accumulated sinking fund. The statement shows that the land in Dagger-lane cost £152. 10s., and that in Sculcoates-lane £1,348. 16s. 6d. The buildings in Sculcoates-lane have cost £21,285, in Dagger-lane £3,175, and the sub-stations £1,196. The engines and dynamos at Dagger-lane cost £9,296, and Sculcoates-lane and sub-stations £33,887; the boilers and economisers at Dagger-lane £2,266, and at Sculcoates-lane and sub-stations £8 072; while the transformers and other plant and works have cost £11,579 at Dagger-lane, and £35,946 at Sculcoates-lane and the sub-stations. The accumulators have cost £2,340, and there have been expended £113,377 on mains, and meters have cost £11,229. The total expenditure has been £252,545, the

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increase during the year being £46,299. The number of units sold for the year ending March, 1903, was 2,385,577, as compared with 1,490,099 in the previous year, the receipts being £31,148, an addition of £7,591.

COLONIAL NOTES.

Ladysmith.—The Corporation's electricity plant has now been erected, and a trial run is expected to be made in the early part of this month.

Melbourne.—Mr. Alfred Edward Morgans, of Perth, has obtained a contract for the construction of electric tramways in some of the suburbs. The contract stipulates that building of the generating station is to be commenced three months after the powers required by the contract have been obtained. The station is to be finished within nine months, and the service is to commence 12 months after that date.

Tamworth (N.S.W.).—Tamworth was the first town in New South Wales to be lighted by electricity, and the municipal plant installed by Messrs. Crompton and Co. has been in constant use for the past 15 years. The Council are at the present time considering the question of private lighting, and a canvass was recently made of the town to find out what amount of support would be forthcoming if the light was made available for private use. The result was most satisfactory, and orders were taken for the equivalent of over 2,000 8-c.p. lamps. Mr. William G. Counsell, the borough electrical engineer, will shortly submit for the Council's consideration a scheme providing for the necessary extensions to plant, and if this scheme is adopted, the motive power will be producer gas, working in conjunction with gas-engines. The estimated capital expenditure will be about £6,000.

PROVISIONAL PATENTS, 1903.

JULY 27.

16456. **Improvements in the manufacture of incandescence electric lamps.** Harry Hogge and Jean Barrollier, 115, Cannon-street, London. (Date applied for under Patents Act, 1901, April 8, 1903, being date of application in France.) (Complete specification.)

16469. **Electrical fog signalling apparatus.** O'Brien Reynolds St. John Palmer, 50, Melton-terrace, New Hartley, Northumberland.

16481. **Improvements in and connected with apparatus for electrically locking railway carriage doors.** William Walmsley, 9, Tempest Hey, Liverpool.

16467. **Improved telegraph pole.** Wilhelm Schütz, Dresden—A. 3, Germany. (Complete specification.)

16509. **Improved field magnet for electrical machines.** Thomas Alfred Hearson, 22, Southampton-buildings, Chancery-lane, London. (Electricitäts-Gesellschaft Alioth, Switzerland.) (Complete specification.)

16511. **Improvements in electric hoist controllers.** William Harding Scott, 47, Lincoln's-inn-fields, London.

16513. **Improvements in and relating to electrical fuses or cut-outs.** William Richard Macdonald and George Edward Heyl-Dia, 322, High Holborn, London.

16514. **Improvements in indicating devices for use with electrical fuses or cut-outs.** William Richard Macdonald and George Edward Heyl-Dia, 322, High Holborn, London.

JULY 28.

16534. **Improvements in and relating to secondary galvanic batteries.** Max Schneider and Julius Beissbarth, 51, Deansgate-arcade, Manchester.

16594. **An improved process for making fireproof casings and covers for electric conductors.** Henry Redmayne Romney, 65, Chancery-lane, London.

JULY 29.

16636. **Improvements in insulator brackets for telegraphic or telephonic purposes.** Charles Henry Brandreth, Imperial-chambers, Albert-street, Derby.

16653. **Improved apparatus for soldering armature leads to commutator bars.** John Alexander Wirth and Jacob Beech, Westinghouse Building, Norfolk-street, Strand, London. (Date applied for under Patents Act, 1901, Oct. 22, 1902, being date of application in United States.) (Complete specification.)

16661. **Improvements in and relating to electrical heating devices.** Milton Henry Schoenberg and James Washington Edwards, 60, Queen Victoria-street, London. (Complete specification.)

JULY 30.

8576A. **Improvements in or connected with the rail return and the utilisation of the current therein on electric tramways.** James Townsley Pearson, 8, St. James's Hall, Burnley. (Date applied for under Patents Rule 9, Feb. 16, 1903.) (Complete specification.)

18711. **Insulators for electrical terminals.** John Alfred Davenport and Arthur Frederic Guy, 10, St. George's-crescent, Liverpool.

16740. **Improvements in time-limit electric circuit controllers.** Edgar Alfred Carolan, 83, Cannon-street, London. (The General Electric Company, United States.)

16741. **Improvements in electric arc lamps.** Edgar Alfred Carolan, 83, Cannon-street, London. (The General Electric Company, United States.)

16742. **Improvements in electric cut-outs or switches.** Edgar Alfred Carolan, 83, Cannon-street, London. (The General Electric Company, United States.)

16744. **Improvements in controlling electric switches.** Edgar Alfred Carolan, 83, Cannon-street, London. (The General Electric Company, United States.)

16745. **Improvements in controllers for electric motors.** Edgar Alfred Carolan, 83, Cannon-street, London. (The General Electric Company, United States.)

JULY 31.

16774. **Improvements in converting electric currents.** Granville Hugh Baillie, 82, Victoria-street, Westminster, London.

16788. **Electric integrator.** William Bullen Day, K Lines, Curragh Camp, co. Kildare.

16806. **Improvements in electrical fuses, ceiling roses, and wall plugs, and method of attaching metal terminals thereto.** James Morton Douglas, 5, Budge-row, London. (Complete specification.)

16808. **Improvements in or connected with holding devices for the collecting brushes of electrical machines.** Griffith Brewer, 33, Chancery-lane, London. (Electricitaets-Gesellschaft Alioth, Switzerland.) (Complete specification.)

16817. **Improvements in dynamo-electric machines of the class employing commutators.** Henry Metcalf Hobart, Oswaldestre House, Norfolk-street, Strand, London.

16830. **An improvement in connection with the trolley wheels of overhead-driven electric vehicles.** William Charles Dunne and Louis Levitt, 23, Coleman-street, London.

16836. **Improvements in and connected with lampholders for electric incandescent lamps.** Ferdinand Subatzus, 81, High Holborn, London.

16852. **An improvement in flexible metallic tubing for armouring electrical conductors and apparatus for its manufacture.** William Henry Kanzon Bowley, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

AUGUST 1.

16856. **Improvements in electrostatic methods of measuring electrical potential differences.** Edgar Walford Marchant and Gladstone Walker Worrall, Liverpool University, Liverpool.

16868. **Improvements in portable accumulators.** Harry Ramsbottom and Jasper Richardson, 427A, Strand, London.

16878. **Improvements in and relating to printing telegraph instruments.** Clarence Mortimer Stiner, 51, Deansgate-arcade, Manchester. (Complete specification.)

16902. **Improvements in electric fuses.** Edward Neville Bray, Frederick Rice Markham, Ferdinand Edward Reiss, and Bray, Markham, and Reiss, Limited, 18, Southampton-buildings, Chancery-lane, London.

16907. **Improvements in controllers for electric-motors.** John Bush, 90, Lausanne-road, Peckham, London.

AUG. 4.

16960. **Improvements in or relating to balance weights for electroliers, lamps, pendants, and the like.** William Soutter, 82, Mark-lane, London.

16965. **Improvements in electrical fire-alarm apparatus.** James Percival Robertson, 77, Chancery-lane, London. (Complete specification.)

16975. **Improvements in electrical cut-outs.** Hugo Korten, 80, Leicester-road, East Finchley, London.

16988. **Improvements in or relating to partitions or diaphragms for electrolytic and electro-plating purposes.** Pierre Steenlet, 111, Hatton-garden, London. (Complete specification.)

16989. **Improved process for obtaining copper by electrolysis from copper-containing solutions.** Pierre Steenlet, 111, Hatton-garden, London. (Complete specification.)

16992. **Improvements relating to electrolytic cells.** Phillippe Auguste Gaye, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

17001. **Automatic electric stopping apparatus for lace and net machines.** Benjamin Joseph Barnard Mills, 23, Southampton-buildings, Chancery-lane, London. (Auguste Pocheron and François Cellery, France.)

AUG. 5.

17034. **Induction transformer for wireless telegraphy stations.** Eugéne Ducretet, 72, Cannon-street, London. (Complete specification.)

17057. **Improvements in and relating to steering gear for motor road vehicles, electric or steam launches, and the like.** Thomas Mathewson and Arthur James Fielding, 11, Southampton-buildings, Chancery-lane, London. (Complete specification.)

17059. **Improvements in incandescent filaments for electric incandescent lamps.** William Phillips Thompson, 6, Lord-street, Liverpool. (Bayerische Glühfadenfabrik Augsburg-Lechhausen Georg Luedecke und Co., Germany.)

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17069. Improvements in geometric telegraphs. Grant Beebe Rossman, 18, Southampton-buildings, Chancery-lane, London. (Complete specification.)

17072. A method of sytonising two electric circuits and apparatus for use therein. Christopher Russell Payne, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

17073. Improvements in electric arc lamps. Thomas Hamilton-Adams, 4, South-street, Finsbury, London.

AUG. 6.

17082. Improvements in the manufacture of trolley poles and means for connecting them to trolley standards in trolleys used for electric tramcars or vehicles propelled by electric traction. Edward May Munro, Henry Brecknell, and Hugh Innes Rogers, Thrissell-street, Bristol.

17105. Improvements relating to insulating supports for use in electric traction systems. Domenico Bordoni, 45, Southampton-buildings, Chancery-lane, London.

17128. Improvements in means for electric signalling between railway trains and between railway stations and trains. Marius Archambault, 47, Lincoln's-inn-fields, London.

17140. Improvements in electromagnets. Frederic de Mare, 72, Cannon-street, London.

AUG. 7.

17149. Improvements in electric traction on a shallow conduit system. Samuel Green Bennett, Clyde House, Heath Town, Wolverhampton.

17150. Improvements in or connected with switches for starting electric motors. Alfred Sykes, 32, John William-street, Huddersfield.

17173. Improvements in electrical starting gates for race-courses. Herbert Fraser Foster, "Turnlee," Laburnam-road, Epsom.

17179. Improvements relating to electric railway systems. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (Morgan Electric Machine Company, United States.) (Complete specification.)

17184. Improvements in clamps for wires, especially applicable for use in overhead electric conductors. Franz Krückl, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

17185. Improvements in frames for alternating-current motors. Giorgio Finzi and Emil Korrodi, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

17195. Improvements in and relating to wireless telegraphy. Octave Rochefort and Emile Mors, 45, Southampton-buildings, Chancery-lane, London.

17207. Improvements in or connected with dynamo-electric machines. Thomas Murthwaite Dutton and the Sandycroft Foundry Company, Limited, 6, Lord-street, Liverpool.

17214. Improvements in protecting devices for electric circuits. William Bradley Woodhouse, 18, Southampton-buildings, Chancery-lane, London.

AUG. 8.

17225. Improved interlocking automatic intercommunication telephone switchboard. Frederick James Lowe, 5, Pearson-terrace, Hyde Park, Leeds.

17229. An improved appliance for gripping and supporting the wires of overhead wire systems of electric traction. John Henry Luby and William Harris, Lloyds' Bank-buildings, Bristol.

17232. Improvements in terminal holders for electric wires, leads, or cables. Charles Henry Stevens, Lloyds' Bank-buildings, Bristol.

17241. Device for re-railing electric or steam tramcars which have accidentally left the lines. Joe William Harrop, Tom Dickinson, and Harry Dickinson, 7, Ray-street, Huddersfield.

17245. Improvements in electric light fixtures. Edgar Alfred Carolan, 83, Cannon-street, London. (The General Electric Company, United States.)

17247. Improvements in electric light fixtures. Edgar Alfred Carolan, 83, Cannon-street, London. (The General Electric Company, United States.)

17248. Improvements in electric rheostats. Edgar Alfred Carolan, 83, Cannon-street, London. (The General Electric Company, United States.)

17249. Improvements in reels for electric cables and the like. Edgar Alfred Carolan, 83, Cannon-street, London. (The General Electric Company, United States.)

17272. A new or improved device for electrically firing blasting cartridges and the like. Thomas Grainger, 9, Regent-street, London.

COMPLETE SPECIFICATIONS ACCEPTED.

To be published August 27, 1903.

1902.

10466. Electrical appliances for working piledrivers. Garvie.

10906. Electric circuit breakers. Lake. (General Electric Company.)

16923. Manufacture of incandescent electric lamps. Lake. (General Electric Company.)

17111. New receiver for wireless telegraphy. Walter.

17347. Telemotor apparatus for working, steering, telegraphing, indicating, and other apparatus from a distance. Brown.

18316. Electric circuit breakers. British Thomson-Houston Company, Limited. (Wood.)

18870. Dynamo-electric generators. Walker.

19483. Apparatus for teaching wireless telegraphy. Ancel.

20644. Arrangement for enabling a working machine to be driven either by a cylinder and piston motor or a rotary motor. Siemens Bros. and Co. (Siemens und Halske Aktiengesellschaft.)

1903.

2774. Ratchet-operated electric switches. Kingsland.

9601. Dynamos. Latour. (Date applied for under International Convention, April 29, 1902.)

10703. Primary and secondary electric cells. Harrison. (Buffa.)

12461. Couplings for electrical conductors. Wherry.

13176. Electric railway and tramway vehicles. Gibbs and Pearson. (Date applied for under International Convention, Oct. 2, 1902.)

14176. Electric heaters or rheostats. Newell. (Date applied for under International Convention, June 27, 1902.)

14204. Telephone systems with central battery. Piltz.

14754. Electric incandescent lamp. Regnart.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.		Last price
Commercial and Industrial.—	£		£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1	..	½-¾
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1	..	½-¾
British Insulated and Helsby Cables, Ord., 1-100,000	5	..	6¾-7¼
—— 6 per cent. Cum. Pref., 1-100,000	5	..	5¼-5¾
—— 4½ per cent. Mortgage Debentures	100	..	102-106
British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red.	100	..	104-106
British Westinghouse Elec. and Manuf., 6 per cent. Pref., 275,001-375,000	5	..	5¾-6
—— 4 per cent. Mortgage Debenture Stock	100	..	100-102
Brush Electrical Engineering, Ordinary, Nos. 1-105,731	2	..	¾-1¼
—— Non. Cum., 6 per cent. Pref.	2	..	1-1¼
—— 4½ per cent. 1st Debenture Stock	100	..	99-102
—— 4½ per cent. 2nd Debenture Stock	100	..	87-92 xd
Callender's Cable, Debentures	100	..	106-110
—— Ordinary	5	..	11½-12½
—— 5 per cent. Pref.	5	..	5¼-5¾
Crompton and Co.	3	..	2-2½
—— 5 per cent. Debentures	100	..	101-106
Edison and Swan United, "A" Shares, 1-99,261	3	..	¼
—— "A" Shares, 01-017,139	5	..	1¼-2½
—— 5 per cent. Debentures	100	..	75-80
—— 4 per cent. Deb. Stock, Red.	100	..	71-75
Electric Construction, Limited, Nos. 1 to 112,100	2	—	1¼-1⅝ xd
—— 7 per cent. Cumulative Pref.	2	—	2¼-3
—— 4 per cent. Perp. 1st Mort. Deb.	100	—	99-102
Ferranti Limited, 5 per cent. 1st Mort. Deb. Stock, Red.	100	..	90-95 xd
General Electric Company (1900), 5 per cent. Cum. Pref.	10	—	9¼-10
—— 4 per cent. 1st Mort. Deb. Stock	100	—	99-102
W. T. Henley's Telegraph Works, Ordinary	5	—	14-15
—— 4½ per cent. Preference	5	—	5-5¼
—— 4½ per cent. Debentures	100	..	108-112
India Rubber, Gutta Percha, and Telegraph Works	10	..	18¼-19¼
—— 4 per cent. Debentures	100	..	100-103
Parker, Thos., Limited, Ordinary	10	..	14¼-15¼
Telegraph Construction and Maintenance	12	..	32-36
—— 5 per cent. Bonds	100	—	100-103
Electric Lighting and Supply.—			
Blackheath & Greenwich District Ordinary 1,201-101,200	1	—	⅝-¾
—— 4½ per cent. Deb. Stk. Certs., Red. and Conv.	100	..	118-121
Bournemouth and Poole, Ordinary	10	..	12¼-13¼
—— 4½ per cent. Cum. Pref., 7,501-15,000	10	..	10-11
—— 6 per cent. Cum. Second Pref., 15,001-22,500	10	..	10¼-11¼
—— 4½ per cent. Debenture Stock, Red.	100	..	103-106
Bromley (Kent) Electric Light and Power Co., 4½ per cent. 1st Debenture Stock, Red.	100	..	102-105
Brompton and Kensington, Ordinary	5	..	10¾-11¼
—— 7 per cent. Preference	5	—	10¼-10⅝
Calcutta Electric Supply Corp., Ordinary, Nos. 1-40,000	5	..	6¼-7¼
—— Nos. 20,001-30,000	5	..	7-8
Cambridge Electric Supply Company, Ltd., £10 Ord.	8	..	14¼
—— " " " £10 Ord.	6	..	10⅜
Central Electric Supply, Ld., 4 per cent. Guar Deb. Stock	100	..	106-109
Charing Cross and Strand, Nos. 1-70,000	5	..	9-9¼
—— 4½ per cent. Cum. Pref.	5	..	5¼-6
—— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000	5	..	4¾-5
—— 4 per cent. Debenture Stock, Red. (Prov. Certs.)	100	—	104-106
Chelsea Electricity Supply	5	..	5¾-6¼
—— 4½ per cent. Debentures	100	—	107-110
City of London, Ordinary	10	—	10¾-11¼
—— 6 per cent. Cumulative Pref.	10	—	13-14
—— 5 per cent. Debenture Stock	100	—	121-126
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100	—	102-105
County of London and Brush Provincial, Ordinary	10	—	8-9
—— 6 per cent. Cum. Pref.	10	—	11¼-12¼
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	100	—	109-112
Edmundsons' Electricity Corporation, Ordinary, 1-50,000	5	—	6¼-7
—— 6 per cent. Cum. Pref.	5	—	6-6¼
—— 4½ per cent. First Mort. Deb.	100	—	106-109
Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-30,000	5	—	3¼-4¼
—— 5 per cent. Debenture Stock, Red.	100	..	95-98
Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000	5	—	5-6¼
—— 4½ per cent. First Deb. Stock, Red.	100	—	100-103
Hove Electric Lighting, Limited, Ord., 1-13,000	5	—	8-9
Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000	5	—	10¼-11¼
—— 4 per cent. Debenture Stock Red	100	—	103-106

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Name.	Amount paid.		Last price.
	£		£
Kensington and Knightsbridge and Notting Hill	100	..	103-106
Kidderminster and District Elec. Lighting and Traction, Pref.	10	..	9½-10⅛
London Electric, Ordinary	3	..	2-2½
—— 5 per cent. Pref.	5	..	5½-6
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	..	100-102
Metropolitan, Ordinary	10	..	17½-18½
—— 4½ per cent. First Mortgage Debenture Stock	100	..	108-112
—— 4½ per cent. Mortgage Debenture, Red.	100	..	97-100
Newcastle-upon-Tyne Electric Supply, Ordinary	5	..	100-103
—— Preference	4	..	102 105
Notting Hill Electric Lighting	10	..	13-14
—— 4 per cent. First Mort. Debs., Nos. 1-500 (Reg.)	100	..	99-102
Oxford Electric, Ordinary, 1-96 and 407-14,310	5	..	5-6
—— 4 per cent. Debenture Stock	100	..	98-101
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100	..	100-102
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5	..	3½-3¾
—— 4 per cent. Debenture Stock	100	..	88-90 xd
South London, Ordinary	5	..	3¾-4¼
St. James's and Pall Mall, Ordinary, 101-20,080	5	..	15-16¼
—— 7 per cent. Pref.	5	..	8-9
—— 3½ per cent. Deb.	100	..	98-101
Urban Electric Supply Co., Ordinary, 8-30,007	5	..	5-5¼
—— 5 per cent. Cumulative Preference, 50,001-80,000	5	..	5-5¼
Westminster, Ordinary	5	..	12½-13¼ xd
—— 5 per cent. Cum. Pref., 110,101-138,251	5	..	6-6½

Electric Railways.—

Central London, Ordinary	100	..	103-106
—— 4 per cent. Pref.	100	..	102-105
—— " " deferred	100	..	105-108
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100	..	116-119
City and South London, Consolidated Ordinary	100	..	62 64
—— 4 per cent. Debenture Stock	100	..	116-119
—— 5 per cent. Pref. Stock '91	100	..	128-132 xd
—— " " " '96	100	..	128-131
—— " " " '01	100	..	125-128
Liverpool Overhead, 5 per cent. Pref.	—	—	13-13¼
—— Ordinary, 1-50,000	—	—	7¼-8
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	—	—	103-104
Waterloo and City, Ordinary	100	—	97-100

Electric Tramways.—

Anglo-Argentine, 1-260,007	5	..	4¼-4⅜
—— Permanent 6 per cent. Debenture Stock, 1888	100	..	125-130
Blackpool and Fleetwood Tramroad	10	..	13½-14½
Brisbane Tramway Invest., Lim., Ord., 1-75,000	5	..	2¾-3¼
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5	..	4¼-4⅜
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100	..	100-103
British Columbia Electric Railway Co., Ord., Nos. 1-20,000	100	..	71-74
—— Non-Cum. 5 per cent. Pref., Nos. 25,001-38,600	100	..	91-94
—— 4½ per cent. 1st Mt. Debs., Nos. 1-6,250, of £240 each	40	..	104-106 p.c

Name.	Amount paid.		Last price
	£		£
British Electric Traction, Ord., 1-300,000 & 60,001-90,000	10	—	11½-12
—— 6 per cent. Cm. Pf., 30,001-60,000	10	—	11½-12½
—— 5 per cent. Perpetual Debenture Stock	100	—	122-125
Buenos Ayres and Belgrano Tram., Ord., 1-100,000	5	—	2⅞ 2⅝
—— "A" 6 per cent. Cm. Pf., 1-40,000	b	—	5-5½
—— "B" 6 per cent. Cm. Pf., 1-27,500	5	—	4⅝-5⅛
—— 5 per cent. Deb. Stock, Red.	100	..	106-108
—— Prov. Cert., all paid	100	..	98-101
Cape Electric Tramways, Nos. 1-480,000	1	..	2-2¼
City of Birmingham Tramways, 5 per cent. Cum. Pref.	10	..	5 5¼
—— 4 per cent. 1st Mortgage Deb., 1-3,000 (1917)	100	..	99-102
Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red.	100	..	102-105
Cork Electric Tramways and Lighting Co., Ordinary	10	..	13-14
—— 5 per cent. Cum. Pref.	10	..	11-12
—— Debentures	100	..	96-99
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10	..	12-13
—— 6 per cent. Pref., Nos. within 1-60,000	10	..	14½-15½
—— 3½ per cent. Mort. Debs., 1-3,000, Red.	100	..	94-97
Imperial Tramways, Ordinary	all	..	22-22½
—— 6 per cent. Cum. Pref.	all	..	14¼-15¼
—— 4½ per cent. Deb. Stock	100	..	112-114
Isle of Thanet Electric Tramways and Lighting, 5 per cent. Cum. Pref., Nos. 30,001-60,000	5	..	4-4½
—— 4 per cent. Debenture Stock	100	..	92-95
Kidderminster and District Lighting and Traction, Pref.	5	..	3⅝-4
London United Trys. (1901), 5 per cent. Cum. Pref.	10	..	11½-12½
—— 4 per cent. 1st Mt. Db. Stock, Red.	100	..	105-107
Metropolitan Electric Trams., Deferred, 1,000,001-1,314,016	1	—	3/16-5/16
—— 5 per cent. Cum. Pref., 500,001-814,016	1	—	¾-1⅛
New General Traction, Ordinary	5	—	½-1
—— 6 per cent. Cum. Pref.	5	—	2-3
—— 5 per cent. Mortgage Debentures, 1-1,713 (Regd.)	100	..	88-93
Oldham, Ashton, and Hyde Tramway, Ordinary	10	—	10½-10¾
—— 5 per cent. Cum. Pref.	10	—	11½-12⅛
Perth Elec. Tramways (W.A.) 5 per cent. 1 Mort. Deb. Stk.	100	—	99-102
Potteries Electric Traction, Ordinary, 20,001-40,000	10	—	9¼-9½
—— 5 per cent. Cum. Pref., 1-20,000	10	—	9¾-10⅛
—— 4½ per cent. Debenture Stock	100	—	102-105
South Lancashire Electric Traction and Power Company—			
—— £260,000 Ordinary	1	—	1
—— £101,132 6 per cent. Preference	1	—	1
—— £528,093 4½ per cent. Debenture Stock	100 p.c.	—	100 p.c.

Telephones.—

National Telephone, Preferred	100	—	00-102
—— Deferred Stock	100	—	79-81
—— 6 per cent. Cum. First Pref.	10	—	13-14
—— 6 per cent. Cum. Second Pref.	10	—	13-14
—— 5 per cent. Non. Cum. Third Pref.	5	—	5-5¼
—— 3½ per cent. Deb. Stock, Red.	100	—	96-98
—— 4 per cent. Deb. Stock, Red.	100	—	101-103
Oriental Telephone and Electric Company	1	—	13/16-15/16

TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line	Traffic Returns for week			Increase or decrease.		Miles of single track open.		Accounts for past year.						Cost per car mile.
	Ending	1903.	1902.	Week.	Current year.	1903.	1902.	Ending	Total receipts	Passengers carried.	Car miles run.	Receipts per Pas-s'nger	Car mile.	Mile of track.	
		£	£	£	£				£			d.	d.	£	d.
Aberdeen Corporation	Aug. 8	1,378	1,238	+ 139	+ 1,495	19¼	17¼	May 31	37,931	9,099,715	794,641	0·98	13·02	1,970	6·14
Ayr Corporation	—	—	—	—	—	8	6	Sept. 25	12,503	2,979,276	290,099	1·00	10·34	1,560	4·7
Birmingham Tramways	,, 8	5,575	5,212	+ 363	+ 7,633	6½	6½	—	—	—	—	—	—	—	—
Blackburn Corporation	—	—	—	—	—	24	24	March 25*g*	40,964	7,234,106	826,558	1·36	11·87	1,705	7·44
Blackpool Corporation	—	—	—	—	—	17½	16½	,, 31	211,168	6,169,121	784,443	1·52	10·8	—	—
Blackpool-Fleetwood Tramways	,, 8	2,243	1,775	+ 457	+ 783	16½	16½	Dec. 31	30,923	2,049,677	584,989	3·62	12·68	1,932	6·99
Bolton Corporation	,, 9	1,938	1,644	+ 293	+ 5,103	38	25	March 31	85,704	17,761,605	1,896,247	1·15	10·75	3,430	5·87
Bournemouth Corporation	,, 5	1,655	—	—	—	10½	—	—	—	—	—	—	—	—	—
Bradford Corporation	,, 8	4,882	3,782	+1,070	+ 9,008	41	—	—	—	—	—	—	—	—	—
Brighton Corporation	,, 3	1,033	998	+ 35	+ 5,417	6½	—	,, 31	—	10,432,508	1,031,928	1·00	10·10	—	—
Bristol Tramways Company	,, 7	6,613	6,283	+ 330	—	51½	51½	Dec. 31	223,480	41,192,899	5,724,114	1·30	9·38	4,348	—
Burnley Corporation	,, 8	902	704	+ 198	—	—	—	—	—	—	—	—	—	—	—
Cardiff Corporation	,, 1	2,133	1,535	+ 598	+12,345	—	—	—	—	—	—	—	—	—	—
Carlisle Tramways Company	—	—	—	—	—	—	—	,, 31	—	2,216,583	320,129*h*	—	—	—	—
Central London Railway	,, 8	6,115	6,859	— 744	— 479*h*	6	—	,, 31	367,225	45,305,110	1,276,971*a*	1·87	66·6 *a*	59,076	35·6 *a*
City and South London Railway	,, 9	2,353	2,686	— 333	— 1,402	6⅜	—	,, 31	165,003*a*	19,069,319*a*	—	—	—	—	—
Cork E. T. and L. Company	,, 6	971	881	+ 89	+ 438	—	—	—	—	—	—	—	—	—	—
Darwen Corporation	July 10	220	243	— 23	— 113	7·23	—	March 31*g*	12,341	2,360,735	254,279	1·25	11·65	1,707	9·36
Dover Corporation	Aug. 8	341	354	— 13	+ 114	3	—	—	—	—	—	—	—	—	—
Dublin & Lucan Electric Railway	,, 9	191	182	+ 9	+ 60*h*	—	—	Dec. 31	5,796	364,796	102,087	3·81	13·62	859	7·68
Dublin U. T., electric cars	,, 7	5,816	5,661	+ 185	} +5,979	46	46	March 31	126,121	24,553,133	3,429,356	1·23	8·82	2,741	5·06*h*
Dublin S. District, Electric	July 31	1,164	1,053	+ 101											
Dundee City Tramways	,, 15	834	718	+ 116	—	22	22	May 15	35,874	9,084,522	752,814	0·93	11·276	1,630	—
East Ham Corporation	Aug. 8	930	639	+ 351	+ 4,198	10·75	7·52	March 31	25,341	9,971,337	650,224	0·61	9·35	2,357	—
Farnworth U.D.C.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Glasgow Corporation	,, 8	13,097	12,826	+ 271	+15,906	124	101	May 31*g*	656,572	177,179,549	14,008,750	0·88	11·25	5,489 *b*	7·40*d*
Halifax Corporation	—	—	—	—	—	30½	27⅔	—	—	—	—	—	—	—	—
Huddersfield Corporation	—	—	—	—	—	34	35	March 31	56,631*h*	9,738,213	1,218,539	1·4	11·14	1,618	6·38
Hull Corporation, E. S.	,, 8	2,097	2,407	— 310	+ 1,706	19	19	,, 31	87,707*h*	21,065,999	2,218,696	1·00	9·49	5,004	5·07
Ilkeston Corporation	July 29	190	—	—	—	—	—	—	—	—	—	—	—	—	—
Kirkcaldy Corporation	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Leeds Corporation	Aug. 8	6,760	6,417	+ 342	+ 6,477	77	—	March 25	262,656	57,239,779	5,773,651	1·11	10·91	3,283	—
Liverpool Corporation	,, 8	10,700	10,750	+ 50	+11,031	101	95	Dec. 31	504,304	108,906,472	11,705,425	1·11	10·34	5,000	6·88
Liverpool Overhead Railway	,, 9	1,971	1,797	+ 164	+ 667	15½	15½	June 30	79,252	10,466,726	986,185*a*	1·82	19·30*a*	5,110	— *a*
Metropolitan District Railway	,, 9	6,497	7,872	—1,393	— 2,039	—	—	—	—	—	—	—	—	—	—
Newcastle-on-Tyne Corporation	,, 8	3,747	2,981	+ 766	—	36	36	Dec. 15	127,852	28,411,899	2,767,444	1·08	11·09	3,551	—
Portsmouth Corporation	—	—	—	—	—	29	29	Sept. 30	47,651	9,168,137	868,157	1·24	13·17	1,643	—
Rochdale Corporation	July 20	157	164	— 7	—	4½	..	March 31	5,416	925,281	127,456	1·38	10·27	—	7·66
Salford Corporation	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Sheffield Corporation	Aug. 9	5,887	—	—	—	53½	46¼	Mar. 25*g*	216,709	56,812,049	4,926,083	0·904	10·428	7,510	7·03*f*
Southampton Corporation	,, 6	1,396	1,279	+ 117	—	11	11	,, 31	35,874	9,084,522	752,814	0·946	11·436	3,760	—
Sunderland Corporation	,, 2	1,546	1,478	+ 68	+ 736	18·48	17·18	,, 31	59,930	13,987,121	1,270,957	1·03	11·3	3,243	6·43
Wallasey U.D.C.	,, 8	1,047	882	+ 165	+ 1,866	10·5	10·5	,, 31*g*	31,307	5,690,378	654,553	1·32	11·47	2,981	6·97

* Includes maintenance of permanent way and proportion of profits paid to the tramway companies for term of unexpired lease. *a* Train mile.
b Per mile of single track. *c* Include rail and tram. *d* including depreciation. *f* Including one section of horse traction. *g* 1903. *h* Half-year's figures.

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INTERNAL-COMBUSTION ENGINES FOR DRIVING DYNAMOS.*

BY HERBERT A. HUMPHREY, M.I.C.E., M.I.E.E.

There are now 50 firms manufacturing large gas-engines of 200 h.p. and upwards. Almost all these firms have entered this new branch of engineering during the last five years, and the large gas-engines now running have been constructed, with but few exceptions, during the last 3½ years. The table attached to this paper shows the number of gas-engines above 200 i.h.p. made by some of the principal firms. The engines now completed or on order number 498, having an aggregate capacity of 310,865 h.p., and of these 390 engines are for dynamos, and give collectively 198,405 i.h.p. The central-station engineer is now fully alive to the fact that the gas-producer and gas-engine constitute the cheapest means of generating electric power where coal is the basis of the energy. The internal-combustion engine is rapidly attaining to sizes of units which are large enough to suit even the big tramway stations, and, when suitably designed, has proved quite as reliable for driving alternators in parallel as the best steam-engine.

The following types of gas-engines are now made for driving dynamos, and figures are added showing the number of impulses per revolution and the horse-power up to which each type is constructed. Single-cylinder single-acting gas-engines, although made in large powers (600 h.p. to 700 h.p.) by the John Cockerill Company, of Seraing, and by Messrs. Richardsons, Westgarth, and Co. in this country, would not usually be chosen in large units for dynamo driving, except where regularity is not important. It is interesting to note, however, that 100-h.p. gas-engine sets of the single-cylinder single-acting type are actually in use at the Embrach Works, driving belt-driven three-phase alternators in parallel, a small additional flywheel being placed on the armature of each machine.

	—	Impulses per revolution.	Usual sizes of engines.	Reference No.
Four-stroke cycle single-acting	Single cylinder	½	Up to 600	1
	Vis-à-vis	1	,, 600	2
	Double *vis-à-vis*	2	,, 1,200	3
	Twin cylinder	1	,, 800	4
	Tandem cylinder	1	,, 1,200	5
	Double tandem	2	,, 2,500	6
	Vertical two, three, and four cylinder	1, 1½, 2	,, 1,000	7
Four-stroke cycle double-acting	Single cylinder	1	,, 1,000	8
	Twin cylinder	2	,, 1,000	9
	Tandem cylinder	2	,, 2,000	10
	Double tandem	4	,, 4,000	11
	Vertical two cylinder	2	,, 2,000	12
Two-stroke cycle single-acting	Oechelhauser, one cylinder	1	,, 1,000	13
	Oechelhauser, two cylinder	2	,, 2,000	14
Two-stroke cycle double-acting	Korting, one cylinder	2	,, 2,000	15

One of the first types to gain prominence was the *vis-à-vis* engine, manufactured by Messrs. Crossley Bros., who make engines of 500 h.p. and 600 h.p., with two cylinders, and the Gasmotoren-Fabrik Deutz, who have carried this type up to 1,200 h.p., using four cylinders. Probably no more engines of this type will be made on the Continent, as the Deutz firm have abandoned the design in favour of double-acting single and tandem-cylinder engines. Consequently, although this *vis-à-vis* type has done excellent service, and is now in use for driving alternators in parallel on a large scale, little need be said about it in face of the change to the double-acting type which is taking place.

Type No. 4 is being made by Körting Bros., of Hanover, who get about 300 h.p. to 400 h.p. out of each cylinder, the two cranks being placed at 180deg. This type is going to be largely adopted, but the tandem engine (type No. 5), with its straight-line stresses and equally-timed impulses, is likely to live longer than the *vis-à-vis* type or the twin-cylinder type. The Premier engine is an example of the straight-line type, and the Premier Gas-Engine Company have held a front place among the pioneers in large gas-engines. The Nürnberg Company and the Cockerill Company also make very powerful engines of the ordinary tandem type, suitable for direct coupling to both direct-current dynamos and alternators. The double-tandem engine (type No. 6) can be carried to very large powers, and makes a simple and strong engine, but it is heavy for its work and covers a large floor space. Very good work has, however, been obtained from this engine, and it is suitable for driving alternators in parallel up to units of 2,500 h.p.

Quite a number of firms now manufacture vertical gas-engines with two, three, or four cylinders (type No. 7), all of them constructed specially for dynamo driving. The Westinghouse Company are the best-known makers in connection with this type of engine, but Messrs. Tangyes, Limited, and Messrs. the Campbell Gas-Engine Company now construct vertical engines up to 300 h.p. and 400 h.p. The last-mentioned company make a four-cylinder vertical engine which is extremely well balanced, and, as it gives two impulses per revolution, provides great regularity of turning moment. Messrs. Fielding and Platt have made their first four-cylinder vertical engine, enclosed type, and expect a number of orders for engines of 100 h.p. to 200 h.p.

Many attempts were made to get over the difficulty of a piston-rod stuffing box, and Messrs. Dick, Kerr, and Co. years ago constructed and ran at Belfast engines with double-acting pistons and piston-rod glands. The solution of the problem has, however, come gradually, and the Cockerill Company, followed by numerous other makers, have now examples of efficient stuffing boxes fitted in the closed ends of gas-engine cylinders and giving no trouble. Once this difficulty is removed, the gas-engine must logically be manufactured as a double-acting machine, for by simply duplicating the valve gear twice the power and twice the number of impulses are obtained from the same size of cylinder without increasing any of the working stresses. So completely has this fact been recognised, that all the leading makers now construct double-acting engines (types 8 to 12), and powers of 1,000 h.p. with single-cylinder engines, and of 4,000 h.p. with double-tandem engines, of the double-acting type, are readily obtainable. Nearly all the important orders which are now being placed for large gas-engines are for the double-acting type, and all the types Nos. 8 to 12 give thoroughly efficient prime movers for central-station work. In fact, the tandem-cylinder engine (type No. 10) and the vertical two-cylinder engine (type No. 12) are among the chief favourites on the Continent and in this country. The Nürnberg Company and the Deutz Company build double-acting tandem engines which leave very little to be desired in the way of simplicity, smooth running, and good turning moment qualities.

The Nürnberg engine has the whole of the weight of the piston and piston rods carried on slides running on guides, so that the piston and stuffing-box friction is reduced to that due simply to the rubbing contact on the piston rings and the packing in the glands. The front slide constitutes the ordinary cross-head, and the back slide block is utilised to introduce and discharge the water required for cooling the pistons and piston rod. This type of engine has so far reached the lowest consumption of both gas and oil for a given output of power.

The new type Westinghouse gas-engine now being made in this country for powers of 500 h.p. to 2,000 h.p. has much the appearance of the vertical Corliss engines so largely used in the United States. The two double-acting Otto-cycle cylinders are carried on A-frames, and the connecting rods are coupled to overhanging crank-pins at either end of the shaft, so that only two large bearings are required. Between these bearings the alternator and flywheel are placed, and the whole forms a very compact and powerful set, occupying the minimum floor space and running at speeds closely corresponding to the usual speeds of similar size steam units used to drive large alternators.

The Oechelhauser engines have been largely built for dynamo driving by the Deutsche Kraftgas-Gesellschaft, and one of their finest examples is to be found in the central power station at Ilsede Hütte, where electric power is developed by gas-engines coupled to alternators, and supplying three-phase current at 10,000 volts to rolling-

* Paper read before the Engineering Conference of the Institution of Civil Engineers.

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APPENDIX—List of Gas-Engines, 200 Horse-Power or Over, Delivered or in Hand.

Name of Maker.	Electrical Generators.			For Other Purposes.			Total for All Purposes.		
	Number of Engines.	Horse-Power of Each.	Total Horse-Power of Engines.	Number of Engines.	Horse-Power of Each.	Total Horse-Power of Engines.	Total No. of Engines.	Total Horse-Power.	Average Horse-Power per Engine.
Société Anonyme John Cockerill, of Seraing.	3	260	780						
	9	800	7,200	13	800	10,400			
	2	1,600	3,200	3	1,600	4,800			
	1	3,500	3,500						
	15		14,680	16		15,200	31	29,880	964
Märkischen Maschinen-Bauanstalt, Wetter a. d. Ruhr.	3	260	780	1	800	800			
				3	1,600	4,800			
				4		5,600	7	6,380	911
Elsässischen Maschinenfabrik Mülhausen.	2	260	520	1	260	260			
	2	800	1,600	3	700	2,100			
	4	1,000	4,000	4	800	3,200			
	2	1,600	3,200	4	1,100	4,400			
	10		9,320	1	1,700	1,700			
				13		11,660	23	20,980	912
Schneider & Co., Creusot.	4	260	1,040	3	800	2,400			
	1	1,600	1,600						
	5		2,640				8	5,040	630
Breitfeld, Danek & Co., Karolinenthal, Prag.	1	260	260						
	2	400	800						
	1	800	800	3	800	2,400	7	4,260	609
	4		1,860						
Richardsons, Westgarth & Co., Ltd., Middlesbrough.	2	250	500						
	1	300	300	9	750	6,750			
	2	800	1,600	1	800	800			
	5		2,400	10		7,550	15	9,950	792
"Simplex" Engines, Grand Total	42		31,680	49		44,810	91	76,490	841
Louis Soest & Co., Reisholz b. Düsseldorf.	1	300	300						
	1	700	700						
	2		1,000				2	1,000	500
Gasmotoren Fabrik Deutz, Köln-Deutz; and Licencees; Ehrhardt & Sehmer Schleifmühle, Post Saarbrücken; Sächsische Maschinen-Fabrik vorm; Richard Hartmann; A. G. Chemnitz.	12	200	2,400	2	250	500			
	3	225	675	1	400	400			
	4	250	1,000	1	400	400			
	1	280	280	1	500	500			
	12	300	3,600	1	700	700			
	2	350	700	1	1,400	1,400			
	1	400	400	1	600	600			
	4	500	2,000						
	5	600	3,000						
	5	1,000	5,000						
	3	200	600						
	5	250	1,250						
	5	300	1,500						
	3	600	1,800						
	1	800	800						
	66		25,005	8		4,500	74	29,505	399
Vereinigte Maschinen-Fabrik Augsburg, "Nürnberg" Engine.	3	250	750	1	500	500			
	1	350	350	1	200	200			
	1	600	600	1	450	450			
	3	700	2,100	4	900	3,600			
	3	800	2,400	1	1,500	1,500			
	1	1,000	2,000	2	1,600	3,200			
	2	1,200	2,400						
	1	350	350						
	2	500	1,000						
	3	1,000	3,000						
	2	1,100	2,200						
	4	1,200	4,800						
	2	1,700	3,400						
	6	2,000	12,000						
	1	2,400	2,400						
	35		39,750	10		9,450	45	49,200	1,088

mills at Peine, about five miles away. The gas-engine sets are in 1,000-h.p. units, and run in parallel with steam-driven alternators, but the latter are to be superseded when the full 6,000 h.p. of gas-engines—*i.e.*, six units—is installed.

Last, but not least, we have the Körting gas-engine, which heads the list with the highest aggregate of power of any type. It is the only engine at present on the market which gives two impulses in one cylinder per revolution, being in this respect like an ordinary steam-engine. Many firms have taken out licenses to build this engine, and in this country it is made by Messrs. Mather and Platt, who have just supplied their first 700-h.p. engine for dynamo driving, and by Messrs. Fraser and Chalmers. Full descriptions of the Körting and Oechelhäuser engines have appeared in the technical journals, and these types are now almost as well known as the Otto-cycle engines.

Brief mention must be made of the Vogt gas-engine, which, like the Körting engine, gives two impulses per revolution in one cylinder. It is unique, in that the explosions take place over water, and the motor cylinder is filled with this fluid. The combustion chambers are above the cylinder level, and the water rises and falls in these as the piston reciprocates. This engine embodies the principle of internal cooling, so that water jackets are dispensed with, and the metal cylinder may be made as thick as strength requires for any size of cylinder. No hot gases come in contact with any moving part of the engine except the valves. Probably a good deal will be heard of this engine

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LIST OF GAS-ENGINES, 200 HORSE-POWER OR OVER, DELIVERED OR IN HAND—*continued*.

Name of Maker.	Electrical Generators.			For Other Purposes.			Total for All Purposes.		
	Number of Engines.	Horse-Power of Each.	Total Horse-Power of Engines.	Number of Engines.	Horse-Power of Each.	Total Horse-Power of Engines.	Total No of Engines.	Total Horse-Power.	Average Horse-Power per Engine.
Deutsche Kraftgas Gesellschaft.	2	250	500	4	500	2,000			
	3	300	900	1	700	700			
	10	400	4,000	1	1,000	1,000			
	3	500	1,500	1	1,200	1,200			
	3	600	1,800	1	1,500	1,500			
	7	1,000	7,000						
	1	1,500	1,500						
	29		17,200	8		6,400	37	23,600	635
Premier Gas Engine Co., Nottingham.	1	200	200	1	200	200			
	14	250	3,500	1	250	250			
	3	400	1,200	1	600	600			
	1	500	500	1	1,000	1,000			
	6	600	3,600						
	1	700	700						
	26		9,700	4		2,050	30	11,750	392
Crossley Brothers, Limited, Openshaw, Manchester.	16	200	3,200	2	400	800			
	6	210	1,260	1	500	500			
	6	250	1,500						
	1	350	350						
	2	400	800						
	4	500	2,000						
	35		9,110	3		1,300	38	10,410	274
Tangyes, Limited, Birmingham.	2	200	400	2	200	400	4	800	200
Westinghouse Machine and Manufacturing Co, East Pittsburg, U.S.A.	35	300	10,500	Returns not complete.					
	4	500	2,000						
	4	650	2,600						
	1	1,000	1,000						
	1	1,500	1,500						
	45		17,600				45	17,600	391
The British Westinghouse Electric and Manufacturing Co., Ltd.	32	250	8,000	1	250	250			
	2	600	1,200						
	34		9,200				35	9,450	270
Snow Steam-pump Works of Buffalo, New York, U.S.A.				2	4,000	8,000			
				6	1,000	6,000			
				1	500	500			
				9		14,500	9	14,500	1,611
Struthers, Wells & Co., Warren, Pa.	2	500	1,000				2	1,000	500
Compagnie de Fives Lille, France	5	400	2,000						
	4	250	1,000						
	7	200	1,400						
	16		4,400				16	4,400	275
Andrew and Co., Reddish, near Stockport.	3	300	900						
	2	250	500						
	5		1,400				5	1,400	280
Gebrüder Körting, Körtingsdorf, Hannover.	2	200	490	2	500	1,000			
	3	220	660	1	700	700			
	5	250	1,250	2	1,000	2,000			
	4	300	1,200	1	1,400	1,400			
	1	350	350	1	1,500	1,500			
	2	400	800	16	2,000	32,000			
	8	500	4,000						
	7	600	4,200						
	5	700	3,500						
	14	1,000	14,000						
	2	1,600	3,200						
	2	1,800	3,600						
	55		37,160	23		38,600	78	75,760	971
Campbell Gas Engine Co., Ltd., Halifax.									
GRAND TOTAL	398		206,805	117		122,260	515	328,065	637

in the future, as the results obtained with an experimental engine of small size are excellent.

In the author's opinion sufficient attention has not been given to the construction of gas-engines intended to take a supply of both gas and air, separately stored under pressure. For central stations of large size the previous compression of the gas and air, so that they may be drawn as required from reservoirs, has much to recommend it, and involves, with proper precautions, no special danger. The advantage of the two-cycle gas-engine would then be attained without the complication of each engine carrying its compressing plant, together with all the extra valves and gear required. Also, there is no reason why the heavy and somewhat noisy cam gear on gas-engines should not be replaced, and the valves operated by compressed air, or even high-pressure burnt gases stored from the motor cylinder itself, controlled by a small rotating valve.

The term "internal-combustion engines" embraces oil-engines, but oil-engines above 200 h.p. are rare, and cannot compete in cost of fuel with gas-engines using cheap producer gas, especially when the system of recovering the ammonia from the coal, as in the Mond producer plant, is available. The Diesel oil-engine has attained a high degree of economy, and has been applied to dynamo driving up to 200-h.p. units.

In general, a gas-engine giving at least one impulse per revolution is necessary for all central-station direct-coupled dynamo sets, and in cases of alternators working in parallel

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engines should be chosen which give two impulses per revolution. The exact solution of the alternator-in-parallel problem is too complicated, owing to the interaction of the sets, to be given here, but some idea of the relative value of different types of engines for this class of work can be gathered from the Klönne diagrams, which take no account

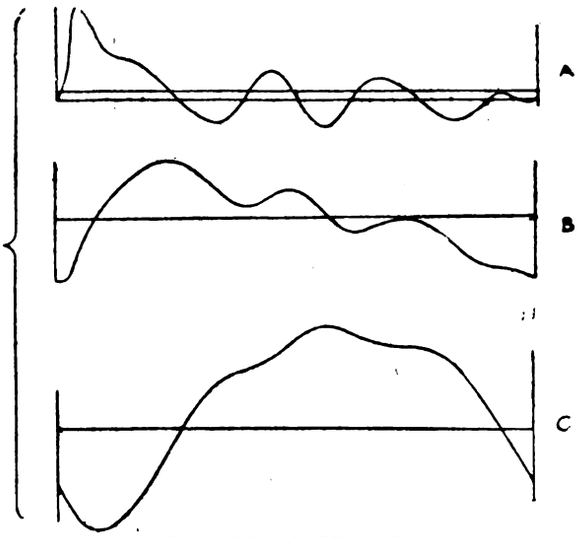

FIG. 1.—1-Cylinder 4-Stroke Cycle.

of this interaction, and are reproduced in Figs. 1 to 6. In each case three curves are drawn: (A) the turning moment curve corrected for inertia of reciprocating parts (the straight line representing the mean work or resistance is made with the same ordinate in all cases); (B) the corresponding angular velocity curve; (C) the corresponding

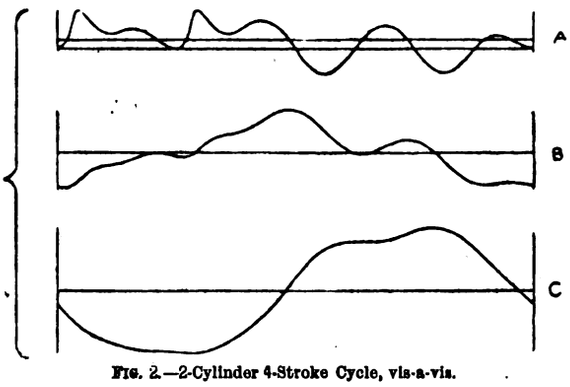

FIG. 2.—2-Cylinder 4-Stroke Cycle, vis-a-vis.

angular deviation curve, showing at any moment the angular difference between the position occupied by the flywheel and the position it would have occupied had the rotation been absolutely uniform. The moment of inertia of the rotating parts, the weight of the reciprocating masses per square inch of piston area, and the ratio of con-

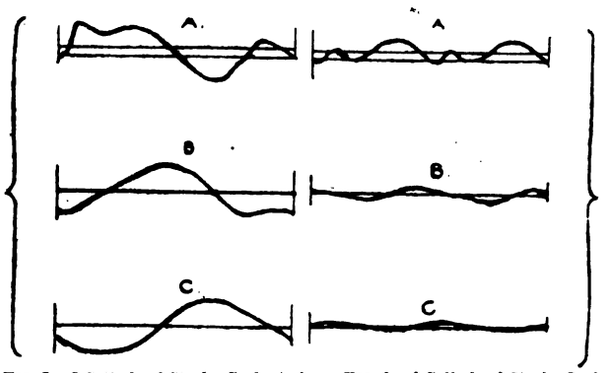

FIG. 3.—2-Cylinder 4-Stroke Cycle, twin. FIG. 4.—4-Cylinder 4-Stroke Cycle.

necting rod to crank length is assumed to be the same for all five cases. Using these diagrams it was found that for a 500-h.p. engine (700 h.p. maximum) running at 125 revolutions per minute, coupled to an alternator having a periodicity of 50 cycles per second, the ratio of the moments of inertia required to restrain the angular deviation to ±3deg. in all six cases was

One-cylinder four-stroke cycle				37·5
Two	,,	,,	*vis-a-vis*	23·1
Two	,,	,,	tandem	10·2
Four	,,	,,		1·0
One	,,	Oechelhauser		11·6
Two	,,	,,		1·0

These are theoretical results, and cannot be directly applied in practice; still they convey to the mind an approximate idea of the relative merits of the different types.

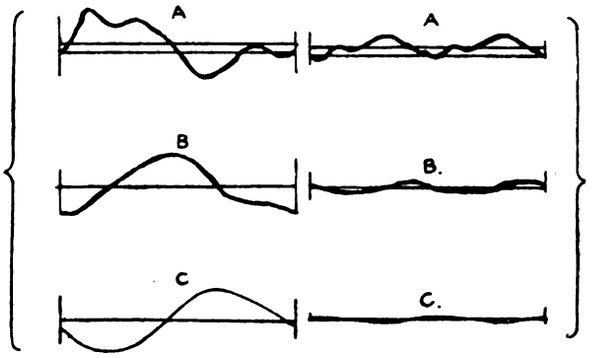

FIG. 5.—1-Cylinder Oechelhauser. G. 6.—2-Cylinder Oechelhauser.

The large central electric stations of the future will employ producer gas and gas-engines, and several existing stations with steam plant are to have gas-engines for additional power with the ultimate object of the entire replacement of all steam plant.

DISCUSSION.

The discussion was opened by **Prof. Kennedy,** who said that he had studied these questions from the point of view of money and economy and speed, and he would have done his utmost to use power-gas engines if they found that they were going to be the things that were wanted. There were a good many of them who had failed to convince themselves of that fact. He was very unprejudiced, because he had very nearly the earliest central station driven by gas-engines on a design of his own. But some further evidence was necessary as to the actual working economically and financially of those engines especially with power gas, not with blast-furnace gas, and this would be most interesting.

Mr. Crossley said they all owed Mr. Humphrey a debt of gratitude for what he was doing in connection with gas-engines. The *vis-a-vis* type was one of the most simple and the cheapest engine, and the most economical in working up to 20in. or 28in., but when they got beyond that they must go to a water piston, and then, of course, they could go to any size of cylinder. The watering of the piston was a considerable nuisance and danger. It was extraordinary how quickly a piston would heat if they withdrew the water, and it was terrible to think of the results. Then there was another reason, that once they had a piston rod cooled going through an explosive chamber they must lose very considerably. In gas-engines where gas cost them practically nothing, it did not matter, but if they had an engine of 28in. cylinder and a water piston, they would find that they lost about 9 per cent. due to this water piston rod. For moderate-size engines up to 28in. with pistons it was better to have the *vis-a-vis* type. With reference to the motion bars, up to a certain size he did not think they were needed, and they were a complication.

Mr. Michael Longridge said he knew very little about gas-engines. A short time ago he endeavoured to get tenders from English makers for 500-h.p. gas-engines, and he found there was hardly such a thing in the country. They had practically no experience of gas-engines in this country. A great many were at work in Germany, but those engines were mostly working with blast-furnace gas. He felt great diffidence in recommending anyone to go in for large gas-engines, although to his mind if they could be brought into a practical state they ought certainly to be the most economical and the best engines. He would be very glad to place an order with any of the agents of those engines either in Germany or in England.

Dr. Hopkinson said that Dr. Kennedy had doubted the value of the gas-engine in comparison with steam for central-station purposes. He would compare a full-load run upon a gas-engine and upon a steam-engine. They might take the comparative figures at something like 2½lb. of fuel per kilowatt-hour for the highest-class steam-engine, and taking into account the various losses in the case of the gas-engine it was something under 2lb. That difference might be made quite insignificant when other factors were taken into account in making up the total cost of energy derived from the two sources. But when they considered the conditions of an electric station where they had a load factor not exceeding 25 per cent., they would find that the comparison took a very different form indeed. He supposed from actual result that 8lb. of coal per kilowatt-hour was not a bad result for the steam-driven electric station. Although figures were not obtainable for gas-engines, still the stand-by losses were enormously less. If all these were fairly reckoned up, they would find that figures in the case of gas-engines which would compare fairly with the 3lb., in the case of the steam-engines would be about 8lb. That was an enormous economy, and he felt sure, if Dr. Kennedy would look at it from that point of view, he would find very ample justification for the view that the gas-engine must be the type of motor for the future in

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the electric lighting station. He considered it purely from the point of view of fuel, and did not take into account the recovery of ammonia, which was remote, but it would greatly reduce the cost of energy.

Mr. Davey said he had listened to a good many gas-engine discussions, and he found that the gas producer was left out of the question generally. The gas-engine was of very little use without the producer. With the blast-furnace gases they had a producer which gave them the gas practically for nothing of fairly uniform quality, and without any difficulties that attended the use of ordinary gas-producers. What they wanted in the application of the gas-engine for general purposes, was a producer which would take the place of the steam-boiler. If they could get a satisfactory gas-producer, which could be worked at the same expense as the steam-boiler for stoking and so on, and they got 70 to 80 per cent. of the calorific value of the fuel. The gas-engine using such gas must be the most economical prime mover; and looking at it in that light, he was rather surprised that he did not find stations with gas-producers and gas-engines of a moderate size. If they had a satisfactory gas-producer of a moderate size, he believed it would lead to a general application of gas-engines.

Prof. Burstall said he had paid some attention to the question of gas-engines driving alternators in parallel. He had seen them, but he was bound to admit that in no case were they used in such a way as a central-station engineer would allow.

After a few words from **Dr. Hopkinson, Mr. Atkinson, Mr. Booth, Mr. Lawson,** and **General Webber,**

Mr. Humphrey replied. He said Mr. Crossley had mentioned the *vis-a-vis* type. It was doing excellent work, and it was only that he looked a long way ahead and saw a certain amount of standardisation when the gas-engine would entirely replace the steam-engine, and in that case they would have fewer types of engines, and probably the double-acting type would be the prevailing one. As to the cooling of the pistons in the case of the Nürnberg engine, they had got the piston carried on blocks, so that only the rings were pressing on the cylinder. Mr. Longridge must have made his enquiries some considerable time ago, because if he now enquired for a 500-h.p. engine there would be no difficulty in seeing plenty of them at work. He could show him six 500-h.p. engines together, and working day and night. There were differences between the two-stroke and the four-stroke cycle engine which would have to be carefully considered, and which did limit the speed, and this had a very important bearing on the question of cooling. A great deal had been said about the relative cost. They had steam-engines and gas-engines running in the same building, and looked after by the same superintendent, and they found that the cost, all included, for the steam-engine was about twice that of the gas-engine. He would be very glad to show them cases where gas was being made regularly and satisfactorily for use in gas-engines. He did not think there was any difficulty even if they wanted a small gas-producer of from 10 h.p. to 12 h.p. With regard to the cycle variation, he was prepared to admit that if they went to a maker and asked what cycle deviation in speed they wanted, he would say $\frac{1}{70}$th or $\frac{1}{30}$th. But that was not necessary, and one of the big American engineers assured him that $\frac{1}{100}$th was good enough for all purposes. Even if it was not, they were prepared to supply something better.

A hearty vote of thanks was given to the author.

ELECTRICAL ENGINEERING IN SOUTH WALES.

Electrical Motive Power in Mines and Collieries.

At the quarterly sessions of the South Wales and Monmouthshire Institute of Engineers, held at Cardiff under the presidency of Mr. Harry Riches, M.I.C.E., M.E., on Friday, July 10, the greater part of the time was occupied in the discussion of questions bearing upon electrical engineering. One of two papers submitted, and which caused a good deal of general interest, was that on "Electric Motive Power in Mines and Collieries," by Mr. W. A. Scott, A.M.I.E.E.

Mr. Scott, who has had wide experience as an electrical engineer, pointed out at the outset of his paper that electric power had been steadily growing in favour for mining operations during the past 10 years, and in the North of England and Scotland many very large plants had been installed for both pumping and haulage underground. It was, however, only during the past two years that any schemes of this description had been introduced into South Wales. Yet during this time some of the largest colliery electric power plants to be found in the country had been put to work, and were running most successfully in this district. No doubt many mistakes were made during the early history of colliery electric plants, and the writer ventured to say that many failures were due to the advice of incompetent persons, and also to that bugbear, the lowest tender, which had much to answer for here as well as in other branches of electrical engineering. There was no excuse now, however, for any mistakes being made, if only the experience gained elsewhere was made use of. But there was a tendency for contractors tendering on their own specifications to cut prices and put in an inferior job, which, unfortunately, was often accepted. The writer proceeded to outline the two chief types of electrical machinery suitable for power work—continuous-current and polyphase alternating-current machines—pointing out that up to the present time electric transmission work in this country had been carried out with the aid of continuous currents, and the majority of engineers were acquainted with the general appearance of this type, but for colliery work there were points of detail in design which were well worth considering, and these he proceeded to enlarge upon. The typical drum armature, the wires of which were embedded in slots cutting to the core, was now adopted in all first-class machines. Incidentally referring to the question of starting switches, Mr. Scott remarked that the type of starter to be used very much depended on the load the motor was to start. They had the choice of two types, liquid and metallic resistance, each of which had its advantages when used in the proper place. The writer's experience had led him to the conclusion that if the load to be started had great inertia, as heavy shears, large pumps, and such like, then the liquid screw-down switch was the best type to use. If the motor required to be reversed often, such as on cranes or main top rope haulage, then a liquid reversing switch had undoubted advantage in point of simplicity and minimum repair. An over-load and no-voltage arrangement could be combined with either of these switches, so that, from a point of safety, there was no difference between them and the metallic type, which were usually fitted with these arrangements. A metallic starter was very satisfactory for starting motors on fairly light loads; but a general mistake made with these was that the time taken to bring the motor up to full speed was quite neglected when ordering the switch. The result was that before the motor attained full speed, the resistances were red hot and the switch contacts burnt. This question of starter was really a very important one, and one which had not received the amount of attention which it deserved. It was not too much to say that the success or failure of a job greatly depended on the starter used. Speaking generally, whatever type of starter was used it should be of first-class mechanical construction, and the parts to be handled in its operation should be efficiently insulated. Metallic starters, when not encased in specified boxes, should on no account be mounted on inflammable supports, and main and switch boards should be supported on iron frames or brick pillars. Many serious fires had been caused by the neglect of these important points. Having expatiated at some length on the transmission line, he passed on to deal with the question of insulation of the cables. This required to be carefully gone into, and what would be suitable for one job might prove quite a failure in another. For mining work the writer's experience was that rubber cables were very unreliable, and paper-insulated cables covered with lead were not satisfactory. During many years' connection with this class of work he had found that cables insulated with bitumen stood better in damp places than any other. Mr. Scott afterwards briefly investigated alternating-current phenomena and machines in their principal features of application in power work, and went on to say that so far very little single-phase plant had been installed for power purposes, as it had presented considerable difficulty in regard to motors. There was, however, some likelihood of its early adoption in certain classes of work, such as railway electrification, although they need not look upon it as a great rival of the polyphase motor for some time to come. He was in favour of the revolving-magnet type, as the construction of the armature could be made a sounder mechanical job. The chief advantages presented by alternating-current machines were the absence of commutators and the ease with which high-pressure currents could be dealt with. If a stand-by exciting power was deemed necessary, Mr. Scott would advocate the electric lighting plant, which should be a direct-current set, built for the same pressure as the exciter, with sufficient margin of power and suitable arrangements for using it to excite the alternators. The polyphase type of motor best suited for mining purposes was the induction motor (or the asynchronous motor). Slot windings presented good features as regards winding and repairs; the coils could be formed before being laid into the slots, and by using mica ducts the mechanical protection was very good. The power factor of these machines was, however, lower, as the air-gap had to be longer. This was not altogether a disadvantage, as in colliery work a small air-gap was very liable to get choked. Some writers, and even some firms, advocated the squirrel-cage motor for all mining work, but the writer's experience was that for motors over 10 h.p. the slip-ring motor, with cased brush-gear, was a far more satisfactory job, and the additional risk introduced by the slip-ring was practically nil. He never recommended concentric cables for three-phase work, and advocated in connection with haulage work some suitable friction clutch on all gears, whether continuous current or polyphase, when the power became considerable. He was greatly in favour of starting large pumps through a by-pass, which he submitted had much to recommend it, and was a very inexpensive piece of work. Proceeding to consider the best type of generating plant suited to colliery work, he remarked that the type of engine which had found most favour with mining engineers was the horizontal slow-speed coupled compound, and there were many good reasons for this preference. First, the steam pressure in collieries was very often not higher than 80lb., but even if it was 100lb. to 120lb. the high-speed engine was not so economical as an automatic expansion-gear compound engine. Simplicity, as well as economy,

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was one of the chief things to be aimed at. By providing an engine which the average colliery engineman could attend to and understand was generally of just as much importance as saving another pound of steam. In the case of large plants, say over 250 kw., or about 400 i.h.p., he would favour a direct-coupled set. It must be remembered, however, that direct-coupled sets for smaller power became very expensive in first cost compared on the basis of output, and unless due account was taken of the first cost when installing any scheme, the interest on capital invested would be a very high proportion of the cost of the units generated. It therefore seemed that for smaller powers of about 200 kw., although the efficiency of the rope-driven set might be a little lower than the slow-speed direct-coupled plant, it would be just as economical in cost per unit when the interest on the first cost was included in this figure. Many engineers advocated high-speed engines for colliery work, but he was of the opinion that, if space would allow, it would be better to put in slow-speed engines and rope-drive, even if their over-all efficiency was somewhat less (but this was not always so). The high-speed engine could only be economical at about its full load, as the valves had a fixed cut-off (which was set for the best results at full load), and at anything under this steam consumption per horse-power increased very much. Another point was that, when the bearings required taking up, a thoroughly skilled man was necessary, as the fittings of these must be accurate or trouble would be experienced. The writer knew of many installations running most satisfactorily with high-speed engines, but for heavy haulage in collieries, which was what they must prepare for now, they were certainly not to be recommended. However, if high-speed engines were adopted, then they must be fitted with forced lubrication to all parts, as by this means the wear and tear was reduced to a minimum. The best lubricating oil was the only thing to be employed in this case, otherwise the wear was very great. The question of lighting would usually crop up, and in most cases this should be done by a separate plant. It was often necessary to run the lighting plant week in and week out, and this could be best done by having a small set either belt driven or direct coupled. If the power plant was three-phase, the lighting should be at the same pressure as the exciters on the alternator shafts. Mr. Scott then gave a description of a large colliery installation—one of the largest in the country—erected under his supervision for the Tredegar Iron and Coal Company, at three of their pits in the Sirhowy Valley, Monmouthshire. This plant was for driving the whole of the haulage, both main and tail and endless ropes, also for pumping. Previously the greater part of this work was done by compressed air, and the remainder by steam, carried to the haulage gears at the pit bottom and some pumps in the shaft. As the output of the pits increased it became necessary either to increase the size of the compressing plant or to adopt some other means of power transmission. On the advice of Mr. Maurice Deacon, the consulting engineer to the company, it was decided to instal electricity, and the three-phase system was chosen as being most suitable for their mines. The object of introducing three-phase current was that commutators could be entirely done away with, and in cases where slip-rings were necessary these could be effectually enclosed in a gas-tight box. Dealing with the magnitude of two of the three collieries, he pointed out that high-tension circuits were in use for transmission of power to what was known as the Bedwellty pits, some mile and a quarter distance. The foundations for the haulage gear and underground pumps had been specially constructed to meet the requirements of the South Wales collieries, as regarded the movement in the floors and walls due to squeeze and heave. It had been often put to electrical engineers at what distance from the boilers did it become better practice to adopt an electric motor in place of a steam-engine? This question had given rise to very many opposing views, but to the writer it did not seem a difficult matter to decide. In the first place, it was obvious that the cost of power would be greater per horse-power at the dynamo terminals than at the engine crankshaft, and if they could use a steam-engine of the same class and efficiency as they used for driving the dynamo, and the distance from the boiler did not cause great condensation in the steam-pipes, then it would not pay to put in a motor, which would require a dynamo to drive it, or, in other words, to add two links in their chain. Therefore, if the power required was about 100 h.p. or over, the factors which would decide whether an engine or a motor should be used would be the length of the steam-pipes and the class of load. If the load was intermittent, then the losses from condensation in the pipes bore a greater proportion to the horse-power developed than when the load was regular, and for this reason alone it was often advisable to put in a motor, which consumed no power when it was not running. The case of small engines was quite another matter. The average steam consumption of the best of them was not less than 60lb. to 70lb. of steam per indicated horse-power, and in most cases it was twice or even three times this amount. If these engines were scattered around the surface (the distance from the boilers need not be very great), the losses in condensation would be nearly as much as would keep the lot running at full load. To quote a case in point, the writer was asked to prepare a scheme for electric driving in a steelworks, and for this purpose he took some tests of the losses in condensation on nine small auxiliary engines, averaging about 10 h.p. each. The steam condensed in the pipes leading to these engines was measured, and found to be 3,604 gallons in 12 hours, and the coal used was 2¼ tons, which gave an evaporation of 8lb. of water per pound of coal. As the boilers were steaming easy, it was safe to say that in ordinary working the average evaporation was not more than 6lb. of steam per pound of coal, which was unwashed small. This meant that the coal used under ordinary conditions of working would be about 2 tons 14cwt. in 12 hours for condensation in pipes to these engines. One only need work this out for the year to see how much was likely to be saved by adopting electricity in such a case. Transmission of power by shafting was, in most cases, a very wasteful method, and they lost, maybe, anything from 15 to 77 per cent. The average was, perhaps, about 40 per cent. In one case in the writer's knowledge 15 h.p. was transmitted to a distance of 263ft. Two shafts, a reducing gear, and four belts were used, and from tests taken it was found that 8 h.p. was absorbed by shafting and belts. Of course, a motor in this case would soon pay for itself. Instances of this sort might be quoted by the dozen, but the writer believed that the economical advantages of electricity were fully realised by mining engineers generally. One other item might be mentioned, and that was the approximate cost of generating electric power. One saw some wonderful figures sometimes given as the cost of generation in some certain cases, but whether these included all the items which should be included it was difficult to say. In one or two installations with which the writer had been connected the costs had been carefully noted, and the units generated were registered by means of wattmeters, which, by the way, should be part of every installation. At a large steelworks in that district the power was generated by two high-speed direct-coupled engines and dynamos, each set being about 350 i.h.p., and one set was large enough to deal with the whole of the load, the other being kept as a stand-by. The average annual consumption was about 300,000 units, and the cost per Board of Trade unit, including coal, oil, waste, and stores, two stokers, two drivers, three arc lamps and motor attendants, one chief electrician, all arc lamp carbons and motor brushes, renewals of incandescent lamps, and all sundry materials connected with the actual use of electricity, for the past 18 months, had worked out at 1·01d. per Board of Trade unit. The cost of power at Pochin Pits, Tredegar, had been estimated at ·43d. per Board of Trade unit for an annual consumption of about 300,000 units per annum; this cost included all stokers', drivers', and electricians' time, and proportion of the chief mechanic's time for supervision. Another instance was Messrs. Dorman and Long steelworks, Middlesbrough, with which installation the writer was connected for some considerable time. Here the annual consumption was something like 2,000,000 units, and the cost per unit was ·224d. Cheap power, however, was not the only advantage of electricity; there were many others, such as higher output from machine tools when used in workshops, less wear and tear, and ease with which portable tools could be adopted. These and many other incidental advantages accrued from the use of electric power, and the writer ventured to think that before long even larger colliery installations than Tredegar would be seen in South Wales. During the past two years great activity had been displayed in England in the formation of large electric power companies dealing with extensive tracts of country, and covering, under their parliamentary powers, vast areas for the supply of electricity in bulk. In certain cases and under favourable conditions with regard to the district to be supplied the companies might meet with success, but this would greatly depend on the price at which they were prepared to supply power to the fairly large consumer. The cost at which these companies could supply would be largely dependent on the nature of the district, whether scattered or not, as it must be remembered electricity was not transmitted without loss, and the greater the distance between consumers the higher the price must be to make it profitable. For small works and factories requiring about 100 h.p. to 150 h.p., it would, no doubt, be found that power from a company at 1d. per unit would be more profitable than putting in a plant and generating it in the works. In cases such as these the companies should have a good field before them. The writer did not think, however, that a company could generate and supply large collieries, requiring, say, 300 h.p., cheaper than the collieries could generate it themselves. In conclusion, Mr. Scott said that it was only by discussion that they could arrive at some general standard for colliery work, and there seemed to be great room for something of the kind, and added that in the non-condensing station it was noticeable, in cases which he cited, that the generating sets were only half the size of those in the condensing station. All the engines were of the high-speed type, and these were in every way satisfactory under the severe conditions of continuous heavy loads. After five years' running the cylinder liners showed practically no wear. The individual

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motor system had been tried largely in America, but he was inclined to think that a combination of the two systems was likely to prove best in the long run—*i.e.*, to run all large tools, such as heavy planers, boring mills, and lathes by individual motors, and all the smaller tools in groups of five to eight, from a length of shafting, for which a 10-h.p. motor would usually be ample.

The discussion on the paper was adjourned to the next meeting.

Electricity as "The Motive Power of the Future."

An animated discussion took place on the views propounded by Mr. HORACE D. B. HOW, A.M.I.E.E., on "The Motive Power of the Future," which Mr. How declared would be "electricity."

Prof. A. C. ELLIOTT, D.Sc. (South Wales and Monmouthshire University College), recalled the fact that when it fell to his happy lot, 10 or 12 years ago, to devise an engineering laboratory at Cardiff he immediately resolved upon electrical driving—the first venture of the kind in the locality, though it was on a very small scale comparatively, and that for a satisfactory reason. But it did not satisfy him, for he was anxious for yet more substantial outcome, and he was now confident of realisation, for the antiquated things of the past had been superseded, and they had automatic tools that could be run up to their proper speed and kept at it for hours. He insisted on the importance of having sufficient regulation. He referred to tests of bare and armoured electric cables as bearing upon their safe adoption in fiery mines, and jocularly observed that it would seem that the word "armoured" exercised in these connections much the same distracting effect upon some minds as the word "Mesopotamia" did upon the famous old lady in the story.

Mr. STEWART (Abertillery) felt anxious to know what sort of engine Mr. How regarded as the one likely to be adopted in the future. They had heard a good deal of the remarkable engine that was about to be put down for the Metropolitan Company in connection with what was expected to be one of the largest installations in the country, and he had himself to do with an installation in which the engineer advised them also to put down an engine of the same class.

Mr. R. FORDAN (Newport, Mon.) did not conceive anyone would care to take a cable in the face of workings where the mine was considered dusty and fiery. But, on the other hand, he saw no objection to taking a cable to a colliery where one could without risk work with a safety lamp. He advised, with regard to the electric cabling of good haulage roads, that the fixings should be out of the way of trams, and, subject to such precautionary provision, he saw no more danger in carrying electricity over the main roads than in carrying ordinary colliery lamps. As to the use of high-speed engines, that was one of the most interesting issues in connection with the introduction of electricity underground. Colliery managers had no doubt been much in favour of slow-speed engines so far, but that was somewhat excusable, bearing in mind that they had been accustomed to them so many years; and again, it must not be forgotten that the mechanics at the coal-pits were not always as experienced as the men engaged on the staff of an engineering works. The great feat of engineering was not to repair an engine after it had broken down—anyone of them could do that—but to maintain the engine in fit and repaired condition as to obviate the harsher experience. High-speed engines would be difficult for the average man to understand for a little while, and that was where prejudice came in. But the difficulty would be in due time surmounted. He, personally, favoured the high-speed engines, for they could be utilised in a very small space, and there were other considerable advantages.

Mr. HOWE replied to the criticism at some length. He believed that some years hence their engineers would all, to a large extent, be electricians—the next generation of engineers would have to be "electrical" men, and he had compiled his paper in view of this fact, and because he thought that many of their engineers knew nothing at all about the subject. He had no hesitation in attributing the prejudice to high-speed engines at collieries to ignorance of them. But this was no "fault" of the engine itself. They had high-speed engines running all over the kingdom, and where collieries had not got proper men to look after them, why, for heaven's sake, get them. Efficiency was what they wanted. He strongly advocated turbines for collieries. As an electrical engineer, he would put down an armoured cable, polyphase machinery, and include switchgear to do any duty required in the most fiery mine in South Wales. Colliery engineers might not be so bold, but he was prepared to do what he said and work the thing for six months, and stay down himself, so confident was he in the feasibility of the proposal to apply electricity in mines. The fear of electricity arose from lack of knowledge of it. If colliery managers would say what they wanted, electrical engineers would do what was required. There was no problem in colliery work that he would be afraid to tackle, and he said this after having devoted a great deal of thought to the subject. There were heaps of places in South Wales where the application of electricity would mean saving the cost of the plant in about three years, and if the system was gradually applied at a works, he was confident that the whole of the pits would be equipped in five years. The maintenance cost was not high, and he summed up the contrastive advantages of electricity as a motive power as fourfold—viz.: in the transmission, high efficiency, reduced cost of attendance, and reduced wear and tear of machinery. Mr. Hugh Bramwell had pointed out that at several collieries in Westphalia winding engines were doing heavy work from depths up to 1,000 yards very successfully with electrical power, and had said also that he thought collieries in the future would be entirely equipped electrically. He (Mr. Howe) agreed with Mr. Bramwell, and predicted that in five years the present kind of winding engines would pretty well have died out in South Wales.

Other contributions were made to the discussion on the paper, Principal GRIFFITHS, of the South Wales College, having already expressed the belief that it was not beyond the resources of science to make arrangements by which the breaking of a cable would not yield a spark.

A vote of thanks was accorded to Mr. How for his paper, and the debate, it was understood, again stood adjourned. The other subjects dealt with were outside the scope of electrical reference.

CHESTER ELECTRICITY ACCOUNTS.

The total expenditure on capital account of the Chester Corporation electricity undertaking on March 25 last amounted to £105,924. Below we give abstracts of the accounts for the past year.

Dr. REVENUE ACCOUNT.	£	s.	d.
Coal or other fuel	1,637	5	9
Oil, engine-room stores, etc.	366	6	11
Wages at generating stations	1,097	14	9
Repairs and maintenance of generating plant, etc.	496	1	1
Repairs of transformers, etc.	257	2	4
Attending and repairs to public lamps	637	15	6
Renewals of lamps	620	4	11
Repairs of market lamps	16	6	2
Rents, rates, and taxes	480	14	0
Salaries—engineer's department	657	19	7
Stationery and printing	85	0	1
General establishment charges	276	1	10
Special charges—insurances, etc.	110	1	1
Total expenditure	6,738	14	0
Amount carried to net revenue account	6,699	8	5
Balance carried to next account	121	16	6
	£13,559	18	11

Cr.	£	s.	d.
Balance from last account	1	11	5
Sale of current per meter	9,286	17	0
Public lighting	3,824	10	4
Rental of meters	348	4	1
Sale and repairs of lamps	46	19	9
Sale and repairs of other apparatus	3	7	8
Repair and maintenance of market lamps	48	8	8
	£13,559	18	11

GENERAL BALANCE-SHEET.

Dr. Liabilities.	£	s.	d.
Capital account—stock outstanding	55,894	18	11
Loans on mortgages	40,924	0	0
Stock redeemed from sinking fund	9,105	1	1
Sundry creditors	2,417	12	0
Net revenue account—balance at credit	121	16	6
Sinking fund account, less amount taken out for redemption of stock (£8,964. 6s.)	2,222	9	6
Reserve fund account	6,080	9	0
	£116,766	7	0

Cr. Assets.	£	s.	d.
Capital account—amount expended for works	101,996	18	7
Stores on hand	344	17	9
Sundry debtors for current supplied	6,875	11	4
Securities held	3 896	11	6
Cash with treasurer	3,637	7	10
Cash in hand	15	0	0
	£116,766	7	0

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T. units		1,142,475
Quantity sold { Public lamps	349,348	
Quantity sold { Private consumers by meter	565,296	914,644
Quantity used on works		139,477
Total quantity accounted for		1,142,475
Total maximum supply demanded (kilowatts)		627

Number of public lamps: 173 arcs, 422 incandescents.

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ILFORD ELECTRICITY ACCOUNTS.

The accounts of the Ilford Urban District Council's electric lighting undertaking for the year ended March 31 last show that the total expenditure on capital account on that date amounted to £97,757. Below we give abstracts of the revenue account and general balance-sheet.

REVENUE ACCOUNT.

Expenditure.	£	s.	d.
Coal or other fuel	2,664	8	0
Oil, engine-room stores, etc.	316	17	6
Wages at generating station	661	19	6
Repairs and maintenance of generating plant, etc.	335	18	10
Repairs and renewals of mains	90	6	7
Repairs and renewals of transformers, meters, etc.	57	15	10
Repairs and renewals of apparatus	19	7	3
Attending and repairs to public lamps	548	15	1
Renewals of lamps	225	14	0
Rates and taxes	149	0	0
Insurance	94	11	0
Salaries—Engineer's department	541	10	6
Accountant and clerical staff	250	0	1
Stationery and printing	132	17	9
General establishment charges	339	17	9
Law and parliamentary charges	49	3	0
Private work	141	16	10
Insurances, etc.	34	6	2
Expenses for certification of meters	73	8	4
Total expenditure	6,727	14	1
Amount carried to net revenue account	5,420	17	2
Balance carried to next account to provide for bad debts	150	0	0
	£12,298	11	3

Cr. Income.	£	s.	d.
Sale of current per meter	7,265	15	8
Rental of meters, etc.	598	3	4
Public lighting	3,693	0	5
Trams department (current supplied)	209	16	2
Private work and miscellaneous	301	14	0
Stores in hand	230	1	8
	£12,298	11	3

GENERAL BALANCE-SHEET.

Liabilities.	£	s.	d.
Capital account	94,478	10	2
Sundry creditors	816	12	10
Balance at credit of net revenue account	104	14	6
Cash due to treasurer and engineer	3,478	16	2
	£98,878	13	9

Assets.	£	s.	d.
Capital account	72,019	0	0
Stores on hand	230	1	8
Sundry debtors	3,981	19	7
Other debtors	153	13	2
Cash with treasurer and in hand	22,493	19	4
	£98,878	13	9

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B. T. units			913,643
Quantity sold: Public lamps	337,932		
Quantity sold: Traction	22,613		
Quantity sold: Private consumers by meter	411,643		772,188
Quantity used on works			38,295
Total quantity accounted for			810,483
Quantity not accounted for			103,160
Total maximum supply demanded (kilowatts)			805

Number of public lamps: arcs, 44; incandescents, 807.

NOTTINGHAM ELECTRICITY ACCOUNTS.

In the accounts of the Nottingham Corporation electricity department for the year ended March 31 last, the total expenditure on capital account is given as £374,478. Abstracts of the revenue account and general balance-sheet are given herewith.

BALANCE-SHEET.

Liabilities.	£	s.	d.
Capital account	229,581	4	1
Consolidated stock (redeemable)	74,533	19	8
Sundry creditors	6,751	18	10
General district rate account	6,000	0	0
Amount set aside for redemption of consolidated stock	7,975	3	9
Consolidated stock purchased and cancelled	763	18	9
Repayment of loans account	21,426	0	0
Reserve fund account	15,480	18	11
Cash due to treasurer and in hand	45,518	12	8
	£408,031	16	8

Assets.	£	s.	d.
Capital expenditure	262,913	13	9
Tramway purposes	111,565	6	0
Stores in hand	2,696	3	9
Sundry debtors	22,881	9	5
Proportion of sinking fund investments	7,975	3	9
	£408,031	16	8

REVENUE ACCOUNT.

Dr. Expenditure.	£	s.	d.
Coal	10,854	10	2
Oil, waste, and water	2,219	7	10
Wages	3,655	3	2
Repairs and maintenance	2,273	0	8
Wages	289	11	0
Repairs, maintenance, etc., of mains	295	18	9
Public lamps, attending and repairs	164	7	4
Rents	1,418	13	0
Rates and taxes	4,120	15	3
Insurance	219	17	2
Salaries	2,305	4	6
Printing and stationery	112	14	9
Establishment and other charges	825	18	7
Law charges	2	0	0
Consolidated stock, management charges, etc.	95	6	1
	28,852	8	3
Bad debts	62	15	1
	28,915	3	4
Balance carried to net revenue account	31,695	14	7
	£60,610	17	11

Income.	£	s.	d.
Sale of current	58,047	3	1
Public lighting	1,287	6	6
Rental of meters	865	15	0
Public lamps, attending, and repairs	181	11	1
Connections to consumers' premises	110	9	3
Stores	9	12	0
Discounts	109	1	0
	£60,610	17	11

WOLVERHAMPTON ELECTRICITY ACCOUNTS.

Following is the abstract of the electricity supply revenue account of the Wolverhampton Corporation for the year ended March 31 last. The total expenditure on capital account on that date amounted to £156,998.

REVENUE ACCOUNT.

Dr. Expenditure.	£	s.	d.
Coal	3,300	18	4
Oil, engine-room stores, etc.	656	18	10
Wages at generating station	1,639	17	10
Repairs and maintenance of generating plant, etc.	965	12	8
Changing over system of distribution	637	8	4
Repairs and maintenance of mains	647	4	9
Attending, repairs, and carbons, public lamps	243	1	2
Rents	56	15	6
Rates and taxes	352	15	9
Salaries—Engineer's department	967	1	1
Accountant's staff (proportion)	50	0	0
Stationery, printing, etc.	131	6	1
Cost of management of Corporation redeemable stock	139	13	6
General establishment charges	137	12	2
Insurances	149	1	8
Bad debts	11	15	6
	10,087	3	2
Amount carried to net revenue account	11,060	3	0
Balance carried to next account	50	0	0
	£21,197	6	2

Cr. Income.	£	s.	d.
Balance from last account	50	0	0
Sale of current per meter	19,432	8	11
Public lighting—Street arc lamps	1,283	15	0
Incandescent lamps	54	14	1
Rental of motors	6	11	7
Rental of meters, etc.	320	15	1
Work executed on account of customers	49	1	6
	£21,197	6	2

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T. units			2,104,684
Quantity sold: Public lamps	85,765		
Quantity sold: Private consumers by meter and traction	1,538,874		1,624,639
Quantity used on works			182,512
Total quantity accounted for			1,807,151
Quantity not accounted for			297,533
Maximum load observed (kilowatts)			1,190
32-watt lamps connected			54,578

Number of public lamps: arcs, 53; incandescents, 22.

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NOTES.

Correspondence Instruction.—Elsewhere in this issue is a notice that instruction by letter in mechanical and electrical engineering can be obtained from Prof. Jamieson, Kelvinside. This class of instruction is of great value to those students, whether in the electrical or mechanical branches of the profession, who by reason of their employment are isolated from the usual means of instruction—such as the various classes held in the large owns in the United Kingdom.

The Motorcar Bill.—This Bill, which has now become law and will come into force the 1st of next year, can be viewed from two standpoints. The owners of motorcars look upon it as a failure in spite of the fact that the higher speed of 20 miles an hour is legalised on country roads. This higher speed, however, is accompanied with other restrictions which are irksome to the expert motorist. From the public point of view we think the Bill moves in the right direction, in that it will prevent undue harassing of motorcar owners by magistrates who lack judgment and are biassed. This Act also makes drivers responsible for any recklessness irrespective of the actual speed at which the car is going. In our opinion the Automobile Club has done more to prevent reckless driving than the new Act, and its plan of expelling from membership any who have been proved to drive at excessive speeds will have an excellent effect.

Wireless Telegraphy Conference.—This international conference, held at Berlin, has now concluded its labours, and it has received the thanks of the Imperial Secretary of State for the German Post Office, speaking for the Emperor. The results of the conference have been embodied in draft regulations for the control of wireless telegraphy, which will now be submitted to the various Governments represented at the conference. The conclusions of these regulations are to be treated as confidential, but it is asserted that they advocate the Government control of wireless telegraphy in all countries. The members attending the conference had every facility offered them by the German companies for seeing the German systems of wireless telegraphy. Another interesting experiment was one by Mr. Schmidt, who showed an instrument that enabled a station using one system to be attuned to the stations of any other system, so as to secure interchange of signals. In other words, he showed that he could interfere with the secrecy of any system now in commercial use. The final solution of the international question of wireless telegraphy has yet to be arrived at.

Electric Railways.—Colonel Mellor, speaking as chairman at the recent half-yearly meeting of the Metropolitan Railway Company, gave some interesting figures as to the advantages which that railway and its patrons would derive from the conversion of the system to electrical working. He spoke on the assumption that the line would carry some 50 million passengers per annum, and that each passenger would use the train for two journeys of 12 minutes per day. It then follows that by the reduction of the time required to run round the circle from 70 minutes, as at present, to 50 minutes by electric traction, the railway would save its passengers no less than the equivalent of 300,000 working days of 10 hours each per annum. The time so economised is valued at 3s. 4d. per day, and makes a saving of £50,000 to the travelling public. Quite apart from this, the increased speed would add 30 per cent. to the capacity of the line, of the rolling-stock, and of the permanent way. The chairman's estimates seem to us well within the mark, and we trust that the time will soon arrive when it can no longer be said that only those who must patronise the tunnels of the Metropolitan Railway Company.

New Annunciator System.—A new annunciator system has been designed by Mr. R. Dachsel, with the idea of reducing the number of circuits required, and which is described in the *Elektrotechnischer Anzeiger*. With the ordinary system each button requires one independent wire, though many may be grouped together on a common return. In the new arrangement two or more return circuits are used. The buttons are then grouped so that those having the same return circuit are connected to separate outgoing circuits, and those on the same outgoing circuits are connected to separate return circuits. Thus, supposing there are four buttons, four lines are required, two outgoing and two return. There is an annunciator drop in each circuit. Those on the outgoing circuits show numbers, those on the return showing colours. Thus, if button No. 1 is pressed, a drop falls showing two numbers, 1 and 2, on different coloured backgrounds. A second drop opens showing one colour, indicating that that number having the same coloured background as the second drop is the number of the button which has been pushed. The system here outlined is the simplest form, as a combination of three or more numbers to a drop, or three or more colours, enables a further saving of wire to be made.

Radium and Cancer.—Dr. Alexander Graham Bell has in a letter to Dr. Sowers, a physician of Washington, made a suggestion which may lead to good results. He said in the letter: "I understand from you that the Röntgen X-rays, and the rays emitted by radium, have been found to have a marked curative effect upon external cancers, but that the effects upon deep-seated cancers have not thus far proved satisfactory. It has occurred to me that one reason for the unsatisfactory nature of these latter experiments arises from the fact that the rays have been applied externally, thus having to pass through healthy tissues of various depths in order to reach the cancerous matter. The Crookes tube from which the Röntgen rays are emitted is, of course, too bulky to be admitted into the middle of a mass of cancer, but there is no reason why a tiny fragment of radium sealed up in a fine glass tube should not be inserted into the very heart of the cancer, thus acting directly upon the diseased material. Would it not be worth while making experiments along this line?" To this letter Dr. Sowers replied: "The suggestion which you make in regard to the application of the radium rays to the substance of deep-seated cancer I regard as very valuable. If such experiments should be made I have no doubt they would prove successful in many cases where we now have failures."

Motorcar Reliability Trial.—The fifth annual motorcar trials organised by the Automobile Club are to be held this year from Sept. 18 to 26, inclusive. The trials will be of reliability and not speed. Elaborate rules have been drawn up, whereby over 130 cars, each of which will be under the continuous observation of an official club observer, will cover 1,019 miles at slow touring speed. It will be the observer's duty to note every stoppage for repairs or adjustments, and even for filling the petrol tanks, so that an absolutely reliable report will be obtained as to the performance of the cars over that distance. Such a test should go far to prove to the public that designs which have been suggested and proved by recent races have been put into practical shape for ordinary touring purposes. In addition to considering ordinary reliability, a number of other points are to be taken note of in making the awards for these trials. Probably the one which will be the most appreciated by the British public is the award of marks for

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absence of dust raising. There is no doubt that this is one of the most serious objections, from the public point of view, to the more general use of cars, and the effect of these trials will be to draw the attention of the makers to this important question. The routes of the trials will extend from the Crystal Palace to various seaside places and back on the same day, so that a large number of people will have an opportunity of witnessing the performance of the cars during the trials. The places to be visited include Margate, Folkestone, Eastbourne, Bexhill, Brighton, Worthing, Southsea, and Winchester.

Radium.—Sir Oliver Lodge, writing to the *Times* under the date of Aug. 14, points out that "all the known properties of radium are consistent with the hypothesis that a rearrangement of parts is going on inside the atom, and that it is not a case of chemical action in the ordinary sense at all. There is no difficulty in accounting for the energy in this way." Incidentally, he mentions that he is struck with the dependence of the populace on "the daily Press for their scientific interest and information. In France it appears that many educated and professional persons have barely heard of the existence of radium, and the name of Mme. Curie means nothing to them. They are, indeed, in the position of English people in 1888-95 with respect to the discoveries of Hertz and his successors, a subject which the Press did not happen to take up until it was popularised by an application to telegraphy. In the equally important matter of radium, however, the British public have had their interest stimulated and have been kept well informed—largely through the agency of the *Times*." We quite agree with him in this last respect, that you cannot get a non-technical public to read the technical Press, but they will absorb a certain amount of scientific knowledge if it is mixed in with other information. Unfortunately, unlike the *Times*, some of our daily papers cannot be said to give scientific information in their columns. We mean that their science notes are too frequently incorrect and too often directly contributed by unscientific inventors, who have as little real knowledge on the subject on which they write as the editors who accept the copy.

Electro-chemical Industries.—A review of the progress made in electro-chemistry and electro-metallurgy will soon convince anyone that electricity is revolutionising certain of the chemical industries. It is to Niagara that one must look for the most advanced improvements in this direction, as the cheap power that can be obtained there is also accompanied with other local advantages such as are not enjoyed by those power undertakings in less highly-developed countries. Amongst the successes at Niagara is the manufacture of carborundum, which is displacing to a large extent other abrasive material. This is especially so in connection with the steel trade, and it is said that the steel industry alone takes 75 tons of carborundum per month. Aluminium is now manufactured wholly in electric furnaces, but the spread of the aluminium industry is not quite so fast as had been hoped. Its position as a successful competitor of copper has been threatened by the fall in the price of that metal. Another commercial undertaking at Niagara is the manufacture of phosphorus in an electrical furnace from phosphate mixtures. Artificial graphite, produced electrically, is a product which has now reached the commercial stage, and this graphite is now being manufactured in very large quantities. The return for 1901 showed a production of almost 1,000 tons, and the increase since then has been marked. In the electrolytic production of caustic alkalies and chlorine, the new industries have to face a widespread monopoly, but even here the electrical undertakings have reached commercial stages, although they produce but a very small percentage of the large total of these materials required. Other processes now in course of development promise wide fields for the use of cheap electrical energy, and also that electrical industries will in time replace the many more roundabout chemical processes used up to the present.

The British Association.—More information is now to hand as to the programme of the forthcoming meeting at Southport. The first general meeting will be held on Wednesday, Sept. 9, at 8.30 p.m. precisely, when Sir Norman Lockyer, K.C.B., F.R.S., president-elect, will assume the presidency, in succession to Prof. James Dewar, M.A., LL.D., D.Sc., F.R.S., and deliver an address. On Thursday evening, Sept. 10, at 8.30 p.m., there will be a *soirée*. On Friday evening, Sept. 11, at 8.30 p.m., a discourse on "Man as Artist and Sportsman in the Palæolithic Period" will be delivered by Robert Munro, M.A., M.D., LL.D., F.R.S.E. On Monday evening, Sept. 14, at 8.30 p.m., a discourse on "The Old Chalk Sea, and some of its Teachings" will be delivered by Dr. Arthur Rowe, F.G.S. On Tuesday evening, Sept. 15, at 8.30 p.m., there will be a *soirée*. On Wednesday, Sept. 16, the concluding general meeting will be held at 2.30 p.m. A good programme of excursions has been arranged, and these will, if the weather is propitious, be much enjoyed by those present. This year the presidents of the various sections are as follows: for Section A, which deals with mathematics and general science, Mr. Charles Vernon Boys, F.R.S.; Section B, dealing with chemistry, Prof. Walter Noel Hartley, D.Sc., F.R.S.L. and E.; Section C, on geology, Prof. William W. Watts, M.A.; Section D, on zoology, Prof. Sydney J. Hickson, M.A., D.Sc., F.R.S.; Section E, which takes geography, Captain Ettrick W. Creak, C.B., R.N., F.R.S.; Section F, dealing with economic science and statistics, Mr. Edward W. Brarrook, C.B.; Section G, on engineering, Mr. Charles Hawkesley, M.I.C.E.; Section H, on anthropology, Prof. Johnson Symington, M.D., F.R.S., F.R.S.E.; Section K, which has botany for its subject, Mr. Albert Charles Seward, M.A., F.R.S.; and Section L, dealing with educational science, Sir William de W. Abney, K.C.B., D.C.L., F.R.S.

The Paris Disaster.—The lamentable disaster on the Paris Metropolitan Railway, to which we referred in our last issue, may or may not be looked upon as due to electricity, according to the care which is taken to examine the information at hand. We notice that the engineer of the line took the same view of the matter that we did—*i.e.*, that the disaster was caused by the officials who ordered the burning train to be pushed forward along the line into a tunnel, instead of shunting it on to sidings in the open air provided for the very purpose of housing disabled trains. To the editor of the *Lancet* the other point commends itself. He is always great on short-circuits, and in the present instance writes on "the fearful results that might arise through a diversion of the electric potentials on electric railways." The editor is so far wide of the truth that he concludes, "There is little doubt, therefore, that the defective motor was the cause of a disastrous short-circuit, with the result that the train and the succeeding trains caught fire in the tunnel." The evidence is clear that the train was on fire before it entered the tunnel, and that the loss of life was due practically to the spreading of the fire along the train by its motion through the air. As we wrote after the Liverpool affair we would again write: that electric traction is, *per se*, more safe than any older means of locomotion. It seems likely that there may be considerable friction between the municipal authorities of the city of Paris and the Metropolitan Company over the recent disaster. In the first instance,

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the tunnels were constructed by the city, we believe, to the designs prepared by the advisers of the city, and the Metropolitan Company was only responsible for the electrical installation and for the capital charges incurred by the municipality. The question, then, as to whether the tunnels are properly constructed with sufficient air ventilation and air shafts, is one which lends itself to litigation between the two parties as to which is mainly responsible for the recent regrettable loss of life.

Radium Researches.—Investigations on the behaviour of the emanations from radium are being carried on by a large number of expert scientists. The advantage of the independent investigations thus being carried out, together with the mutual discussion of the results obtained, should do much to clear up the mysteries of these emanations and the peculiar properties of radium. A *brochure* just issued from the *Proceedings* of the Royal Society contains four important papers on this subject. Amongst the contributors of these papers are Lady Huggins, Miss Willcox (of Newnham College), Sir William Ramsay, and Mr. Soddy. The first named, in conjunction with her husband, Sir William Huggins, endeavoured to obtain the spectrum of the spontaneous and luminous radiation from radium at ordinary temperatures. A preliminary prismatic examination of the glow from pure radium bromide was made by eye, when a very faint spectrum was noticed. Photography was then invoked in order to obtain, if possible, a record of the blue, violet, and ultra-violet regions of the spectrum. Ultimately, with an exposure of 72 hours, a negative was obtained, consisting of eight bright lines and at least eight faint lines, together with a misty trace of continuous spectrum in the blue region. The final result, so the authors say, has shown, quite unexpectedly, that the seven strongest lines in the new spectrum agree not only in position, but also in relative intensity and character, with bands of the spectrum of nitrogen, and, further, that nearly the whole of the ultra-violet radiations appear to come from nitrogen. Additional photographs are, however, to be taken with a longer exposure, when "it may be that indications of helium, and possibly of radium itself, may be forthcoming." The last two named experimenters investigated the connection between the radium emanations and helium. They affirm that from spectrum analyses the helium always accompanies the radium emanations. The characteristic lines have been observed, identical in position with those of a helium tube thrown into the field of vision at the same time. Sir William and his co-experimenters extract the emanations by the aid of a special pump, and deal with it as they would a gas, condense it in a U-shaped tube, surrounded by liquid air—a cold of about 190deg. C.—and even "wash" it with another gas, while the passage of emanation from place to place through glass tubes can be followed by the eye in a darkened room. The communications which are supplementary to these papers include one by Mr. W. B. Hardy and Miss Willcock, referring to the influence of the rays from radium upon chemical change, and other actions. Tubes containing a solution of iodoform in chlorophyll were enclosed in a box of black cardboard, and they remained unchanged for 60 hours. On placing the box over radium bromide the tubes became purple in about 10 minutes. Further instances of chemical decomposition are given. Lastly, there is a paper by the Hon. R. J. Strutt, a son of Lord Rayleigh, on the most penetrating rays of radium. Altogether, some notable advances are indicated by these authors in their respective departments.

Variable Speed Control.—Mr. Wm. Cooper read a valuable paper before the recent Chicago convention of the National Electric Light Association, in which he compared the relative advantages of electrical and mechanical methods of variable speed control for general power purposes. The conclusion he arrives at are instructive, and in the following we abstract some of the most important. In the first place, in the installation of a new manufacturing plant in which machinery will be used that will require to be used at varying speeds, the methods employed should be considered in about the following order: first, what system will assist in yielding a maximum output from the machinery installed; second, the comparative costs of the different methods installed. Usually, in the consideration of the advisability of installing any certain method of operation, the questions are put in the reverse order to that given above, the question of cost being wrongly placed before that of output. Great care should be exercised in the selection of motors for different machines to determine whether the horse-power required is practically constant or varies with the speed. In most machines of a reciprocating action—slotters, shapers, planers, etc.—the power required varies with the speed, as the power is consumed in the reversals of the machines, and not in the actual work being done. In cases of this kind, the motor will be called upon to do its maximum work at the maximum speed of the machine, while in the case of machines in which the work performed is constant, irrespective of the actual speed of the machine itself, the power required to drive it will be practically constant throughout the entire range of variation. In machine-shop tools, such as lathes, boring mills, milling machines, etc., this condition exists. When the range of different voltages impressed upon the armature of the motor, and the range through which its speed is changed by changing the amount of magnetism in its field, are properly apportioned, the minimum sized motor for a given total speed variation is obtained. To get the minimum speed we must use some other method than field control, because the field is already up to its maximum strength, and we therefore introduce a lower voltage. The ratio that this lower voltage bears to the normal voltage is the same as that which the lower speed bears to the normal speed. By the combination of multi-voltage and field control we are able to use the minimum size of motor for the given work. In conclusion, the author presents the following few simple rules for use in determining the relative size of motors for constant horse-power application: (1) the total range of speed, using both variable voltage and field regulation, will be as the square of the range of voltages; (2) the change in horse-power will be directly proportional to change of voltage impressed on the armature, the field being constant; (3) the change in horse-power by change of field strength will be inversely proportional to the change in speed, the voltage on the armature remaining constant; (4) the relative size of the motor, as referred to the maximum speed, will be directly proportioual to its speed variation, when using variable voltages; (5) the relative size of the motor, as referred to the maximum speed, will be as the square of the speed variation when using field regulation.

Electric Batteries with One and Two Electrolytes.—In a paper on the above subject recently read before the French Academy of Sciences, Berthelot discusses the general relations existing between the E.M.F.'s of the various elements with equal or different electrodes and electrolytes. These relations may either be of a general character, being a consequence of the general laws of electricity, or else constitute special laws established on more or less sure hypotheses, and requiring confirmation

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by experiment. The results recorded in the present paper are relative to measurements made after the equilibrium corresponding to normal initial conditions was established—*i.e.*, before any noticeable disturbing phenomena due either to polarisation, or to an alteration of the metals; or, finally, to a progressive mixture of the electrolytes through the partition wall of porous vessels had occurred. The author first discusses elements made up of a single electrolyte, two different electrodes and two wires of the metal of one of the electrodes. Berthelot confirms for the case of several elements, the electrodes of which (M, M′, M″) consisted of zinc, copper, and platinum respectively, and where the electrolyte was a solution of the different salts, acids, or mixtures of both, the relation

$$E_1 + E_2 = E_3,$$

as derived from the equations

$$E_1 = M \mid A + A \mid M' + M' \mid M,$$
$$E_2 = M' \mid A + A \mid M'' + M'' \mid M',$$
$$E_3 = M \mid A + A \mid M'' + M'' \mid M.$$

This formula, deduced in virtue of Volta's law, is confirmed in the case of the following substances: H_2SO_4, KCl, H_3BO_3, $ZnCl_2$, $2KCl + Na_2A_4S_2$, $2NaCl + K_2SO_4$, $2NaCl + ZnSO_4$. As regards elements with two electrolytes A and B, there may be formed nine different elements from three different electrodes, three having equal and six different electrodes. Now it may be seen that

$$\text{E.M.F. (M A B M')} + \text{E.M.F. (M' A B M)} =$$
$$= \text{E.M.F. (M A B M)} + \text{E.M.F. (M' A B M')},$$

corresponding additional relations being deduced in a similar way. The whole of Berthelot's experiments shows these laws to be true.

Hull Telephones.—It will be remembered that the fight between the Corporation and the National Telephone Company at Hull, has by no means been confined to the ordinary scope of competition. The Corporation had an agreement with the company with regard to wayleaves which they could terminate, and this has placed them in a better position when arranging for intercommunication between the Corporation exchange and the National system. As a result of lawsuits and lengthened negotiations the following agreement has been accepted by both parties—*i.e.*, "That in consideration of the National Telephone Company withdrawing their appeal and agreeing to mutual free intercommunication between their subscribers in the Hull area and those who may join the Corporation system, and also mutual intercommunication between the latter and the subscribers of the company in other towns through the trunk wires of the Postmaster-General without any terminal or other charges being made by either the company or the Corporation, the Corporation shall continue present and future underground wayleaves to the company until the expiration of the company's licence in 1911, on the terms of the agreement of March 18, 1899, except that the payments under such agreement shall be reduced by one-half as from March 18 next, the cost of the necessary junction lines to be borne equally by the company and the Corporation." We are of opinion that as the result of our discussion with the representatives of the company that, in the event of the Corporation not entering into competition at present, an alternative proposal could be effected on the following basis: (1) The company to forthwith introduce (in addition to the existing party lines and other services) a measured service tariff on the following scale: £5 to cover 600 calls per annum; £6, 1,000; £7, 1,600; £8, 2,100; £9, 2,600, all inward calls to be free, and excess local calls to be charged for at the rate of 1d. per call. (2) The unlimited rates to remain as at present; and (3) the company to pay for the underground wayleaves the full charges mentioned in the agreement of March 18, 1899. In spite of this agreement, we believe there is to be considerable opposition at the forthcoming enquiry over the municipal loan for telephone purposes.

Atmospheric Electricity.—In a recent report of the United States Weather Bureau some interesting experiments are described which had for their object the determination of the normal distribution of electrification in the atmosphere. The investigators have used, like Franklin, a special kite as a means of determining the electrification of different strata in air. The cord which held the kite was wound spirally with a fine copper wire attached to an electrometer, so that, by the usual optical methods, accurate readings of the electric intensity at any height could be obtained. The most notable results recorded are that the higher regions of the atmosphere—viz., from 7,600ft. to 12,300ft. above sea-level—are always in an electrified condition, and that the electric intensity is very greatly increased during showers or thunderstorms. In perfectly calm weather the needle of the instrument moved forward or backward as the kite rose or fell in the air, showing that the electric intensity varied with the altitude. A detailed account of the electrical state of the atmosphere during a storm is given. Under such conditions a torrent of sparks could be drawn from the conducting wire, but the current was not enough to light up an incandescent lamp of 105 volts. In other experiments the water-dropping collector was used, especially in investigating the distribution during a thunderstorm. Here, at one moment, the electrometer would show that the atmosphere had a strong positive electrification; this would increase until a flash of lightning occurred, when the needle would oscillate violently, finally showing a strongly negative condition. The intensity of electrification at any one point during a storm depends upon its distance from the storm area. The constant existence of some electrical condition in the atmosphere lends interest to enquiries as to the extent of the earth's electric field. Investigations at the highest altitudes it is at present possible to reach seem to show that the upper limit is in the area between 10,000ft. and 15,000ft. above sea-level. Above this area the electric potential may be regarded as constant. The cause of this phenomenon has not yet been satisfactorily elucidated, and various theories have been brought forward to account for it. These all agree in regarding friction between particles of the same or different materials, such as water and air or water and ice, as the initial cause. These researches seem to indicate that the impact of rain on the surface of a lake or sea, or even the wind blowing on these surfaces, produce electricity, which may be the initial cause of thunderstorms.

Three-Phase Transmission Systems.—The recent paper read by Mr. Blackwell before the Niagara Convention of the American Institution of Electrical Engineers had for its subject the consideration of various systems of multiphase transmission mains and the question of earthing various portions of the same. In the course of the discussion, Mr. Peck showed that the added responsibility of earthing is mainly concerned with the voltage distortions which result from the short-circuiting of transformers by grounding or otherwise. The effect of the distortion thus superinduced may be great enough to more than double the voltage across certain of the lines under certain conditions and with certain connections. To catalogue the conditions and their effects would be to cite bodily Mr. Peck's tables, to which reference should be made for particulars.

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Some things, however, are worth noting. Either pure star, grounded generator and all, or pure mesh connections are safe enough from abnormal voltages. Of the mixed systems in common use, most are somewhat liable to the chance of getting abnormally high voltages on some part of the circuit, of which the chance of a short-circuit on a raising transformer is the most likely cause. With one branch of a raising mesh out there is a beautiful chance for trouble ahead. The moral is that the high-voltage transformers must be kept out of mischief by particular care. In ordinary practical operation the crippling of a raising or reducing transformer puts the circuit so thoroughly out of business that the distribution of voltages becomes a matter of secondary importance anyhow. Any system of operation which saves copper is liable to serious derangement of the voltages in its respective parts, and in using such a system, whether the common three-wire or some strange and complex polyphase system, it ought to be distinctly understood that one has to pay a reasonable price in care for the saving in cost of conductors. In the early days of the three phase system it was a constant source of joy to the unregenerate to see the continuous-current contingent, whose daily food was balancing and boosting, howling about the dreadful result of unbalanced load on a three-phase system. It is doubtless true that with the feeder drop common in direct-current practice, a three-phase distribution would be in a bad way; but this is all ancient history now, and we recur to the grounding question. Our contemporary, the *Electrical World*, adds: "In our opinion, considered merely as a safety precaution, the grounded neutral is decidedly to be recommended. It unquestionably requires a little more care than an ungrounded system, but it reduces the main risks very materially. Incidentally, it allows the safe use of working transmission voltages which otherwise would have to be classed as somewhat hazardous. What is more, those plants which have adopted the plan find that it causes far less inconvenience than they were prepared to meet. Whether a system should employ a star system which permits grounding is a question to be decided on its merits. Where a large secondary distribution is to be attempted, the saving in copper by using a star with neutral is so great that it will commonly be used whatever the connections back of it may be; and these latter connections should certainly be considered in the light of such possibilities as Mr. Peck has described. But in many cases the connection can be chosen without reference to any extended network, and the choice will generally fall on one of the mixed systems. Pure mesh connection in large plants has fallen into partial disuse, and the advantage, of which much was once made, in using two of the transformers to form a resultant mesh, has been proved to be of very little moment. Few who have tried it on a large scale would care to repeat the experiment, and on the scale of most recent plants the gain in using two transformers instead of three is negligible. At present the whole question is largely a matter of convenience."

Evaporation of Metals. — In the issue of the Chemical Society's *Journal* for the current month will be found a long abstract of a paper by Mr. F. Krafft on "The Evaporation and Boiling of Metals in Quartz-Glass and in the Electric Oven in the Vacuum of the Cathode Light." The observation that many substances boil quite regularly and at a definite temperature under the pressure of a column of their own vapour only in the vacuum of the cathode light, can be extended to metals by using suitable apparatus. For this purpose quartz vessels are invaluable, as they can be taken out from an electric furnace at 600deg. or 1,200deg., allowed to cool, and put straight back again without breaking, even when they contain metal; neither do they crack at the point at which the tube emerges from the furnace. They can be readily used for temperatures up to 1,200deg., and, with care, even at 1,200deg. to 1,400deg. Tight joints can readily be made which will maintain the cathode light vacuum, but as the vessels are attacked by oxides it is advisable to admit carbon dioxide or nitrogen rather than air when the vacuum is no longer needed. The use of an electric furnace is not only convenient, allowing as it does of a rapid and exact regulation of the temperature within 2deg. or 3deg. over a range from 14deg. to 1,400deg., but is, in fact, almost essential, as the quartz vessels do not project far from the furnace, and it is necessary that the wax which is used to make tight the joint should not be melted, as would inevitably be the case with any of the ordinary types of furnace. In the vacuum of the cathode light, zinc sublimes so rapidly, even at 300deg., that the upper part of the vessel becomes covered with an opaque layer of metal in the course of a few seconds; actual boiling occurs when the temperature outside the tube is about 640deg., and the process is very rapid, 5 grm. being distilled in 30 minutes. In a large apparatus it should be possible to distil a kilogramme of zinc at constant temperature and in quite a short time. Cadmium begins to sublime at 322deg, and boils when the temperature of the oven is 474deg. Selenium distils quickly at 380deg., whilst tellurium begins to sublime at 430deg, and boils at 555deg. Lead begins to evaporate at about 1,000deg., and at 1,180deg. (temperature of oven) boils vigorously. Tin is much less volatile and does not show any sign of evaporating at 1,100deg. Antimony evaporates freely at 670deg., and rapidly distils at 775deg. to 780deg. Bismuth begins to evaporate at 540deg. and boils at 1,045deg. to 1,050deg. Silver evaporates very rapidly near its melting point, but does not boil at 1,229deg.—the highest temperature of the experiment; a second experiment showed a very rapid evaporation at 1,340deg., but no boiling. Copper evaporates at about 1,300deg., but probably would not boil below 1,500deg. or 1,600deg. Gold is even less volatile than copper, and shows only a slight evaporation at 1,375deg.; it might boil at about 1,800deg. It is notable that the boiling points are in the order of the valencies, and not of the atomic weights of the metals. The actual temperatures at which the metals boil depends on the temperature of the oven and also on the height of the vapour column, which can be easily varied by raising or lowering the distilling tube in the furnace, since complete condensation takes place immediately outside the furnace. The boiling point of cadmium under a 6cm. column of vapour rose from 424deg. to 450deg. as the temperature of the oven was raised from 462deg. to 540deg., under a 9cm. to 10cm. vapour column from 435deg. to 480deg. (oven temperature 488deg. to 583deg.), and under a 13cm. to 14cm. column from 430deg. to 474deg. (oven 485deg. to 589deg.); the boiling point thus rises regularly with the height of the vapour column, but only rises relatively slightly when the temperature of the oven is raised considerably. With the oven temperature at 714deg., zinc boils at 545deg. under a vapour column of 60mm., at 553deg. under 100mm. of vapour, and at 560deg. under 135mm. of vapour. With a furnace temperature of about 1,100deg., bismuth boils at 994deg. under 60mm., at 1,014deg. under 90mm., and at 1,045deg. under 135mm. of vapour. Antimony under a short vapour column boils at 735deg. (oven 778deg. to 780deg.). Under a short vapour column, lead boils at 1,140deg. to 1,142deg. (oven 1,226deg.), under 45mm. of vapour at 1,172deg. to 1,173deg. (oven 1,225deg.).

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LONDON UNITED ELECTRIC TRAMWAYS.

BY B. PONTIFEX.

The enormous development of the tramways in the West of London since the adoption of electric traction is very well set forth by a list of the sections open to traffic, those authorised and under construction, and the proposed extensions, together with their many connections with other railway and tramway systems, now either in actual operation or under construction.

Sections of the London United Electric Tramways Open for Traffic.—Shepherd's Bush to Southall; Shepherd's Bush to Hounslow; Shepherd's Bush to Twickenham, Hampton, and Hampton Court Palace; Hammersmith Broadway to Hounslow; Hammersmith to Twickenham, Hampton, and Hampton Court Palace; Richmond Bridge to Twickenham, Teddington, Kingston Bridge, and Hampton Court Palace; and Kew Bridge to Richmond.

Authorised Extensions.—Acton to Willesden; Southall to Uxbridge; Hammersmith to East Acton; Richmond to Hammersmith Bridge, *vid* Barnes and Mortlake; Hounslow to Cranford; Hounslow to Kempton Park; Twickenham to Kempton Park; Hampton to Molesey, Thames Ditton, Surbiton, Talworth, and Hook; Kingston to Surbiton; Kingston to Kingston-hill; and Kingston to Tooting, *via* New Malden, Raynes Park, and Wimbledon.

Proposed Extensions.—Cranford to Slough and Maidenhead; and Hounslow to Staines and Virginia Water.

That the above systems will be of the greatest use in opening up the districts through which they pass is clearly shown by the following tables of fares and distances covered by the London United and their business allies, the Metropolitan District Railway, and compared with those of opposition routes; the average fare per mile, as shown in the tables below, being 0·4d. against 0·76d., with the average mileage per 1d. at 2·29 miles as against 1·33 miles. The map (Fig. 1) also shows the special facilities for intercommunication between the London United Electric Tramways and the various branches of the District Railway and the allied "tube" railways, by means of which direct communication will be established between different suburban districts which at present are only served by roundabout routes.

The site of the central power-house at Chiswick, together with those of the sub-stations and car depôts at Fulwell, Hounslow, Hanwell, and Acton, are indicated by the

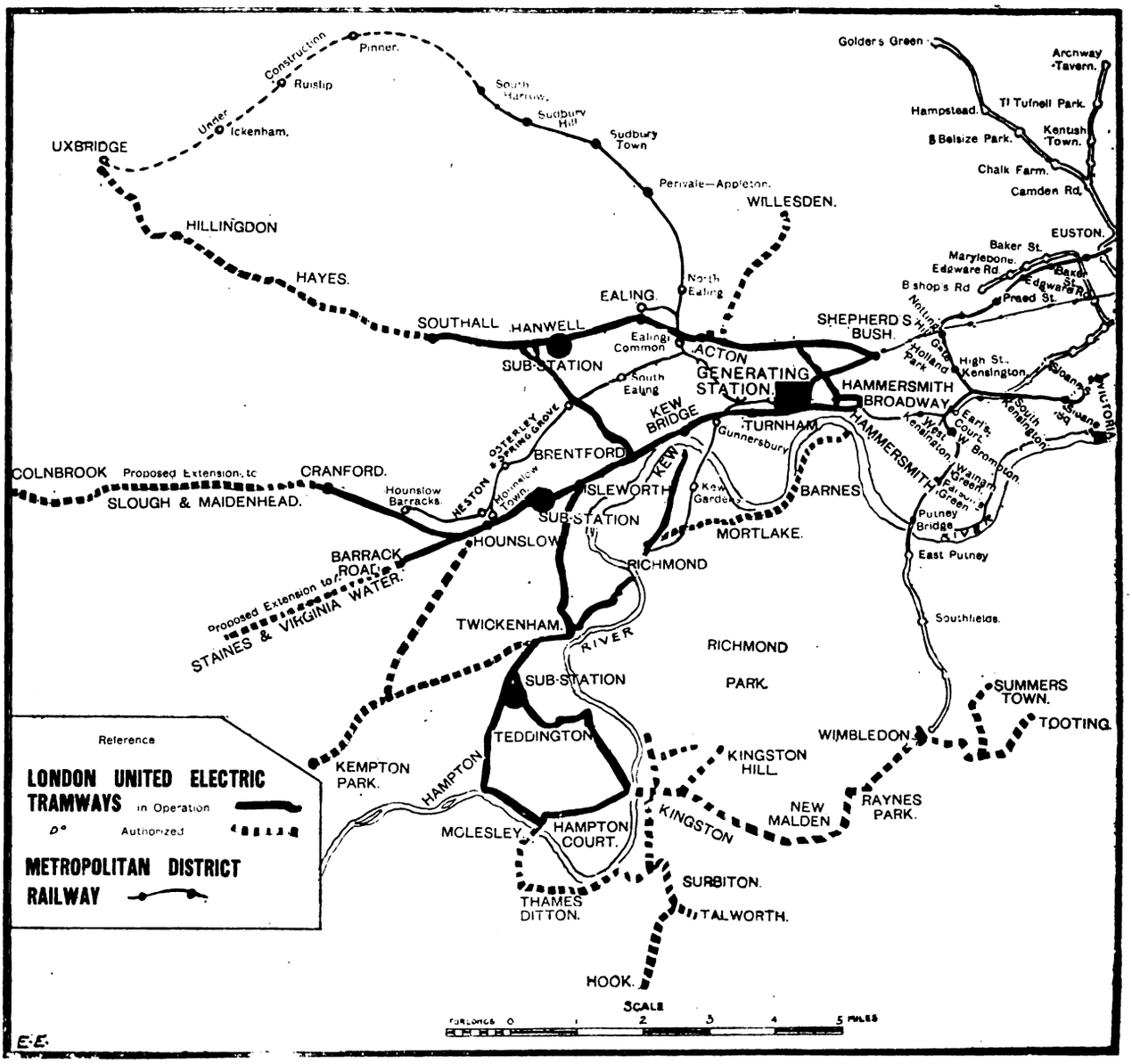

FIG. 1. Map of the Tramway System of the London United Tramways Company.

small black squares and circles. Their equipments will be described in detail, but the following list of the size and capacity of each will give a good idea of the amount of traffic handled by these lines:

	Cars.	Converters. Number.	Converters. Size.
Acton car-shed	30	—	—
Hanwell car-shed	70	3	300 kw.
Hounslow ,,	50	2	300 kw.
Fulwell ,,	200	3	500 kw.
Chiswick ,,	75	1	500 kw.
Chiswick power station			3,500 kw.-4,000 kw.

The plant at Chiswick power-house (Figs. 2, 3, and 4) is arranged in the following manner.

BOILER-HOUSE.

There are 11 Babcock and Wilcox boilers in one row

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COMPARATIVE TABLE OF FARES AND DISTANCES.

Either way between City (Aldgate) and	Tramway to Hammersmith.			Tramway and District Railway to City (Aldgate Met.).			Competing railway fares from various points to City.		
	Distance. Miles.	Fare.	Average fare per mile.	Distance. Miles.	Fare.	Average fare per mile.	Distance. Miles.	Fare.	Average fare per mile.
Uxbridge	13·49	6d.	·44d.	21·24	9d.	·42d.	20·77	1s. 6d.	·86d.
Hillingdon	11·37	5d.	·44d.	19·12	8d.	·42d.	18·53	1s. 4d.	·86d.
Sunbury	10·63	6d.	·56d.	18·38	9d.	·49d.	17·83	1s. 6d.	1·01d.
Cranford	8·50	5d.	·59d.	16·25	8d.	·49d.	16·18	8½d.	·52d.
Hounslow (Barrack-road)	7·52	4d.	·53d.	15·27	7d.	·46d.	16·18	8½d.	·52d.
Southall	7·30	3d.	·41d.	15·05	6d.	·40d.	14·27	9d.	·63d.
Hampton Court	10·85	6d.	·55d.	18·60	9d.	·48d.	16·57	1s. 4½d.	1·00d.
Teddington	9·20	5d.	·54d.	16·95	8d.	·47d.	15·07	1s. 2d.	·93d.
Hanwell (Broadway)	5·62	2d.	·35d.	13·37	5d.	·38d.	12·77	7d.	·55d.
Twickenham	6·87	4d.	·58d.	14·62	7d.	·48d.	12·83	1s. 1d.	1·01d.
Isleworth (Busch Corner	4·50	3d.	·66d.	12·25	6d.	·49d.	13·15	1s.	·91d.
Surbiton Station	12·80	6d.	·47d.	20·55	9d.	·44d.	13·57	1s. 2d.	1·03d.
Kingston Bridge	11·46	5d.	·44d.	19·21	8d.	·41d.	13·57	1s. 2d.	1·03d.
Brentford (Half Acre)	3·79	2d.	·53d.	11·54	5d.	·43d.	11·67	10d.	·86d.
Richmond	4·66	3d.	·64d.	12·42	6d.	·48d.	12·45	11d.	·88d.
Ealing Broadway	4·12	2d.	·49d.	11·87	5d.	·42d.	12·03	8d.	·66d.
Kew Bridge	2·75	2d.	·73d.	10·50	5d.	·50d.	10·68	10d.	·94d.
Acton	3·24	1d.	·31d.	10·99	4d.	·36d.	10·42	7d.	·67d.
Turnham Green	1·75	1d.	·57d.	9·50	4d.	·42d.	9·03	8d.	·89d.
Hammersmith	—	—	—	7·75	3d.	·40d.	7·70	3d.	·39d.
Maximum length of journey..	13·49 miles			21·24 miles			20·77 miles		
Average fare per mile	·49d.			·44d.			·76d.		
Average mileage per penny...	2·02 miles			2·29 miles			1·33 miles		

The table shows the maximum journey obtainable, but the average fare per mile and average mileage per penny given is that of the whole of the journeys combined.

The sections of the Metropolitan Railway shown on the diagram are the northern half of the Inner Circle and the section under construction from South Harrow to Uxbridge, over which the District Railway has running powers.

down the boiler-house, each capable of evaporating 11,000lb. per hour. Ten are fitted with two furnaces, but the last boiler has only one, though the grate area is the same—namely, 60 square feet—a result that is obtained by doing away with the dividing wall between the furnaces and proportionately decreasing the over-all width of the boiler. Each boiler has 140 4in. tubes with wrought-steel headers, two water-drums, and a cross steam-drum. They are all fitted with the Hopkinson water alarm, which acts both at high and low water level Stoking is carried out by means of Vicars's mechanical stokers, the gear for which is driven by two 10-h.p. electric motors through worm gear, one motor at each end of the boiler-house. All the coal is delivered to the stokers from overhead bunkers, and is raised by an electrically-driven Hunt conveyor, which is also used to remove ashes on the lower half of the run. The coal for each boiler is automatically weighed before falling into the stoker hoppers (Fig. 5). The fire-bars are cooled by means of fine steam jets playing on both the back and front of each grate. The burnt gases pass into an overhead brick-lined steel flue with a Green's economiser of 340 4¼in. tubes, fitted with motor-driven scrapers. Contrary to the usual practice, the flue does not lead into the chimney at the ground level, but at a height of 40ft. above it. This enables the draught to be more thoroughly checked by the economiser tubes, and avoid the sometimes heard complaint that economisers require more forced draught or a taller chimney. The chimney itself is of steel, lined with firebrick for three-quarters of its height, and reaches a height of 260ft. The feed water is softened by the Archbutt-Deeley process, and is delivered to the boilers by three-throw Blake-Knowles feed pumps. The working pressure is 160lb. per square inch,

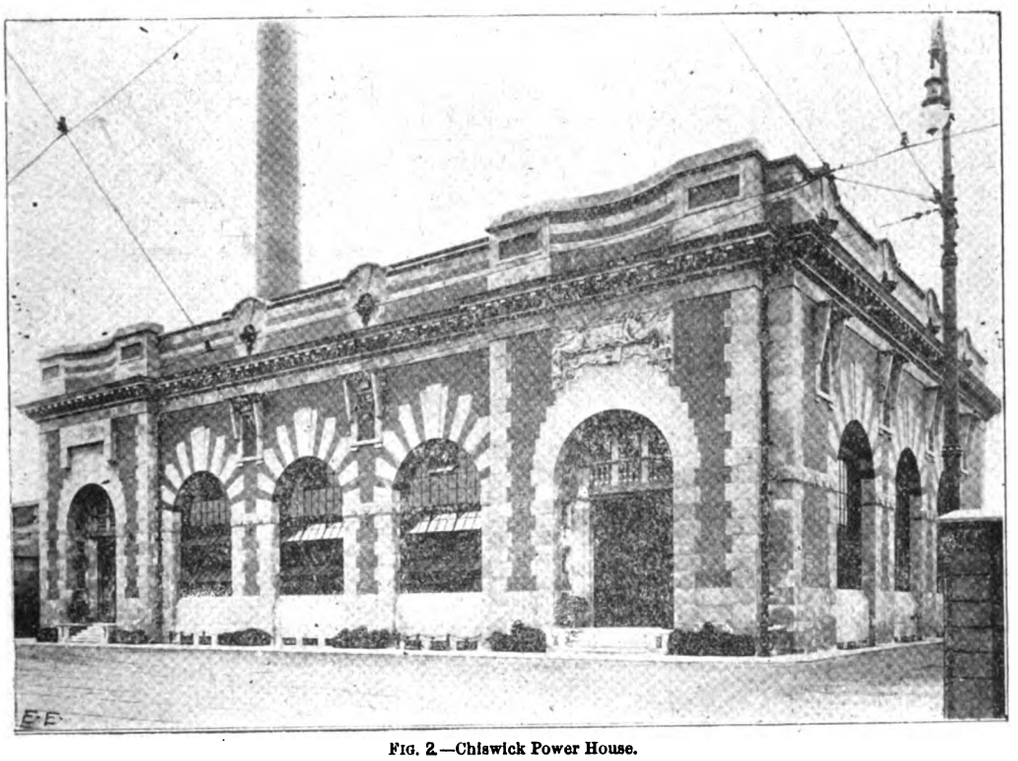

FIG. 2.—Chiswick Power House.

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ENGINE-HOUSE.

Generating Plant.—(*a*) Two Allis vertical cross-compound engines (Fig. 6) are each coupled to two 250-kw. G.E. traction generators, arranged one on each side of the flywheel, so that each set is really a 500-kw. generator. The engines are fitted with the Reynolds-Corliss valve gear with pneumatic dashpots; the cut-off on both high and low pressure cylinders is controlled by a belt-driven governor. There is also a supplementary governor which at six revolutions per minute above the normal releases a weight by means of a trigger catch, and so works a throttle valve which shuts steam completely off the engine. The diameter of the high-pressure cylinder is 22in. and the clearance 2 per cent., and of the low-pressure cylinder 44in. and 4 per cent. The length of stroke is 42in., and the engines run at 90 revolutions per minute. The valves,

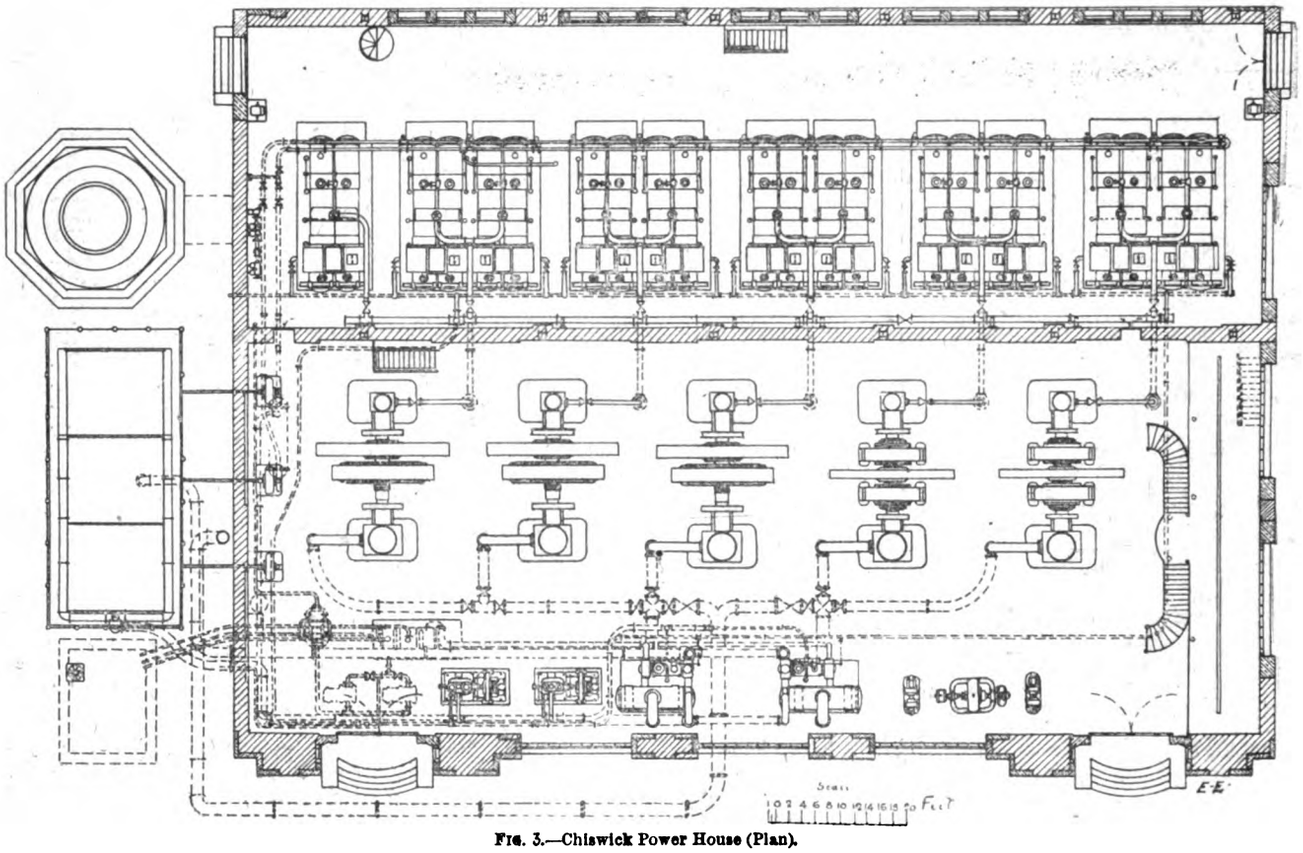

FIG. 3.—Chiswick Power House (Plan).

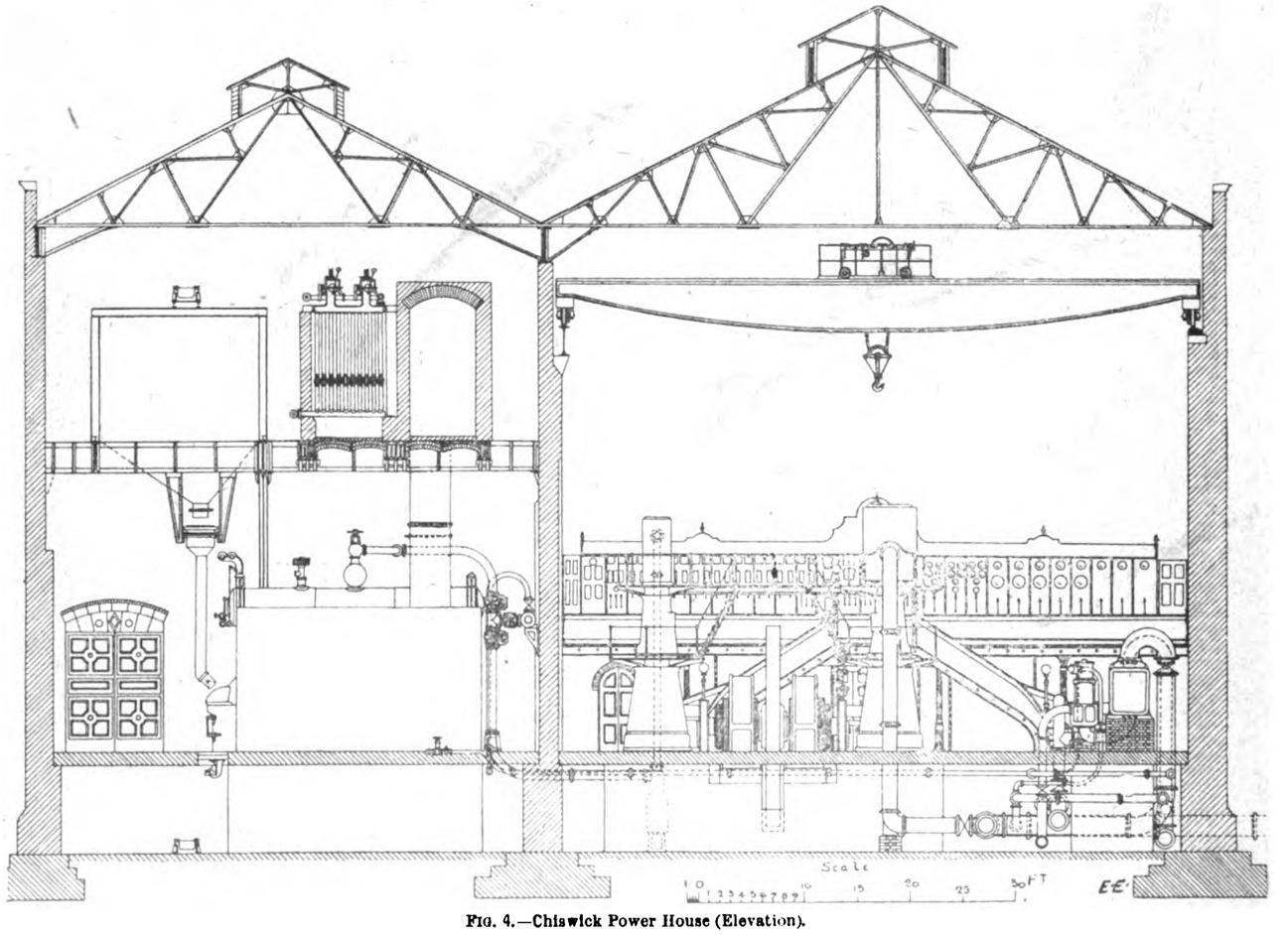

FIG. 4.—Chiswick Power House (Elevation).

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which are driven by the usual T-headed rocking spindle working off a wrist plate, are situated in the cylinder covers. The cylinders and receivers are lagged with asbestos and covered with steel plates. The receivers

at 94 revolutions per minute. These machines have a stationary armature, star-wound, with the middle point earthed, giving an output of 98 amperes per phase with a frequency of 25 cycles per second at 5,000 volts. The

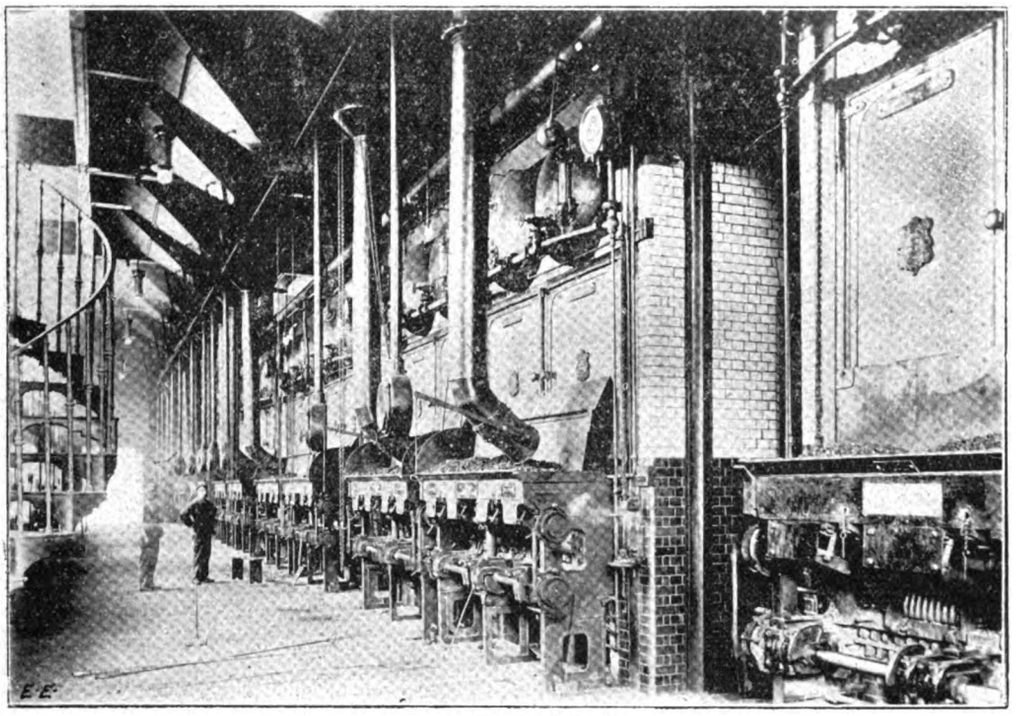

FIG. 5.—Chiswick Boiler House.

between the high and low pressure cylinders are fitted with reheater tubes round which live steam is passed; the outlet from the reheater is controlled by a steam-trap.

The traction generators are compound machines giving

fields are of the revolving flywheel type, and are 32-pole, with cast-iron slip-rings and carbon brushes for the field current, which is 15 amperes at full load and 13 amperes at no load. The field current is taken from the running

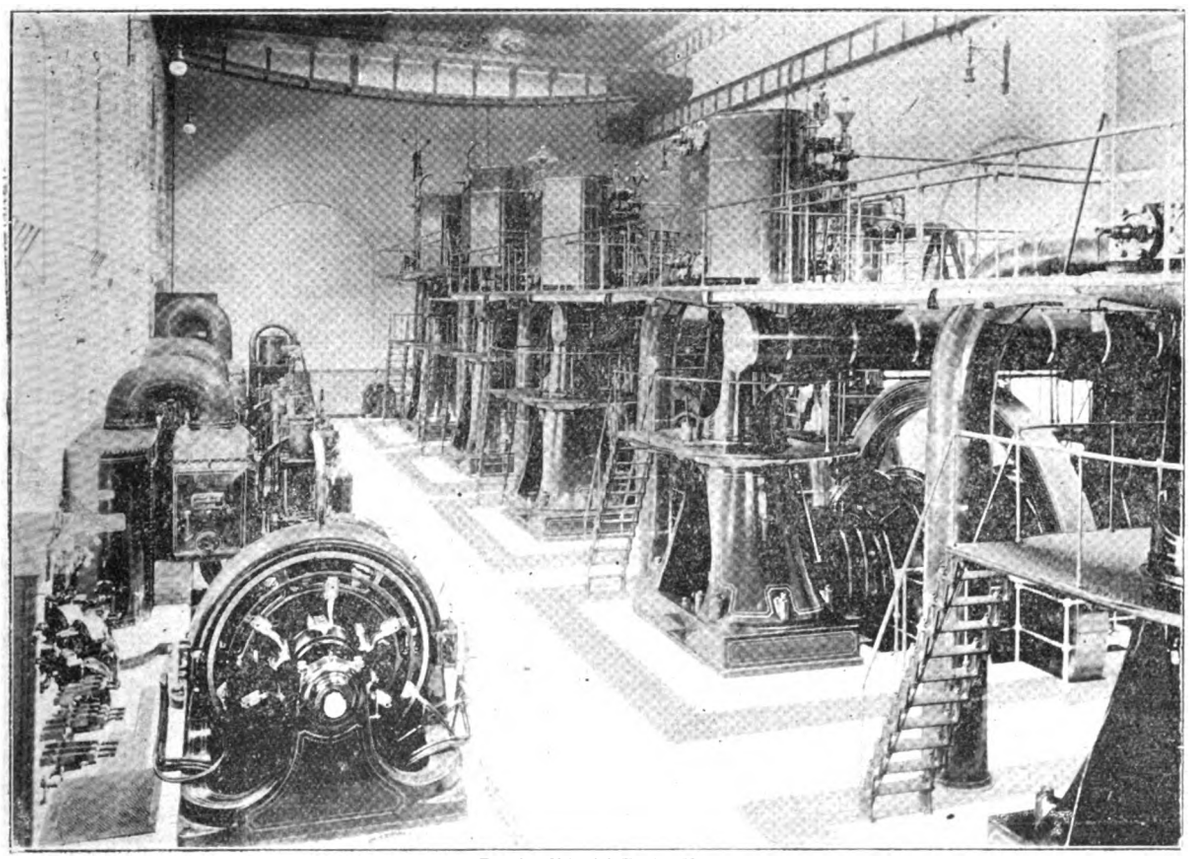

FIG. 6.—Chiswick Engine House.

500 amperes at 500 to 550 volts, and have often run at a continuous overload of 25 per cent., and can do 50 per cent. on an emergency. They are eight-pole machines; armature diameter is 5ft. 2in. and that of commutator = 4ft. 3in.

(*b*) One Allis engine of same size and type as above is coupled to a 500-kw. three-phase G.E. alternator running

direct-current generator, being tapped off the machine side of the negative circuit breaker and protected with a 200-ampere Peard fuse. This machine is capable of running under similar conditions of overload to those of the direct-current generators.

(*c*) Two 1,000-kw., 5,000-volt, three-phase alternators

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are coupled to two Allis cross-compound vertical engines, both engines and alternators being of the same type as previously described. The diameter of the high-pressure cylinder is 26in., and of the low-pressure cylinder 54in. The stroke is 48in., and the speed 94 revolutions per minute. These larger engines have water-jacketed guides and main bearings, and the wrist plates which carry the eccentric motion to the exhaust and steam valves are fixed on separate spindles. In this respect they differ from the 500-kw. type, which are not water-jacketed, and have both wrist plates working on one spindle. In other respects the design is similar. All the main engines are fitted with hand adjustment on the low-pressure cut-off for use if desired as an alternative to governor regulation. The diameter of the field is 32ft., and the field current is 30 amperes at full load and 26 amperes at no load. The amperes per phase are 116, and the frequency is 25 cycles per second.

There is also a 75-kw. Belliss compound enclosed engine, coupled to a B.T.H. 150-ampere 500-volt machine, running at 400 revolutions per minute. This is used for depôt lighting and motors at times when the larger engines are not running.

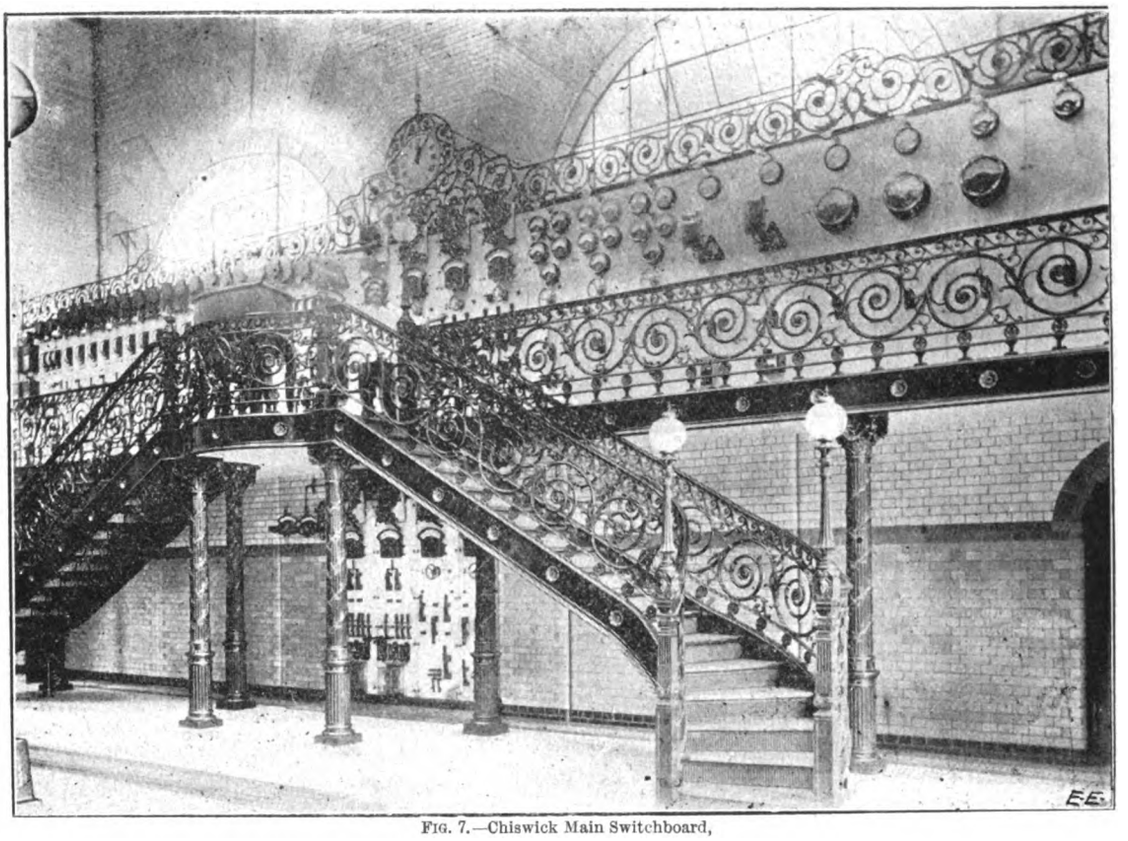

FIG. 7.—Chiswick Main Switchboard.

Condensing Plant.—There are two Wheeler condensers, each of 1,600 square feet tube area, and capable of dealing with 32,000lb. of steam per hour. These have double-acting vertical air and circulating pumps, worked from one rocker shaft and fitted with hard rubber valves. The pump rods are solid Tobin bronze, and the plungers have Tuck's canvas packing. The condenser tubes are $\frac{5}{8}$in. internal diameter by 10ft. length. Also one Wheeler condenser, similar to above, but capable of dealing with 40,000lb. of steam per hour, with a tube area of 2,200 square feet. Three Barnard-Wheeler cooling towers deal with the discharge from the above condensers. The fans for each tower are driven by a direct-coupled electric motor of 35 h.p. The hot-well is enclosed. Two three-throw Blake-Knowles pumps driven by 5-h.p. motors discharge water from the hot-well through Railton and Campbell filters to the feed tanks over the boilers. Between the exhaust main and each condenser is fitted a Baker oil separator, in which the steam on its way to the condenser is brought in contact with a body of standing water at the bottom of the separator, and afterwards passes through angle-iron baffles, which remove the grease and moisture. This increases the volume of liquid in the separator, and an overflow continually falls from a pipe which leads to a small pump, by means of which the mixture of grease and water is forced into a settling tank. Here the oil rises to the surface, and after filtering is used

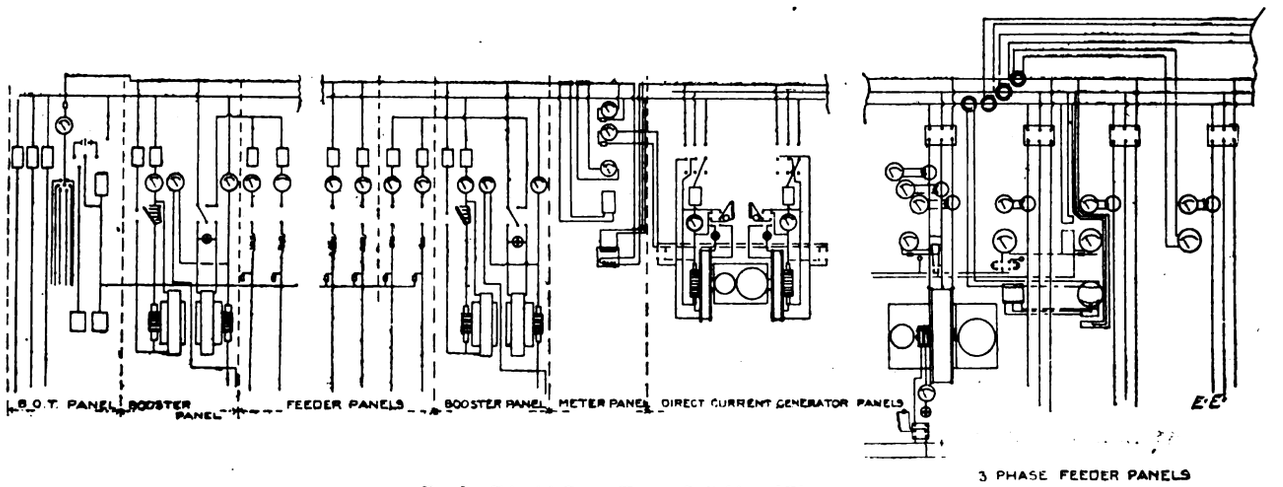

FIG. 8.—Chiswick Power House—Switchboard Diagram.

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for pumps, etc. These separators are found to be most effective. Any small quantity of grease that may escape is dealt with by means of the Railton and Campbell filters on its way to the feed tanks, as mentioned previously.

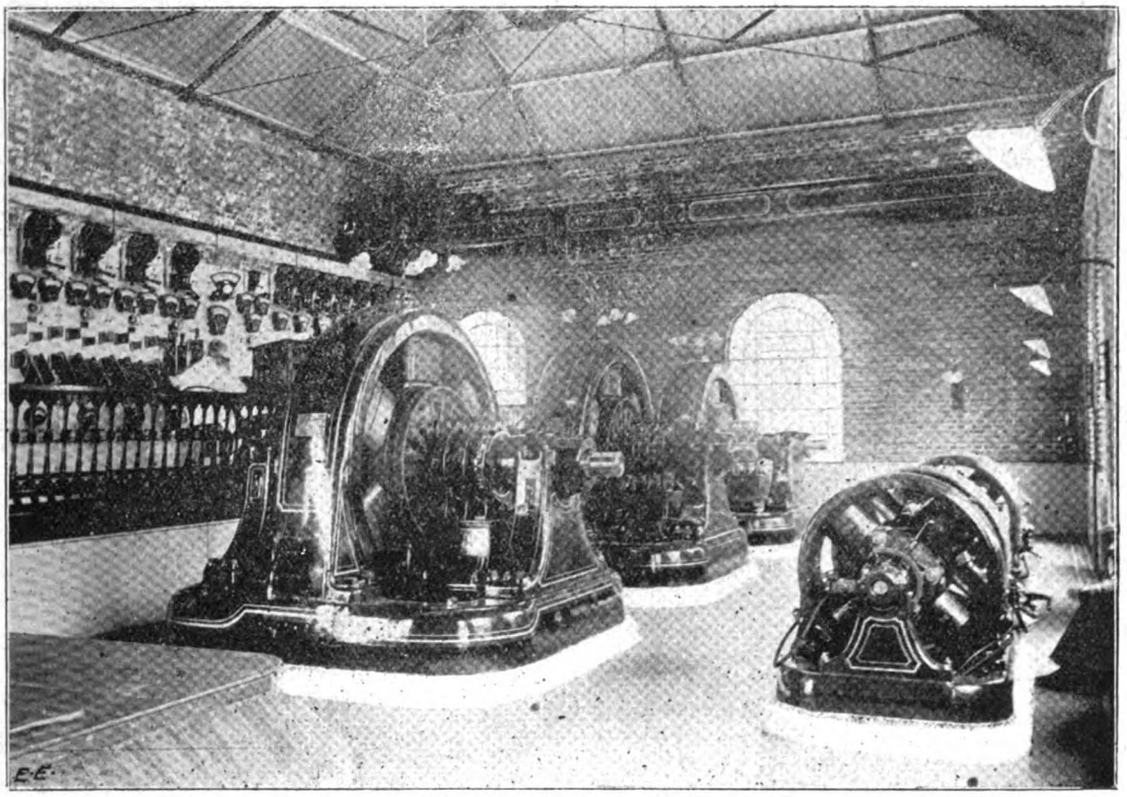

FIG. 9.—Fulwell Sub-Station—Interior.

Four Warden oil filters are used to filter the spent oil from all engines.

Auxiliary Electrical Plant.—A 500-kw. rotary converter (Westinghouse six-pole machine), running at 500 revolutions per minute, is supplied with three-phase alternating current by six 100-kw. Westinghouse static transformers, coupled two in parallel on each phase. This machine is to enable the alternating plant to help the direct current, or *vice versâ*. When running direct current to alternating current, the rotary field is excited by a small motor-generator, the induction motor of which is driven from the slip-ring current from the rotary. By this means the speed of the rotary is kept constant. The pole-faces of the rotary have copper shoes fitted to prevent surging. There are also two negative boosters, 15 kw., giving 300 amperes at 50 volts on the generator side, and driven by direct-coupled 500-volt motors. The generator field is excited by the current passing through the positive feeder of the district to which the negative cable of the booster is connected. The regulation obtained by this means is quite automatic.

Main Switchboard.—This is composed of 27 panels (Fig. 7), arranged along a gallery at the southern end of the engine-room, as follows: One Board of Trade panel, with testing ammeter, earth-current recorder, and three recording voltmeters for registering the potential difference along the rail; two negative booster panels; eight direct-current feeder panels, two feeders per panel, with circuit breakers, switches, and lightning arresters; one meter panel, with main and recording ammeters, two main voltmeters, and one direct-current wattmeter; four direct-current generator

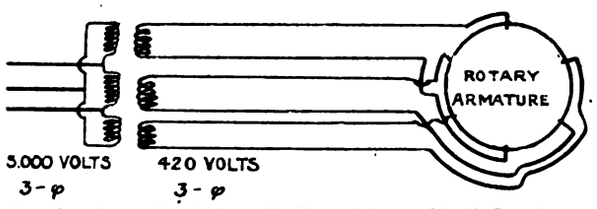

FIG. 10A.—Connections between Six-Phase Rotary and Static Transformers.

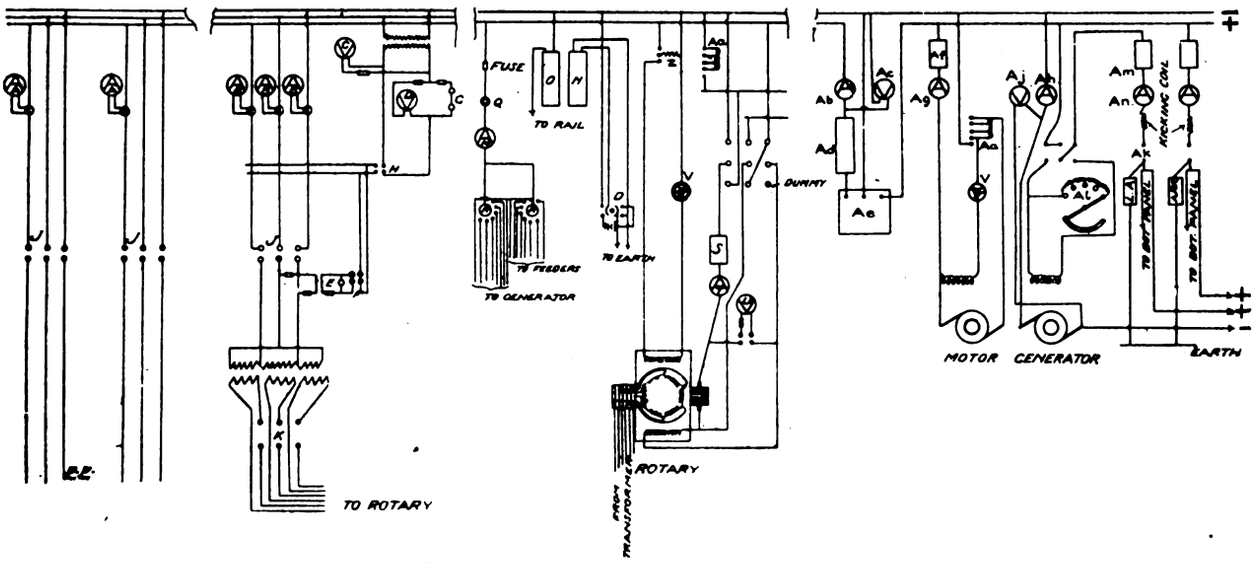

FIG. 10.—Fulwell Sub-Station—Switchboard Diagram.

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panels of B.T.H. standard pattern, with circuit breakers; three alternate-current generator panels, each with a lever working a 200-ampere oil-break switch, a carbon-break field switch, voltmeter (5,000 volts), and three ammeters; six high-tension feeder panels, each controlling one feeder to the sub-stations, with one oil-break switch and one ammeter; two high-tension panels controlling the transformers, used with the 500-kw. rotary. There are also, fitted on swinging brackets, main ammeters, main and synchronising voltmeters, and integrating wattmeters.

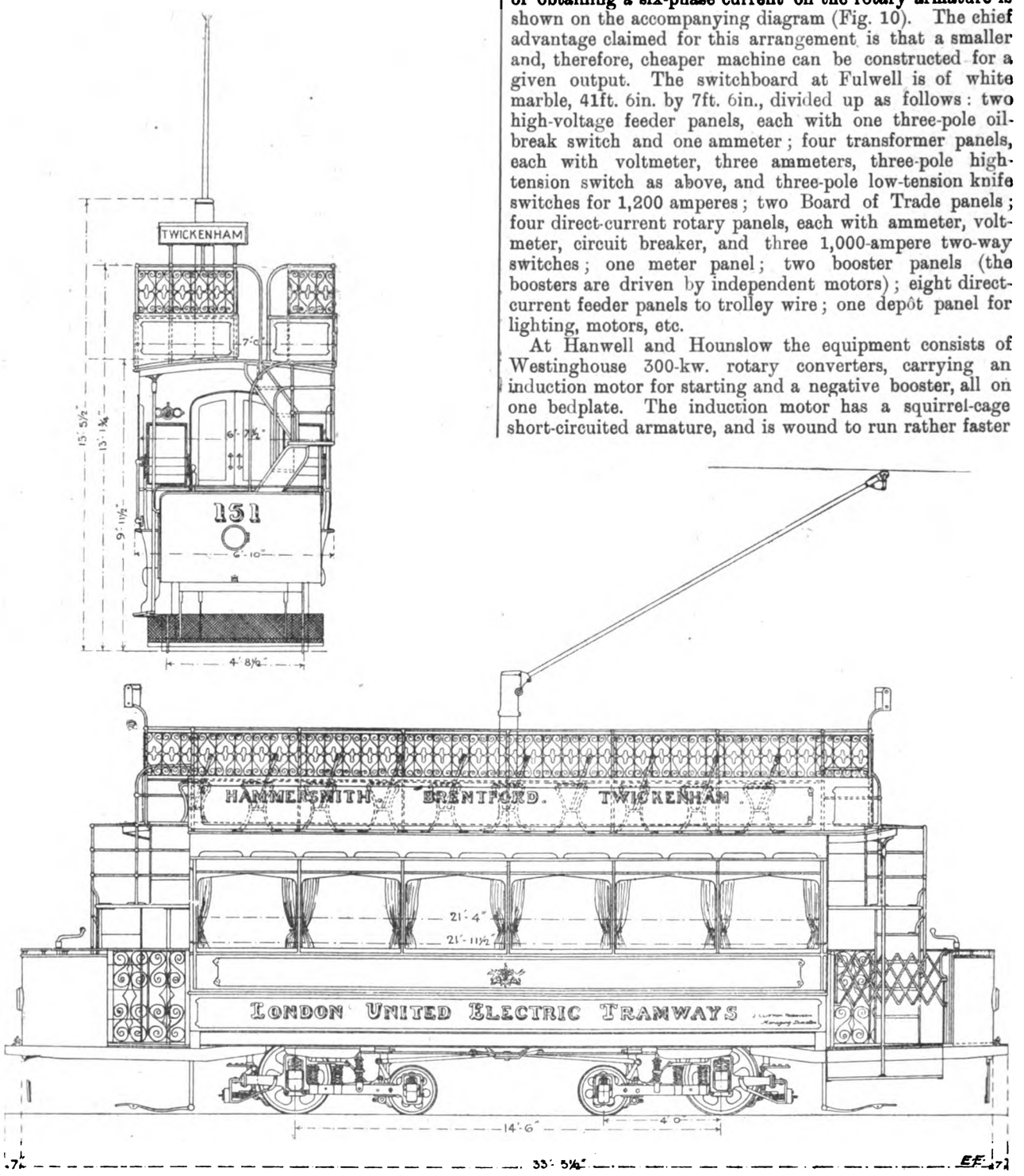

FIG. 11.—Typical Car on the London United Tramways System.

Auxiliary Switchboards.—Rotary board: The low-tension alternate-current and direct-current panels for the 500-kw. rotary are fixed close by it, and are of standard Westinghouse pattern. There is also a board of four panels, arranged as follows: the first panel controlling the depôt lighting, the second the depôt motors, the third the fan motors for cooling towers, and the fourth for the 75-kw. generator set.

Sub-Stations.—From the power-house at Chiswick three-phase current at 5,000 volts is supplied to the sub-stations over three-core, lead-covered, paper-insulated cables laid in stoneware conduits. These sub-stations are situated at Fulwell (between Twickenham and Hampton), Hounslow, and Hanwell.

The Fulwell sub-station (Fig. 9) is the most recently opened and has an equipment of three 500-kw. six-phase rotary converters, by the British Thomson-Houston Company. There are three 200-kw. static transformers, which supply current to each of the converters at a pressure of 420 volts, making a total of nine transformers; the method of obtaining a six-phase current on the rotary armature is shown on the accompanying diagram (Fig. 10). The chief advantage claimed for this arrangement is that a smaller and, therefore, cheaper machine can be constructed for a given output. The switchboard at Fulwell is of white marble, 41ft. 6in. by 7ft. 6in., divided up as follows: two high-voltage feeder panels, each with one three-pole oil-break switch and one ammeter; four transformer panels, each with voltmeter, three ammeters, three-pole high-tension switch as above, and three-pole low-tension knife switches for 1,200 amperes; two Board of Trade panels; four direct-current rotary panels, each with ammeter, voltmeter, circuit breaker, and three 1,000-ampere two-way switches; one meter panel; two booster panels (the boosters are driven by independent motors); eight direct-current feeder panels to trolley wire; one depôt panel for lighting, motors, etc.

At Hanwell and Hounslow the equipment consists of Westinghouse 300-kw. rotary converters, carrying an induction motor for starting and a negative booster, all on one bedplate. The induction motor has a squirrel-cage short-circuited armature, and is wound to run rather faster than the ordinary speed of the rotary, which is by this means quickly brought up to phase, and can be easily switched in. The direct-current side of the switchboard is similar to that at Fulwell, though smaller, but the high-voltage three-phase panels are fitted with Westinghouse long-break three-pole switches, each pole fitted with a separate circuit breaker, instead of the oil-break switches in use at Fulwell.

There are three rotary converters at Hanwell and two at Hounslow. The high-voltage three-phase current is

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transformed down to 340 volts for delivery to the converters, by means of Westinghouse oil-insulated 100-kw. transformers, three to each rotary. At each sub-station there is a small motor-driven Reavell air-compressor for cleaning purposes.

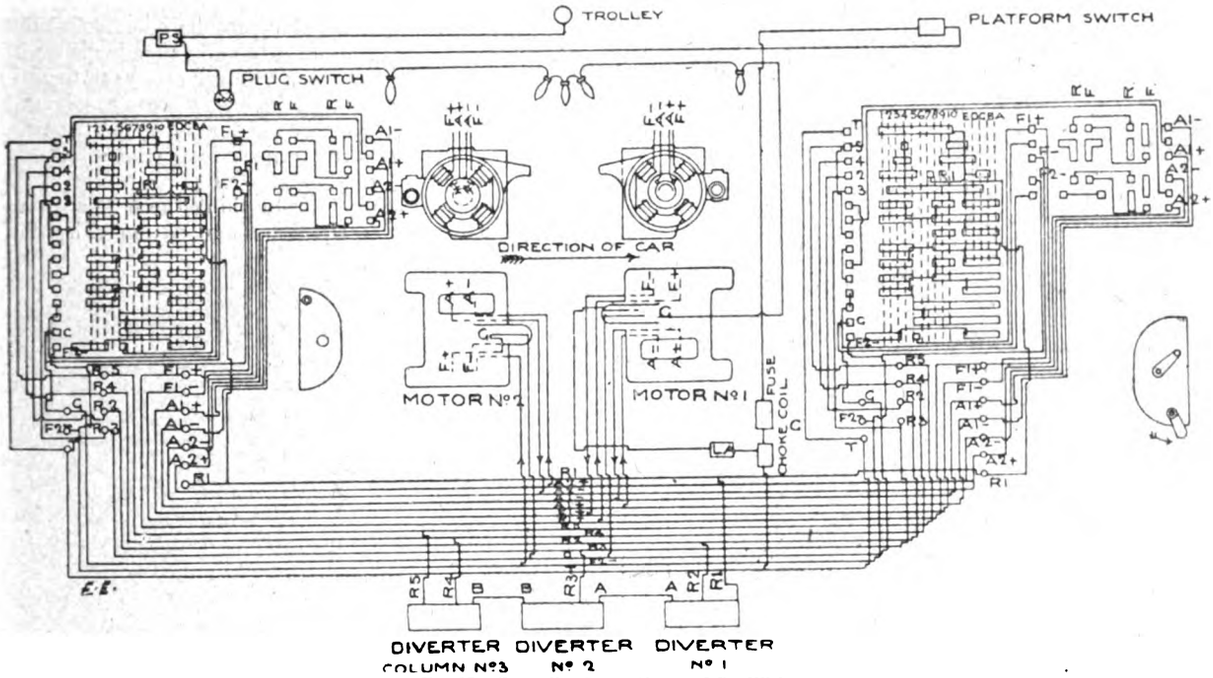

FIG. 12.—Controller Connections and Car Wiring.

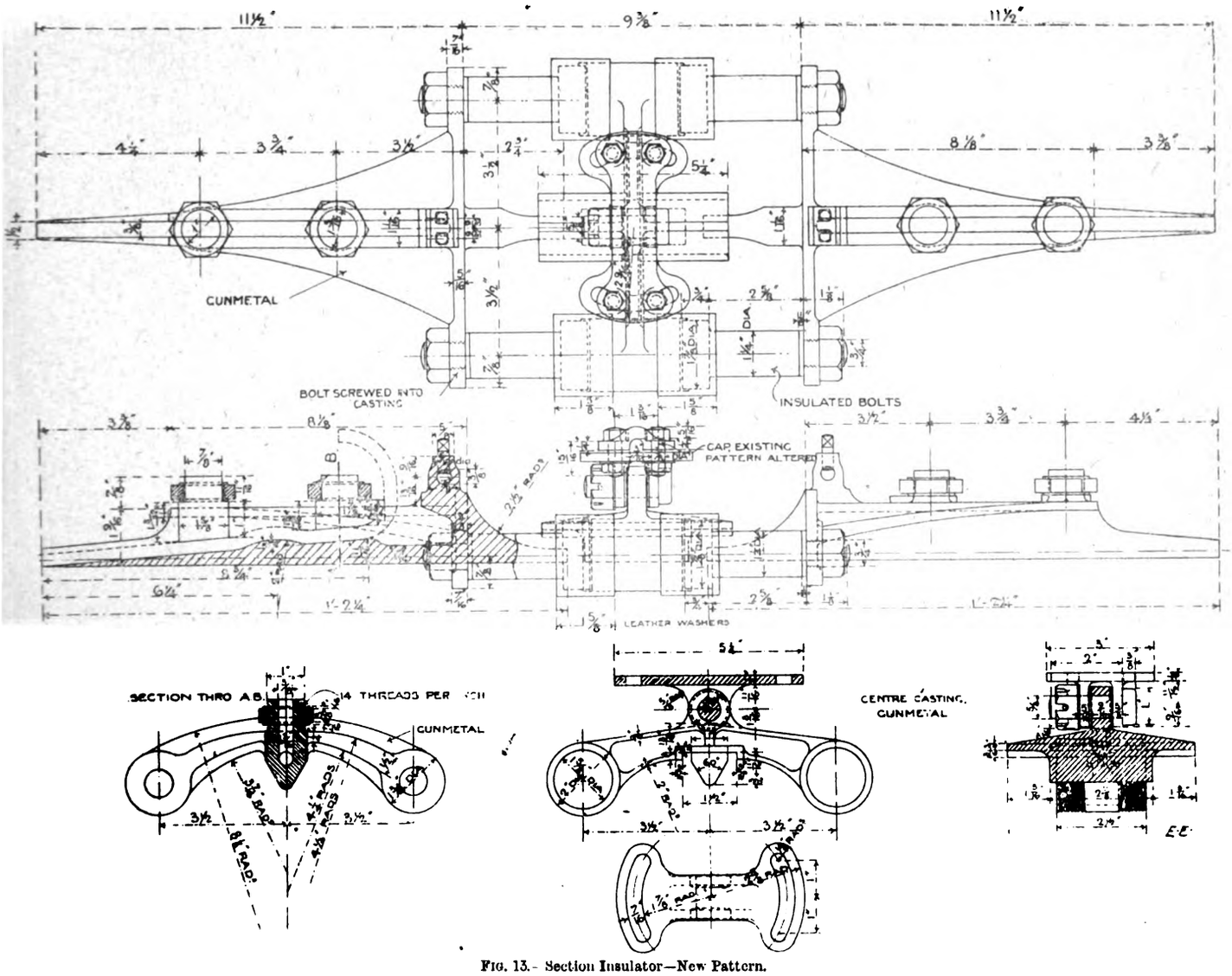

FIG. 13.—Section Insulator—New Pattern.

CAR DEPOTS.

These are placed as follows: Chiswick—car shops for repairs, painting, etc., and stabling for 75 running cars; Acton (old horse-car depôt)—30 cars; Hanwell—70 cars; Hounslow—50 cars; Fulwell—200 cars. In all there are 300 cars in use, but without any fresh depôts there is accommodation for 125 more.

CARS.

The cars in use on this system are all of the double-deck

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pattern, with maximum traction trucks (Fig. 11). Messrs. Hurst, Nelson, and Co., of Motherwell, N.B., built 100, and

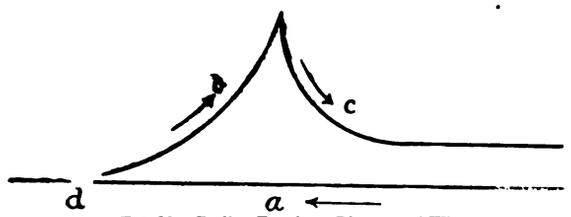

FIG. 14.—Trolley Turning—Diagram of Wire.

these are fitted with Peckham trucks carrying 58-G.E. motors and B-18 controllers supplied by the British Thomson-Houston Company. Messrs. Milnes and Co., of Birkenhead, constructed 150, and all of these have Westinghouse equipments, 49 B motors, and No. 90 controllers, but 50 have the M'Guire truck, while the balance are carried on Brill maximum traction trucks, as also are 25 cars built by the British Electric Car Company and fitted with Westinghouse motors and controllers. Throughout all the cars destination indicators have been fitted by the British Electric Car Company, these being their standard pattern with transparent names on canvas, which can be moved over rollers to change the destination indicated, which is rendered visible at night-time by two incandescent lamps, which also serve the purpose of illuminating the top of the car. The interiors of the cars are very handsomely got up with dark and light oak moulding, with maple panels, and the seats provided are an object lesson in comfort for nearly all the tramways in the kingdom, while the passengers on a few railways would think the millennium was at hand if they received equal accommodation. The Wood's

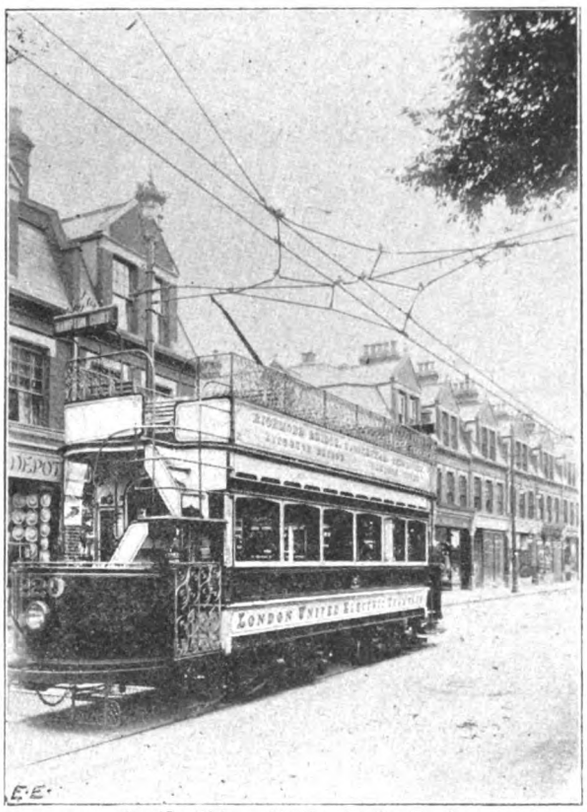

FIG. 15.—Richmond Bridge—Trolley Turning.

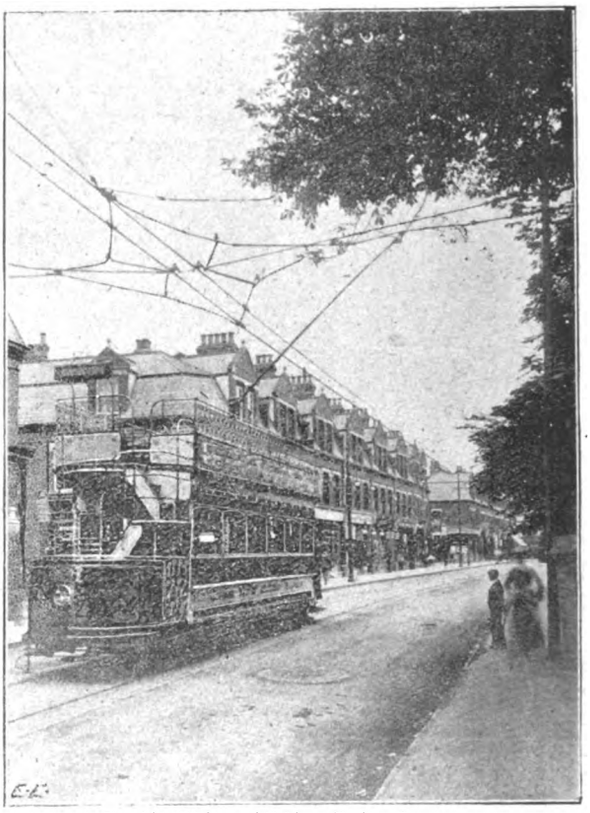

FIG. 16.—Richmond Bridge—Trolley Turning.

swivelling trolley head is in use throughout the system, and similar advantage is taken of the Wilson-Bennett lifeguard.

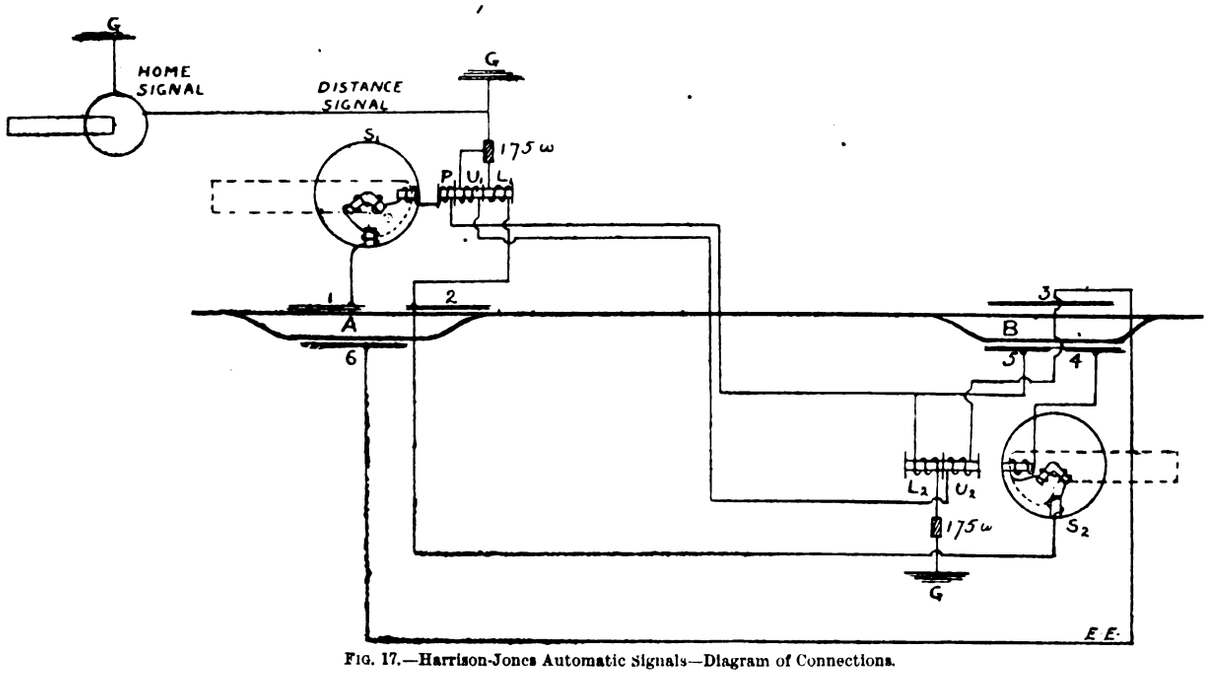

FIG. 17.—Harrison-Jones Automatic Signals—Diagram of Connections.

The vexed question of brakes does not cause much trouble on a line over flat country such as the London United Electric Tramways Company traverse, therefore

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the cars only carry the ordinary ratchet hand brake and the electric short-circuiting brake, but two cars have been fitted with magnetic brakes, one supplied by the British Thomson-Houston Company, and the other by the Westinghouse Company, for the purpose of experiment. Chilled cast-iron brake-blocks and wheels are used on all cars on the system.

Three water-carts mounted on single trucks are kept at work in dry weather. These are only used for watering the rails, since the various district councils have not yet grasped the economy of motor-driven water-carts on roads through which the tramlines pass.

Overhead Work, etc.

The overhead work is of the ordinary standard construction, carried by span wires from side poles or from

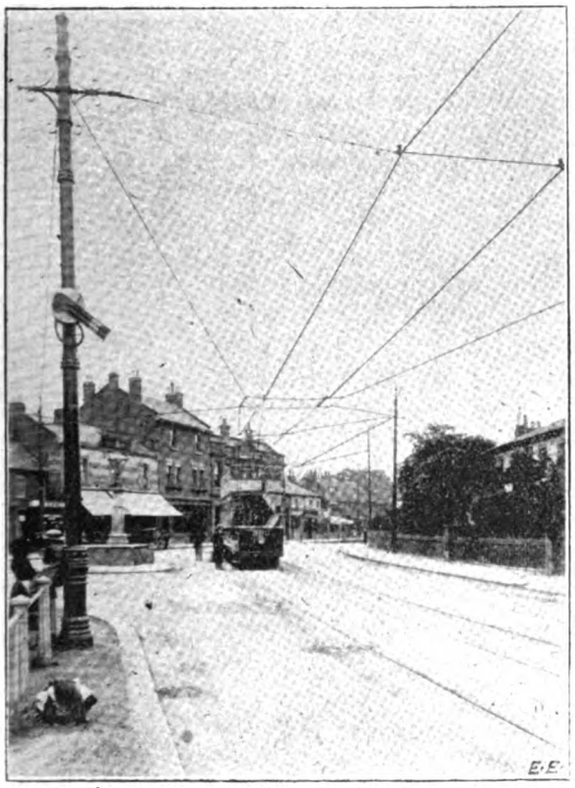

Fig. 18.—Automatic Signalling at Heath-road, Twickenham.

rosettes on buildings in narrow roads by centre poles (through Ealing), or by side bracket poles, as circumstances require. Apart from this there are some interesting features that are somewhat different from ordinary practice.

each section, with a corresponding saving of time when any section has to be isolated, whether owing to an accident or for ordinary routine work.

The accompanying drawing (Fig. 13) shows the details of the new section insulator which is being adopted in

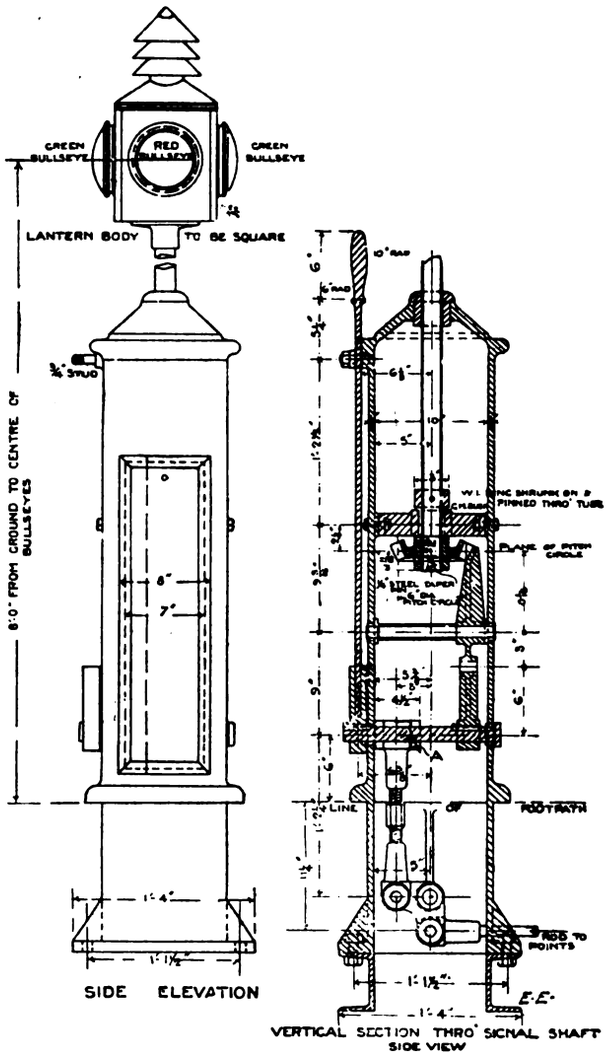

Fig. 19.—Signalling and Point Switchin Box.

place of the old standard with a wooden or fibre insulating gap. The new pattern has a double air-gap in the trolley path, and is far stronger, having two bo[l]+ to carry the strain of the tension in the overhead wire instead of one.

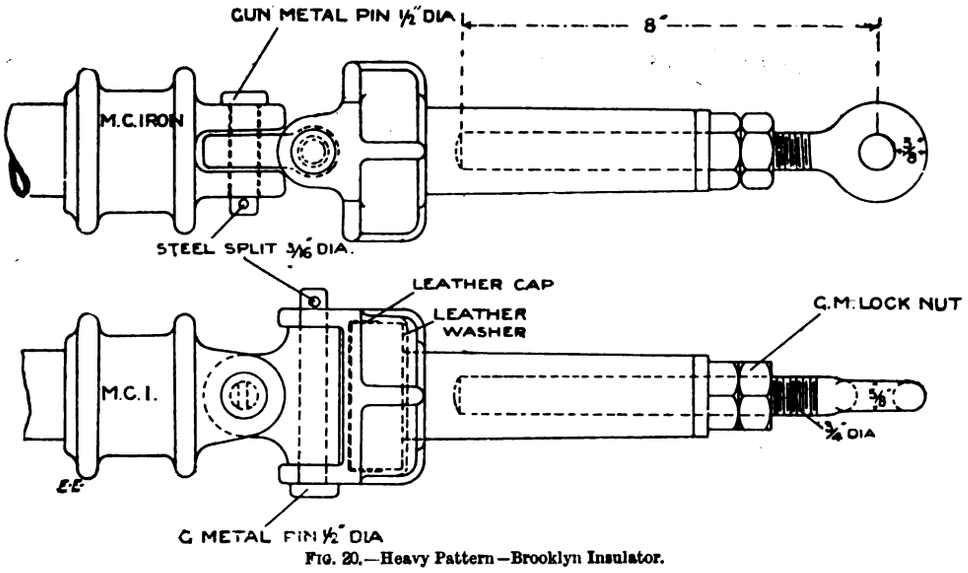

Fig. 20.—Heavy Pattern—Brooklyn Insulator.

The feeders are being rearranged so that they are not connected to either side of the insulating ears of each section, but to a special feeder ear in the centre. This gives the advantage that there is one section switchbox only for

At busy junctions the points are controlled from a signal box on the pavement. This is of cast iron, similar in pattern to a section box, but rising from the top is a four-sided lantern. The action of the lever which works the

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points also revolves this lantern, and shows a light indicating which route is open. Judging from appearances, the man who works the points in the middle of the road at Westminster Bridge would certainly appreciate one of these signal boxes instead of having to dodge the heavy traffic at that terminus.

At the Richmond Bridge terminus there is an arrangement of the trolley wire which automatically reverses the trolley as the car starts on its return journey. For convenience, only one half of the arrangement is shown in the diagram (Fig. 14). While the car is on the section *a* the trolley pole is in its usual position, and remains so until the trolley head passes the frog, *d*, when the car stops. When the driver starts the car on the return journey, the trolley head runs out over the curve *b* to another frog, which is fixed at such a distance that the trolley pole is at right angles to the car when the head is in this position; as the car continues its journey the head naturally follows the curve *c* back to the line again on the other road. Double the amount of overhead work shown is needed on this line because the trolley standards are not placed in the centre of the car roof, and the exigencies of the track bring the cars up to the terminus with the standards both right and left handed of the centre line, and the locking gear does not allow of a complete revolution of the trolley pole in either direction, which would, of course, break the trolley cable eventually, if allowed, and would certainly strip the insulation.

At Heath-road Bridge, Twickenham, automatic signalling has been adopted over a stretch of single track on which the view is blocked by a railway bridge under which the track dips and which is further complicated by a sharp curve. Referring to the drawing (Fig. 17), A and B are two sections of double track with single track intervening. A car passing along the track enters A, when the trolley head makes contact between the live wire and contact piece No. 1. This sends a current through L_2 and locks the signal at B against any car travelling in the opposite direction; when the contact 2 is reached, both signals are locked at danger, so that no car can follow on to the single track, neither can any car meet the one now on it. When contact 3 is reached both signals are released. The reverse occurs when a car comes from the opposite direction.

All the fittings in original overhead work are being replaced by the heaviest patterns now available, and the new posts are also heavier than usual, because it has been found that any apparently additional outlay on these points really justifies itself on account of the resulting economy in maintenance.

The track rails are the ordinary standard heavy girder rail with bonded joints and flat sole-plates, laid on a bed of concrete in conformity with the usual practice.

In conclusion, I must express my hearty thanks to Mr. J. Clifton Robinson, C.E., the managing director and engineer of the company, and his technical staff, by whose courtesy every facility has been given me in the preparation of this article.

THE VERBAND DEUTSCHER ELEKTROTECHNIKER.

The Parallel Running of Alternators.

BY H. GÖRGES.

(Concluded from page 200.)

Very similar phenomena occur in driving a synchronous motor. A synchronising force is also present in this case, and consequently there is the same tendency for natural oscillations to be set up, these being damped as in the generator. The output of the motor may be subject to periodic fluctuations, but this will be the case only under exceptional circumstances—for instance, if the motor drives shafting to which a steam-engine is also coupled. On the other hand, it will frequently occur that the periodicity of the alternating current conveyed to the motor is not quite constant, but subject to slight periodically varying fluctuations. The motor will then—even if we previously assume that it runs at a uniform speed—possess lead and lag relative to the voltage of the input current. These relative oscillations are increased by resonance, so that we obtain actual mechanical oscillations—that is to say, variations in the speed of the motor. By means of damping, these forced oscillations may again be reduced at will, but only at the cost of uniform input. This brief consideration shows us that the phenomena in connection with a synchronous motor are analogous to those which occur in the case of generators running in parallel. In order to more closely observe the phenomena, we must take the governor of the driving engine into our final consideration. The action of the governor, due chiefly to the great diversity of types in vogue, is so complex in character that it requires a special consideration which it is quite beyond the scope of this paper to give. We must, therefore, content ourselves here with a brief consideration of those points which more especially concern parallel running.

One of the principles on which the steady action of the governor depends consists in that its degree of sensitiveness must be less than the degree of irregularity in the flywheel; in other words, it must not be sufficiently sensitive to respond to the differences in speed corresponding to the irregular acceleration of the piston. But we have seen that in parallel running the degree of irregularity is increased either by the presence of natural oscillations, or more especially by an increase of the forced oscillations due to resonance. In determining the permissible sensitiveness of the governor, the designer can no longer base his calculations on already established rules, but must take into consideration the particular phenomena attending parallel running, and provide for it being greater than the irregularity. If this care be not observed, the limit can be easily exceeded, with consequences which may be illustrated by a simple example. We have seen that at the instant of greatest lead the driving moment and the input of energy are at a minimum, and the output yielded, apart from damping, at a maximum value. This instant, however, is preceded during a half period by too high a speed, which, according to our assumption, will have been responded to by the governor, so that at the commencement of a fresh cycle the input of energy is still further reduced. Let us imagine the case of a Watt type of governor, whose arms are thrown out, due to the increased speed, and which therefore admits less steam at the beginning of a fresh stroke of the piston. If a state of equilibrium was previously upset due to the greatest lead, because the input was less than the output yielded, then the balance will be further disturbed by this decrease, and the return swing made more pronounced. At the instant of greatest lag the minimum output corresponds temporarily with the maximum input of energy and increased supply of steam. It is obvious that the governor must help to increase the oscillations in proportion to its sensitiveness to the changes in speed. If we were to retard the action of the governor for another half-period, then the reduction in the quantity of steam admitted would correspond with the greatest lag, and thereby effect a reduction of the oscillations. By the use of oil dash-pots or other means of damping the movement of the governor we may ensure either that the governor will not respond to the variations in the speed during one revolution, or that it shall help to effect a reduction of the oscillations. Without such provision a constant increase of the oscillations may occur, even if the moving parts be extra massive, and this increase will inevitably cause the machines to fall out of step. But if the generators have damping, then the degree of variation in the speed is not increased to the same extent when running in parallel, as would otherwise be the case. It is therefore possible that damping may be employed with advantage here also, if it is unnecessary in connection with the other oscillations. In this case the damping of the dynamo replaces the damping of the governor.

The oscillation with which we have just dealt may be illustrated by means of a device which I will now briefly describe. This consists of a horizontal shaft driven by means of a driving rod and crank of adjustable length from a shaft mounted under it, and revolving uniformly in its bearings in such a manner that the first shaft is constrained to produce oscillations of a sine-like character about its axis. The amplitude of the oscillations is

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indicated by a pointer fixed to the shaft. A heavy copper disc running on ball bearings is mounted on the oscillating shaft, being coupled to the latter by means of two watch springs. Now, if the upper shaft be held, then the copper disc will produce natural oscillations directly it is moved from its position of rest. A scale arranged at the periphery of the disc in conjunction with a mark set opposite the zero division of this scale enables the amplitude of the oscillations to be observed. The period of the natural oscillations amounts to about three seconds, so that the number of natural oscillations produced per minute is 20. Now, if we excite the electromagnets between the poles of which the copper disc revolves, then a damping effect will be produced, which may be made stronger or weaker at will by varying the excitation.

The superposition of the oscillations may be clearly seen if we set the upper shaft in quick motion and then give the disc a knock. The forced oscillations are now difficult to distinguish, the natural oscillations ensuing apparently as if the shaft were at rest. The length of oscillation depends upon the strength of the impulse which we give the disc. By means of damping we can eliminate the natural oscillations. There then remain the small forced oscillations, which correspond exactly to the cycle of the oscillating shaft. These forced oscillations are found to have about 180deg. phase distortion relative to the induced oscillations, thus proving the theory to be correct.

The interference between the oscillations is seen better if we decrease the rate of the shaft oscillations. When the apparatus is hand-driven, it is scarcely possible to turn with sufficient uniformity to avoid the continual setting up of natural oscillations. By means of damping we can, however, eliminate these. Let us gradually reduce the oscillations of the shaft when we have slight damping. It will be seen that the copper disc then oscillates exactly in synchronism with the pointer attached rigidly to the shaft, but that its amplitude of oscillation increases as we reduce the speed. By turning so slowly that the oscillations of the shaft become far slower in their succession than the natural oscillations represented by the copper disc, the length of oscillation of the disc will be reduced again until the movement synchronises almost exactly with that of the pointer.

By cutting off the damping we can easily set the disc in such violent oscillation by means of resonance that it will swing more than 180deg. to either side, while the shaft itself swings through only ± 15deg. In this case the oscillations are increased more than twelvefold by resonance. By switching in the damping we can very quickly moderate these oscillations. Indeed, we must resort to this means to prevent the apparatus from injury. If we drive the lower shafts by means of a small motor instead of by hand, so that greater uniformity is obtained in the speed, then the apparatus can also be used for making quantitative measurements. The means of adjustment provided enable the length of the oscillations of the shaft to be varied between 22deg. and 38deg. By regulating the tension of the watch springs, the duration of oscillation may also be adjusted to the required value.

The theory of the oscillations not only gives us an explanation of the behaviour of alternate-current machines when running in parallel, but also governs other important questions. Yet the very existence of alternate currents depends upon oscillations. The insight obtained into the production of the oscillations by studying the question of parallel running is of especial value to us in pursuing the study of the pressure rises which occur in high-tension mains, and is of further use in connection with wireless telegraphy.

TUNBRIDGE WELLS ELECTRICITY ACCOUNTS.

From the accounts of the Tunbridge Wells electricity department for the year ended March 31, 1903, it appears that the total expenditure on capital account to that date amounted to £71,456. Abstracts of the revenue account, general balance-sheet, and statement of electricity generated, sold, etc., are appended.

REVENUE ACCOUNT.

Dr. Expenditure.	£	s.	d.
Generation of electricity	4,689	3	9
Distribution of electricity	90	3	6
Public lamps—attending and repairs	397	9	10
Rents, rates, and taxes	255	13	3
Management expenses, salaries, etc.	1,228	19	3
Insurance	33	5	0
Sundry expenses	38	6	1
Gross profit transferred to net revenue account	5,677	14	3
	£12,410	14	11

Cr. Income.	£	s.	d.
Sale of electricity to private consumers	9,242	19	7
Public lamps	2,432	7	1
Meter rents	386	19	2
Sale of ashes	20	10	3
Fees for extra tests	7	9	6
Miscellaneous	274	19	4
Income tax refunded	45	10	0
	£12,410	14	11

BALANCE-SHEET.

Dr. Liabilities.	£	s.	d.
Tunbridge Wells Corporation Stock	65,477	13	5
Mortgage loan	5,000	0	0
Redemption of stock	7,151	2	2
Repayment of loans	2,171	19	10
Premium on stock issued	247	10	5
Sundry creditors on capital account	768	0	1
Free wiring account—amount due to company	16	10	2
Sundry creditors on revenue account	934	11	3
Profit appropriation account—surplus at date	3,116	8	5
	£84,883	15	9

Cr. Assets.	£	s.	d.
Property, permanent works, etc.	71,465	17	0
Discounts on stock issued	5,366	5	10
Cash in hand—capital account	3,984	3	1
Stores in hand	354	6	11
Sundry debtors for current supplied	3,457	18	8
Cash in hand—revenue account	255	4	3
	£84,883	15	9

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T.U.		892,712
Quantity sold { Public lamps 264,187 / Private consumers by meter 475,961 }		740,148
Quantity used on works		14,000
Total quantity accounted for		754,148
Quantity used in distribution		138,564
Number of public lamps		49,878
Total maximum supply demanded (kilowatts)		579

GUERNSEY STATES TELEPHONE DEPARTMENT.

The report for the year ended Dec. 31, 1902, shows that the number of subscribers, extensions, and other lines at that date amounted to £1,073, and that the total number of subscribers and public telephone calls for the year amounted to £533,039. Abstracts of the revenue account and balance-sheet are appended.

REVENUE ACCOUNT.

Dr. Expenditure.	£	s.	d.
Working expenses	812	19	4
Office expenses	249	18	7
General expenses	1,298	1	7
Reserve account for depreciation, etc.	965	4	4
Balance, being net profit for year	157	2	7
	£3,483	6	5

Cr. Receipts	£	s.	d.
Revenue receipts from public telephones, etc.	3,390	12	4
Interest on deposit account and State bonds	63	15	11
Discounts received	28	18	2
	£3,483	6	5

BALANCE-SHEET.

Dr. Liabilities.	£	s.	d.
Capital account—advances from States	22,585	0	0
Reserve account for depreciation, etc.	2,717	12	5
Reserve account for contingencies, etc.	195	9	11
Sundry creditors	166	13	4
	£25,664	15	8

Cr. Assets.	£	s.	d.
Land and building, work, and expenses	21,091	6	3
Stores, tools, and stationery on hand	869	10	7
Office furniture	104	1	10
Sundry debtors	506	16	1
Guernsey 3 per cent. State bonds at cost	1,700	0	0
Cash at bankers and in hand	1,393	0	11
	£25,664	15	8

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THE

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TO CORRESPONDENTS.

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All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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EXHIBITIONS.

Has not the time come to discuss seriously the true value of exhibitions? The past is past, and what has been done cannot be undone; but what of the future? Every year or two the Government is coerced into finding fifty or a hundred thousand pounds more or less for the expenses of a commission to some exhibition or other. Does the nation get value for its money? If the exhibitions were in this country, there might be some object in such expenditure, but usually they are held in other countries, which obtain the immediate benefit, if any. What are the advantages put forward, and what are they worth? In the first place, it is said, and with some amount of truth, that exhibitions bring buyers from all parts of the earth to see the latest improvements, and that if our competitors only show, their goods are bought and ours left out in the cold. In other words, exhibitions are held to be a good form of advertising. Granted, but why should the nation at large pay part of the cost of advertising a man's goods? Surely that payment is part and parcel of the manufacturing cost, and should be borne directly by the maker. The main question an exhibitor asks is, Will it pay? and if the answer is in the affirmative, he exhibits; and if in the negative, the fractional assistance he gets from a Government grant will not induce him to do so. The benefit to the individual is the benefit to the country at large; if the one gets a favourable monetary return, so does the other, and *vice versâ*. Of all the howlers for pecuniary assistance, there is none so great as the howling artist who says the country ought to show everywhere the results of its artists' work. What for? To attract shillings to an exhibition the profits of which go into another nation's pockets? Why advertise artists any more than bootblacks? The country has a long purse, and everybody who needs a sovereign thinks the nation ought to provide him with that amount of pocket money. Self-help is no longer a fashionable craze, but begging is. In our opinion, the patronage of exhibitions abroad is a mistake; if you want a big bazaar, have it at home. When have we in recent years obtained any advantage from exhibitions? Their value is in the earlier stages of any industry, not subsequently. France, in 1878 and 1881, did good with exhibitions, and from what was done and seen at Paris the electric era commenced. But we doubt if any such advantage could accrue to the industry again. Exhibitions now do not enlighten; they are merely salesrooms. We know the best and worst that can be exhibited. Government expenditure, if these conclusions are correct, is unwarranted. The thing assisted is not educational, but merely financial, and the direct payments should be made by those who get the direct receipts. This brings another question. Is it of advantage to have a perambulating sample and salesroom? Undoubtedly, yes, for certain manufacturers, these differing according to locality and circumstance. But the Government funds ought not to provide a travelling showroom, any more than it provides a traveller with samples. The latter is just as much a perambulating showroom as an exhibition annexe—no more, no less; yet manufacturers do not come to the Government for financial aid in sending out travellers. All this preliminary is intended to show that exhibitions at the present stage of the world's history are merely money-making concerns, and to argue if that is so, our Government at any rate can better spend its money in some other direction—preferably by leaving it in the pockets of the taxpayers. Everywhere, municipally and Governmentally, the energy and business capacity of the individual is being ignored, and restrictions

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of all kinds are cropping up like autumn leaves in Vallombrosa.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

THE ELECTRIC TUNNEL DANGER.

SIR,—An article in the *Daily Mail* of the 13th inst. gives the details of an interview with Mr. Yerkes, in which he is reported to have said that "it is absurd to talk about covering cables with asbestos and other non-flammable material, as when a wire breaks the current forms an arc, which destroys asbestos as readily as wood." The moral of the article is a good one: that non-flammable wood and fittings should be used on electric trams wherever possible, but the statement regarding the universal inflammability of electric cables is not strictly correct.

As Mr. Yerkes is recognised as an authority in electric railway affairs, may we point out that we make a patent cable which will not take fire, and have used same in pit work extensively, and also upon the rolling-stock of a tunnel electric railway, it being specially examined and passed by the Board of Trade for this purpose.

We agree with Mr. Yerkes that asbestos should not be relied upon. The materials we use are jute and hemp rendered non-flammable by special chemical treatment. This can be applied as an outer cover to any type of cable.

For heavy usage, such as trailing cables, we braid over all with leather strip, and this arrangement has been highly approved of by colliery experts as the safest type in use.

Where such non-flammable cable is used, although an arc may momentarily occur under specially advantageous conditions, there would be no chance of the cable covering itself taking fire, as the *material will not burn*.

We are quite willing to submit this class of cable to any tests that interested persons may desire.—Yours, etc.,

W. T. GLOVER AND CO., LIMITED.

WIRELESS FIRE-ALARMS.

SIR,—I have read the comments you have made after my letter published in your last week's issue, and would say that the condensation of my letter fairly represents my ideas. I note with pleasure that you implicitly admit (1) that wireless telegraphy furnishes the best, and perhaps the only, solution of the conditions printed by the Fire Prevention Congress of London for automatically warning and directing fire stations; (2) that there is not much need to fear that any two fire-alarms will act simultaneously. Concerning the opinion you express in your last paragraph, I consider it quite unjustifiable, because it is impossible to construct an automatic fire-alarm which will not give a false alarm when necessary precautions are taken in the design of the apparatus. In the same way, the authorities in London condemn, generally in a too absolute way, all automatic apparatus without giving the inventors the opportunity of refuting their objections. In short, the question is reduced to the following dilemma. Either it is necessary to use automatic alarms, in which case the fire brigade might be exposed to false alarms; or it is necessary to use fire-alarms which are not automatic, in which case the brigade may be called too late for useful service. It seems to me that the first choice is the better. You say finally: "He does not realise our point that his wireless fire-alarm station would be receiving at odd times Morse code messages from other wireless telegraph systems in the neighbourhood, or from casual experimenters." This seems to me to be so easily avoided that I had hardly thought it necessary to consider the case. If it was not that the apparatus ought to be very simple, I could give a dozen remedies. I will confine myself to two simple ways which are applicable to prevent interference in wireless telegraphy generally. The first is to so arrange the automatic Morse that it will only be unlocked if the telegram is preceded by a certain signal—a very long dash, for example. This will avoid false alarms, but will not avoid trouble during the transmission of the actual signal. The second way is to so regulate the receiver that it would only respond to signals longer than of a certain length—*i.e.*, longer than the ordinary signals. This result can be obtained without any trouble by mechanical means. Again, syntonisation for small distances will largely avoid the danger which you point out.—Yours, etc.,

E. GUARINI.

[We have read the above letter with interest, and are pleased to see Mr. Guarini so hopeful in overcoming the trouble of interference, which still seems to us to be a very real one. As they say, "the proof of the pudding is in the eating," and we await with interest the practical trial on commercial lines of a wireless fire-alarm system. We can only add that we are far from this admission credited to us above, and have yet to be convinced that such a system is advisable or practical.—ED. *E. E.*]

THE SLOT-CONDUIT SYSTEM AND THE SCHUCKERT SURFACE-CONTACT SYSTEM.

Here in England, especially in London, where the question of a system for the electric tramways is at present much in discussion, it is of extreme importance to obtain some particulars regarding the revenue-earning capacity of systems other than the overhead trolley, which is greatly objected to on account of the heavy street traffic.

At the International Tramways and Light Railways Association Congress held at the Agricultural Hall in July, 1902, reports on the experience obtained with various traction systems came up for discussion. Unfortunately time did not permit the question to be adequately discussed, and one had to be satisfied merely with the remarks of Mr. Ziffer, the gentleman chosen to read the paper on underground current supply systems, who referred in particular to the slot-conduit system in Paris and Brussels, and the surface-contact systems of Claret and Vuilleumier, Générale Electric Company Monaco, Diatto, Lorain Steel Company, Kingsland, and Schuckert. The last-named system was worked for two years in Münich in the regular tramway service, after having been examined and tested by the special experts appointed by the Bavarian Government and the Münich Municipality. It had, however, at the time of the congress, already been substantially modified, continuous efforts having been made to further develop it in all its details, so as to enable it to fulfil all working requirements and the other customary conditions laid down for such a traction system.

The system in its present design has attained so high a degree of safety that it is in this, as well as in other respects, a great improvement on the slot-conduit system. It may be mentioned that during the whole period of working of the Schuckert surface-contact system in Münich no single accident occurred, whilst there were eight wire breakages on the overhead trolley. Although the surface-contact section was admittedly very much shorter than the lines equipped on the trolley, yet the fact as stated above is an interesting commentary on the relative safety of the two systems. The only system which offers anything like the same safety for public traffic is the slot-conduit system, but the cost of installation and maintenance is so enormous that only towns having extraordinarily heavy traffic are able to introduce it. Even then towns such as Berlin and Vienna, which have for some time had the slot system in operation, are desirous of abandoning this method of working, as in consequence of the heavy working expenses and the repeated interruptions to traffic, the causes of which are always the same, the slot-conduit system can scarcely lay claim to reliability and economy.

Despite the fact that slot-conduit systems have been for nearly 14 years in service (Budapest) there is very little information available as to the cost of installation and working, and even the statements in the returns issued by the various undertakings differ very substantially. We consider it, however, desirable to utilise those particulars which were furnished by the tramway departments of Brussels and Paris and submitted at the International Tramway Congress, and we furnish herewith as far as possible a statement of working expenses in order to

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compare these with the expense of working the Schuckert surface-contact system.

BRUSSELS SYSTEM.

The Brussels tramway has 6·21 miles double track—*i.e.*, 12·42 miles of the slot-conduit system in operation—and the present lines have been in operation since May and November, 1897. For the maintenance of the slot-conduit system the following staff is required: one track superintendent for the continual examination of insulators, conductors, connections, etc.; four track inspectors; six conduit cleaners to clean out dirt, and from time to time, say every two or three months according to requirements, wash the insulators with water, etc.

In addition, the paving adjacent to the conduit sections entails very considerable cost of maintenance. Another expense in the maintenance arises from the necessity of regulating at special times the distance of the two rails which form the slot. Difficulties are caused in cold weather by the swelling of the pavement and the resultant narrowing of the slot.

The maintenance of the rolling-stock on slot-conduit systems consist mainly in renewing the contact ploughs. This last-named item in the maintenance varies very much, depending largely on the care and attention of the car driver. The cost of the maintenance is reduced by offering the drivers an annual premium provided no contact ploughs are injured. The mistake most frequently made by the drivers is the omission to raise the contact ploughs at the line terminus, thereby allowing them to foul the points. A special item of expense incurred in working the slot-conduit system is the cost of keeping pointsmen at all the junctions which are used in regular service by the cars. As the junctions on a slot-conduit system must be locked, they have to be moved according to the direction in which the car is travelling. The consequences of an incorrect position of the points are so serious, that one cannot leave their manipulation in the hands of drivers or conductors. This is specially the case on lines with heavy traffic. In order to obtain a comprehensive idea as to the working expenses, the following particulars and cost of working a slot-conduit system in comparison with the Schuckert surface-contact system are furnished.

The report of the Brussels tramway did not contain all figures requisite for the preparation of a statement of the working expenses, etc. For instance, in the report the cost of installation of the 6·21 miles (10 km.) double track is given at "£78,430"; but the cost of paving, trenching, and other work in connection with the displacement of the existing water and gas mains, drains, and electric light and telephone wires, etc., is stated at "£2,350 extra per car in service," without mention of the number of cars employed.

The cost for working the points is given at "0·378d. per car mile," but no data is given as to the actual number of car miles run.

In order to ascertain what these important additions to initial cost and working expenses amount to, we will assume that with an 18 hours' service 33 cars run 1,631,988 miles per annum. (This is not too high an estimate, considering the traffic conditions on the line in Brussels.) We thus find that the extra cost incurred in the installation of the slot conduit, owing to the shifting of pipes, etc., in the roadway, amounted to

$$33 \times £2{,}350 = £77{,}550.$$

The cost of working the points amounts to

$$1{,}631{,}988 \times 0{\cdot}378\text{d.} = £2{,}570 \text{ per annum.}$$

Furthermore, assuming the wages of the track superintendent mentioned above at 6s. per day, the four inspectors at each 4s., and the six cleaners at each 3s. 6d., we find that the cost of cleaning the conduit alone costs per annum £821.

The working costs of any system should cover the interest on capital, payment to the sinking fund, and in this case there must be added the cost of cleaning the conduit, and, further, the cost of point shifting.

The total cost of installation, therefore, amounted to

$$£78{,}430 + £77{,}550 = £155{,}980.$$

Comparing this with the cost of installation of a line of same length on the Schuckert surface-contact system under similar conditions in Brussels—viz., £70,588—we find that the conduit system necessitated an additional expenditure of £85,392. The annual charge for interest (4 per cent.) and sinking fund (assuming 21 years) on this sum amounts to £6,086; to this add cost of working points, £2,570, and cost of cleaning the slot conduit, £821, and we have an annual extra cost of working of £9,477 for the 6·21 miles, or £1,526 per mile of double track more than with the Schuckert surface-contact system, inasmuch as the costs for cleaning the conduit and for shifting the points are not incurred with the Schuckert system, and, furthermore, there is no extra expenditure necessary for the shifting of gas or water pipes, etc., as no greater depth of road surface is occupied than necessary for laying the rails.

PARIS SYSTEM.

The Compagnie Générale Parisienne de Tramway, Paris, works municipal lines which are also constructed on the slot-conduit system. This system is employed on three different lines having a total length of 6·52 miles double track—*i.e.*, 13·04 miles conduit. The working expenses of this plant are composed in a similar way to those of the Brussels tramway. The maintenance of the conduit and the accessory parts had up to the time of the report to the International Congress consisted of the replacing of some insulators for the conductor bars and the adjustment of the width of the slot in several places where, owing to the pressure of the wooden pavement, it had become too narrow. The maintenance of the track would probably be about the same as for an ordinary tramway track, but the cost of cleaning the conduit has to be added.

It is also stated in the report that the points of the slot conduit system are far more complicated and susceptible than those of an ordinary tramway line. It is, therefore, necessary to pay special attention to this point, and to employ for the duties of point shifting properly experienced pointsmen at comparatively high wages. It is of interest to have had confirmed that breakdowns have been experienced owing to the points not having been properly shifted, as a consequence of which the plough has been pushed into another track and smashed. The same defects which at once came to light on the first lines equipped on the conduit system, and resulted in interruptions to traffic, have not yet been overcome on the newer and more recently installed lines. When accidents happen with the conduit system the consequences are much more serious, on account of the interruption to traffic. This is especially the case, as there is the danger of the contact plough breaking or sticking in the slot, and should such an accident occur the respective car is brought to a standstill, together with all following cars, the whole service being delayed during the time which the removal of the contact plough requires. With the surface-contact system, however, it is always possible to have any car which is accidentally injured pushed forward by the car following immediately behind it. So far as the maintenance of the rolling-stock is concerned, only the wear of the contact plough has to be taken into account. Such a plough is far more expensive than the trolley wheels, but as it is stated that the life of the former is much longer (about 10,000 car miles), the costs per car mile should be in both cases about the same. The cost for renewing the linked chain skate used in the Schuckert system works out at approximately the same per car mile. A further increase of the working costs will be caused by dividing up the feeders into sections of about 1,000m. to 1,500m. This is necessary in order to be able to switch over the different sections of the line, so as to as far as possible avoid disturbances and breakdowns in case the insulation has become faulty. It is claimed that the current losses are so small that under the worst working conditions they will scarcely exceed a few amperes for the entire system. It must, however, be again pointed out that current losses depend directly on the attention paid to the maintenance of the entire plant—that is to say, these losses vary according to the state of the insulation at any time. The insulation of the underground conductor is, in consequence of the climatic conditions,

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subjected to considerable variations, and it is necessary to wash from time to time the insulators in the conduit if heavy current losses are to be avoided. It is therefore safe to maintain that the construction of the slot-conduit system in no wise excludes, as often erroneously assumed, the possibility of current leakages.

In order to ascertain the revenue-earning capacity of the Paris slot-conduit system, it is necessary to make an assumption with regard to the car mileage, as also in this case exact figures are not given in the official returns. We will, therefore, in order to make a comparison with the surface-contact system, assume for the purpose of calculation the same figures as for Brussels—viz., 1,631,988 car miles with 33 cars running 18 hours per day. The length of the line is 6·52 miles double track—*i.e.*, 13·12 miles conduit.

For the construction of 13·04 miles single track the cost of installation works out at "about £218,235," including earthwork and paving, the construction of the slot conduit, the track laying, connection to the drains, displacement of gas and water mains lying in the path of the conduit. The expenses for cleaning the conduit of the entire line per year are given at "£1,729." The costs for controlling the points per year are not given, and we will, therefore, assume the same figures as for Brussels—viz., £2,570.

The cost of installing the Schuckert surface-contact system on a line of same length under similar conditions in Paris would not be more than £75,660. Deducting this sum from the cost of the slot-conduit system—£218,235—we find that the latter has cost £142,575 more. Interest at 4 per cent. and sinking fund spread over 21 years will require on the extra cost of installation £10,162 per annum. Adding to this cost of cleaning conduit, "£1,729," and cost of controlling switch points, £2,570, we find that the 6·52 miles of double track costs £14,461 per annum—*i.e.*, £2,217 per mile double track—more than the Schuckert system. With this latter system there would also be a considerable saving in working expenses in consequence of the smaller sum required for interest and redemption of the initial outlay, and no charges for cleaning the conduit, adjusting the points, and shifting the telephone wires and gas and water pipes.

As a matter of fact the working expenses of the slot-conduit system will be, indeed, very substantially higher, as one must allow a certain percentage for the current losses on the conduit system, if great care is not taken to clean the insulators in the conduit at frequent intervals, and to keep the whole system throughout in perfect order.

The switchboard plant in the central station and the complete installation of a slot-conduit system involves a substantially greater expense, inasmuch, as already reported by the Compagnie Générale de Parisienne, the conduit line is divided into sections of 1,000-1,500m., and each of these sections is connected by separate feeding cables with the switchboard installation.

This should be sufficient to prove the correctness of the general assumption that the cost of working a slot-conduit system is substantially higher than that involved in working the overhead system. If the Brussels Tramway Company, in answering the enquiry sheet for the twelfth general meeting of the International Tramway Association, states: "Although generally speaking, the cost of installation of the slot-conduit system is much more expensive than that of the overhead-wire system, yet the difference in working expenses is not very considerable," then it is not taken into consideration that the working cost is made up of the interest and sinking fund charges on the cost of installation plus the cost of maintenance of the entire plant, and the cost of pointsmen and conduit cleaners are forgotten. The cost of maintenance is also substantially higher than that of the Schuckert surface-contact system, as will be perceived from the above figures. That it is higher than on lines equipped with the overhead system is proved by the returns of the various undertakings.

In comparison with all other existing systems, the Schuckert surface-contact system has with the overhead system the lowest working charges, and it has been proved by practical experience that the Schuckert system in its present form does not require higher maintenance charges than the overhead system. The cost of installation is very much lower than that of the slot-conduit system, and is, as compared with it, not so high that a line so equipped would only pay with extremely heavy traffic. The Schuckert system can, therefore, on account of its safe and efficient working, claim to be adapted to replace the overhead system in all streets in which the conditions of heavy traffic do not allow of the adoption of the overhead system.

The great objections often brought forward against the introduction of a surface-contact system are entirely set aside by the results obtained with the Schuckert system in practical working, and it can safely be claimed that this system, in comparison with all others, possesses the following advantages:

1. Higher guarantees for safe and regular working than any other system.
2. Simple and rapid track installation without inconvenience to ordinary traffic.
3. Better insulation, and consequently lower current consumption, than with any other system.
4. Facility of adopting any existing standard car for the surface-contact system.
5. Ease with which cars can be made to travel in either direction without necessitating the driver leaving the car for switching over the apparatus.
6. Convenience for use with combined systems, where the overhead trolley is used on the outlying portions of the town and underground supply within the town area, the only necessity being to replace the trolley pole when passing to the overhead sections.
7. No possibility of danger from live studs, as the switches are interconnected in such a way that the same current which closes the switch to a stud over which the car has just arrived forcibly opens the switch of a corresponding stud which the car is just leaving; this latter stud being rendered inactive before it is exposed. In the exceptional case of this action failing, three different and independent safety devices come into operation to cut off the current supply on the 100 yards section on which the car happens to be situated.
8. All working parts easily accessible for inspection and localisation of faults.
9. Cost of maintenance not more than that of the overhead trolley system.

QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any questions should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

611. Two 300-kw. alternators running in parallel and fully loaded, when a short-circuit occurs on one of the high-tension feeders. After the feeder being made dead, the two machines are put in parallel again on the 'bus bars (with no load). Would it be safe to switch in the remaining (say six) feeders one by one?—P. C. S.

612. Are shunt motors of the same brake horse-power ever wound to give different starting torques? If so, what is the practical maximum torque per brake horse-power in pounds-feet that can be obtained?—F. E. H.

ANSWERS.

Question No. 603.—Why do some firms use star and mesh starting switch on squirrel-cage three-phase motors, and does star coupling increase the torque and reduce the current taken for a given starting torque, or is the torque greater when mesh coupled, the turns per phase being the same in each case?

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Best Answer to No. 603 (*awarded* 10*s.*).—Star and mesh starting switches are usually employed for increasing the starting torque, the motor being normally star coupled and being changed to mesh whilst starting. This has the effect of increasing the volts per phase (A to B, Figs. 1 and 2) at starting in the ratio of 1 : 1·73, and since the maximum starting torque varies approximately as the square of the volts per phase, this torque is increased in the ratio of 1 : $(1{\cdot}73)^2$ or 1 : 3.

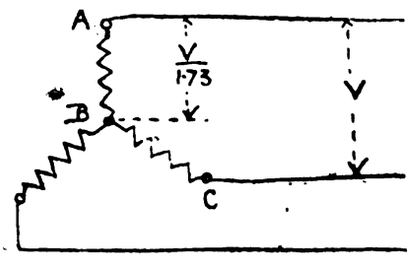

FIG. 1.

Occasionally, however, in the case of motors intended to start at light load the above connections are reversed, the normal condition being the mesh connection, and this being changed to the star connection for starting. This has the same effect as reducing the volts per phase by an auto-transformer, and reduces the initial rush of current when starting up light, though at the same time it reduces the starting torque and the motor requires a longer time to reach full speed.

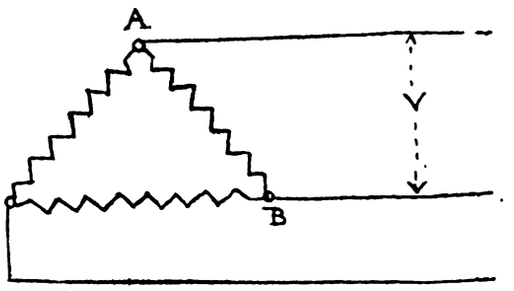

FIG. 2.

With regard to the latter part of the question, if by the "turns per phase" the number of turns between A and B in Figs. 1 and 2 is meant, the star connection will give a lower maximum starting torque per ampere taken from the line than the mesh connection in the ratio of 1 : 1·73. If, however, the total turns from A to C in Fig. 1 are equal to the turns from A to B in Fig. 2, the star connection would give the same torque per ampere taken from the line as the mesh connection. In all cases the maximum starting torque depends on the volts per turn of winding—*i.e.*, the flux—as well as the total turns per phase, but not directly on the method of connection, whether mesh or star. The latter is, however, more commonly employed, as it prevents the possibility of idle currents circulating in the windings.—Q.

Answer to No. 603 (*awarded* 7*s.* 6*d.*).—The "star" connection of the coils of a three-phase motor offers advantages to the manufacturer over the "delta" or mesh grouping. With the latter arrangement of the coils the voltage per phase is equal to the voltage between the line wires, while with the Y grouping the voltage per phase is equal to the line voltage divided by $\sqrt{3}$ (= 1·732). The constructional advantages secured by the adoption of the Y grouping will be apparent (especially in high-voltage machines) when consideration is given to the insulation of the conductors and section of iron required for the stator. An example will best serve to bring out this last point: three-phase motor, 150 h.p, 600 revolutions per minute, 550 volts, eight poles, 40 periods per second. The voltage per phase with Δ connection of the stator will be 550 volts, and with Y connection will be $\frac{550}{\sqrt{3}}$ = 320 volts. For the purposes of this example we will assume the same drop in the winding for each case—viz., 20 volts. Hence the back E.M.F. to be generated in the stator coils is 530 volts for the Δ and 300 volts for the Y grouping. We will consider the same number of turns in series per phase in each case—viz., 80. A convenient formula for the flux to be produced in the stator in order to generate the requisite back E.M.F. is the following*:

$$M = \frac{E \times 10^8}{4{\cdot}44\ T\ N},$$

where E is the effective E.M.F. generated in volts;
T the number of turns in series per phase;
N the number of magnetic cycles per second (equal to the periodicity); and
M the number of C.G.S. lines *simultaneously* linked with the T turns.

Inserting the above values for these terms, we get for the Y grouping $M = \frac{300 \times 10^8}{4{\cdot}44 \times 80 \times 40} = 2{\cdot}15$ megalines, and for the Δ grouping $M = \frac{530 \times 10^8}{4{\cdot}44 \times 80 \times 40} = 3{\cdot}72$ megalines. Considering the fact that the magnetic circuit of an induction motor is worked at a low density—about 40 kilolines per square inch—it will be evident that the Y grouping offers advantages to the manufacturer, notwithstanding that the current in the conductors is $\sqrt{3}$ greater than that with the Δ grouping. If, however, a large starting torque is required, the Δ grouping should be adopted. This will readily be seen from the following formula for the torque:

$$T = s\,.\,B_m{}^2\,K,$$

where T is the torque in pounds-feet;
s the slip;
B_m the maximum value of the flux density in the air-gap; and
K a constant depending on the mechanical construction of the motor.

Now, for the same slip the torque is proportional to $B_m{}^2$, and B_m is proportional to the total flux in the stator. The total flux, as will be seen on reference to the first equation, is proportional to E—the voltage per phase of the stator winding. This depends on the grouping, and hence for the same turns per phase the torque will be about 75 per cent. greater when the stator coils are connected Δ fashion than when they are connected in Y, other things, of course, remaining the same.

Advantage is taken of this fact in polyphase electric railways for giving a good starting torque. The ends of the stator coils are brought out to a special switch, which is arranged so that at starting the stator coils are Δ connected, and as soon as the car is under weigh, the switch is thrown over, connecting the stator coils in Y fashion. This arrangement for temporarily increasing the torque of a three-phase motor is much advocated by Mr. C. E. L. Brown, and is adopted by the firm of Brown, Boveri, and Co. on their polyphase mountain railways.

For the same horse-power output the current in the conductors with the Y grouping will be $\sqrt{3}$ times greater than that with the Δ grouping. The line current in each case will be the same as that in the conductors when the Δ grouping is employed. It will now be apparent that for high-voltage machines it is advantageous for the manufacturer to adopt the Y grouping, while for low voltages it is more economical to substitute the Δ grouping. In the former case a saving of iron is effected, and in the latter a saving in copper. In the above comparison between the two methods an ordinary case is taken, in which only a normal starting torque is required; special cases, in which a very great starting torque is required, would, of course, be met by the adoption of the Δ grouping.—A. D.

Answer to No. 603 (*awarded* 5*s.*).—There are comparatively few firms who have installed motors which are so arranged, the reason being that the conditions which demand the arrangement are very infrequent. The writer has installed motors so arranged in works where starting apparatus, whether auto-transformer or rheostat, would be inadmissible by reason of the unsuitable environment or rough class of labour. Consulting engineers and their

* This formula is due to Mr. H. F. Parshall. (See "Electric Generators," by Parshall and Hobart, p. 80.)

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clients sometimes object to any form of starter for three-phase motors in such places as foundries and chemical works, where the labour is frequently of a very rough class, and anything which can be damaged is generally the object of the workman's unremitting attention.

The disadvantages of switching a three-phase motor with a squirrel-cage rotor directly on to the mains, even when the load is comparatively small, are sufficiently well known. To obviate these, the motor, instead of having its three windings connected permanently in star or mesh, has the ends of each phase brought out to two terminals, consequently the motor has six instead of three terminals. These are connected to a simple rotary or change-over switch, in one position of which the three inner ends of the phases are connected together, thus forming the middle of the star. In the next position (the running position) the ends are connected in mesh, the proceeding being obviously a simple one. A motor of this kind is invariably switched into circuit with the coils in star connection. If it is wound to operate at the usual line pressure in mesh connection, as it should be, it will, in star connection, present $\sqrt{3}$ times the impedance to the passage of the current, as the turns across each line wire have been increased in this proportion; therefore, the initial current, which might reach three to five times the full-load amperes, is reduced to from 1·73 to 2·9 times the full-load current, a figure which is not objectionable with small motors. Of course, if the motor has any considerable work to do in starting it will take longer to accelerate when started as above, as the current per pole and phase has been reduced, and, therefore, also the torque (roughly as the square of the stator current), hence small reductions in the stator current have a very prejudicial influence on the starting torque, and the system is only employed when the motors are used to drive shafting or light machinery. Considering the advantages of starting induction motors by other methods, the star mesh system is only likely to be employed under the unusual conditions already indicated.—ELECTRA.

Answer to No. 603 (*awarded* 5*s.*).—The reason why a star and mesh starting switch is sometimes used with a squirrel-cage three-phase motors is that by starting the motor with the windings star connected a greatly reduced current is taken from the mains than with the normal or mesh connection. The starting torque is also correspondingly reduced, and in the same ratio as the current. In other words, the starting torque per ampere remains the same whether a star or mesh coupling be used. This can most readily be seen by taking a concrete case. Let us consider a three-phase motor wound for 200 volts, and having a stationary impedance of, say, five ohms per winding. Suppose the stator is normally connected "mesh" when running, and that it is thrown direct on to the mains.

The current per winding at starting will be $200 \div 5 = 48$ amperes, and that taken from the mains $\sqrt{3} \times 40 = 69{\cdot}3$ amperes. The torque will be proportional to the square of the current in the windings, and for comparative purposes we may call the toque $40^2 = 1{,}600$. The torque per ampere will be $1{,}600 \div 69{\cdot}3 = 23{\cdot}1$.

Now, taking the case of the same motor star connected, we find the voltage on each winding to be $200 \div \sqrt{3} = 115{\cdot}5$ volts. The current per phase is $115{\cdot}5 \div 5 = 23{\cdot}1$ amperes, which is also the line current. The torque is therefore represented by $23{\cdot}1^2 = 533$, and the torque per ampere 23·1. From these figures it may be seen that starting with the windings in star reduces the starting current and torque to one-third, but gives the same torque per ampere input. Starting the motor in this way gives the same values of torque and current as starting with an auto-transformer or compensator having a ratio of $\sqrt{3}$ to 1. Starting with a choking coil or resistance in series with the motor would not be so advantageous, as the torque would decrease with the square of the current taken from the mains.—R. C.

Question No. 604.—Describe how the two motors on an electric tramcar are connected up when braking with rheostatic brake, giving sketch showing path of current.

Best Answer to No. 604 (*awarded* 10*s.*).—The principle upon which a brake of the type specified in the question acts is that which involves the conversion of the motors into generators, and this idea has been the means of introducing a number of electromagnetic devices which are most effective as braking appliances. There are several essential arrangements which must be made in the application of such a brake before that brake can be used to advantage. In the first place, all connection with the source of supply must be broken—that is, the motor equipment must be isolated from the system—otherwise no braking effect could be obtained by the motors; also, the field windings of the motors must be reversed. For since the current generated by a series motor driven as a generator is opposite in direction to that current which must

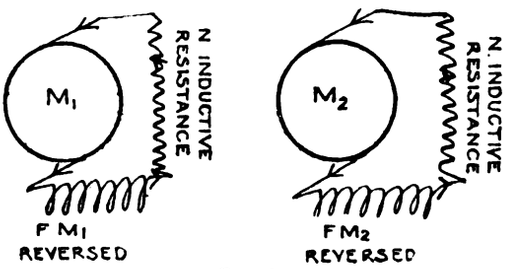

FIG. 1.

be supplied to the series motor to drive it as a motor in the same direction, therefore if the field windings are not reversed, the result will be that the first effect of generation will be to oppose the residual magnetism in the field magnets and then reduce it to zero. And when once that position is attained, it cannot be altered until the supply is brought into requisition again. In a two-motor equipment either the motors can act independently as generators, sending a current through a resistance, or either they can both be connected up together and act jointly as generators.

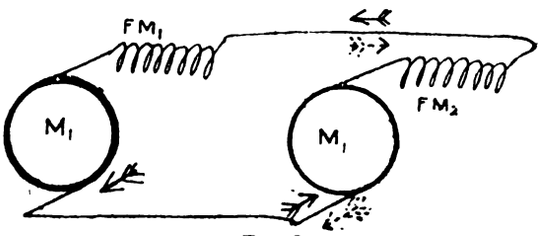

FIG. 2.

Fig. 1 is a diagram of the connections where both motors are connected separately with resistance in circuit. This resistance is gradually taken out until practically the motors are short-circuited, with only their individual armatures and field windings in circuit; and by this means only the brake is sometimes actuated and applied. Another method is that of continuing the above method and connecting the two machines together in parallel. As such each acts as a generator and generates an E.M.F., and on closing the circuit these two distinct voltages oppose each other, and if they were equal would annul each other.

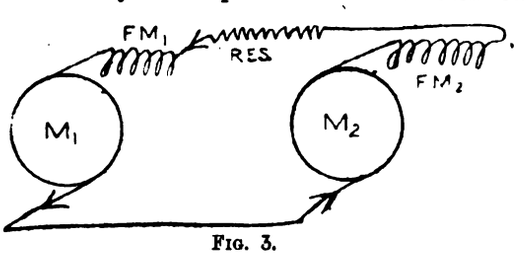

FIG. 3.

This point of equality is never desired, for no braking effect could be obtained with such a state. Such a condition is never obtained in practice Either the permeability of the field magnets of the two motors varies, or else there is some other slight difference in the construction of the motors. In Fig. 2 we have the connections of such an arrangement. The tendency of currents due to the separate and opposite E.M.F. is shown by the full arrow head and the dotted arrow head. The stronger E.M.F. overcomes the weaker one, however, and reverses its field. This reversion in the field produces a likewise reversion in the direction of the current generated by that

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machine, and this current then increases the current flowing through the whole circuit, which is shown by the full arrow head. The motors are now in series, and as such help each, with the result that, with only the field windings and armatures of the two motors in circuit, an enormous current traverses that circuit, and produces a good braking action. And this current is maintained until the momentum of the car is checked.

Fig. 3 shows the arrangement of connecting the motors together directly in series, and with resistance in circuit. In this case the direction of the currents generated by the respective machines are the same on the first application of the brake. With a resistance in circuit, however, the current does not rise immediately to a great value. But the current is gradually increased by cutting the resistance out, and with all of it out, the case is identical with the second of the above cases.

The current generated in either of the above cases can, whilst producing a braking effect in the armature of the motor, be used in the braking appliances. These may be either magnetic track brakes, disc brakes, or Foucault current brakes, which are all energised by the current generated by the motors.—G. W. B.

Answer to No. 604 (*awarded 7s. 6d.*).—The controller of a tramcar using electric brakes is arranged so that by moving the handle from zero in one direction supplies the motors with energy from the trolley wire, and moving it from zero in the other direction disconnects the motors from the line and short-circuits the motors through a graduated resistance and generally also through an electro-magnetic brake. One type of magnetic brake consists of two cast-iron discs, one of which is fixed to the motor and has a coil of wire wrapped round it, the other is keyed on the axle. The braking action is due to three causes: (1) car is driving the motors as generators and thus doing work, the amount of which can be varied by adjusting the external resistance in motor circuit, and thus the speed of the car is retarded to a greater or less extent; (2) the magnet brake discs are brought into close contact with the axle discs, and resultant friction diminishes the speed of the car; (3) eddy currents are set up in the brake discs as they revolve in the intense magnetic field of the magnet brake discs, and these cause speed to be retarded.

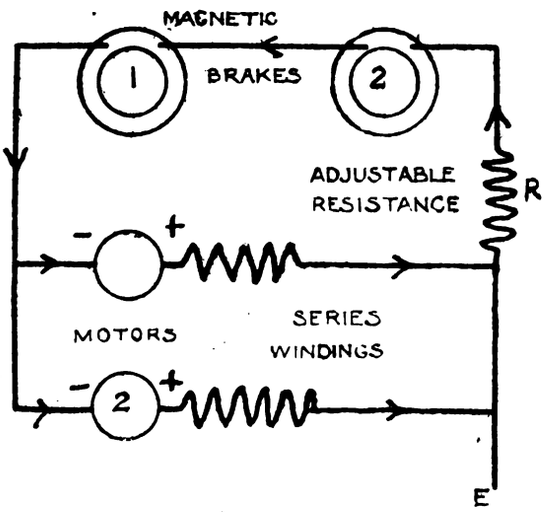

FIG. 1.

The path of the current generated by the two motors when driven by the impetus of the car is clearly shown in Fig. 1. When the electric brake is used, the controller handle must be moved to the first notch of the adjustable resistance, R. The motors start generating current and the speed of the car is retarded. This causes the current generated to drop, and the controller handle is made to cut out more resistance. This brings up the current again, and the speed is again retarded and so on. There is never any need to reverse the motors on a car having electric brakes, as the car can be stopped as quick or quicker than reversing, and without the severe strains thrown on motors and gearing by reversing.

It has been found in practice, that even with electric brakes skidding of car wheels may take place if the full current from the motors were free to flow through magnet discs, as the first flow of current is far in excess of that necessary to stop wheels, and the surplus only heats the motors. To overcome this difficulty, an arrangement known as a "limit switch" has been provided, which consists of a solenoid in series with brake discs, this raising an iron core attached to the switch and causing it to make connection with earth. The connections are shown in Fig. 2. The brake is applied by switching on to the

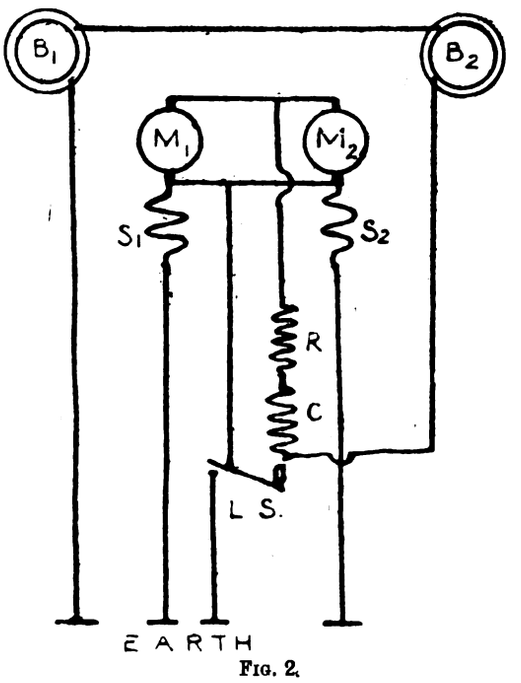

FIG. 2.

first notch of adjustable resistance, R, a current is generated by the motors, M_1 and M_2, which passes through the series windings, S_1 S_2, to rails, then to brakes, B_1 B_2, through solenoid, C, and resistance, R, back to motors. The limit switch, L S, acts against a tension spring, which can be adjusted so that the switch will short-circuit the series windings, thus stopping the current at a point that will prevent the car wheels skidding. Under average track conditions and with ordinary tramcar the switch should be adjusted to act when the current reaches between 30 and 35 amperes. By this means skidding is avoided, and, therefore, flats are not made on the car wheels, and also undue heating and straining of the motors does not take place (Fig. 2).

The metal of which the brake discs are made must be very hard, or excessive wearing takes place. Owing to the hardness of the metal, the discs were found to stick together after the current was taken off, this being due to residual magnetism. This was a disadvantage, as more current was taken to start the car in order to overcome the sticking of the brakes. This difficulty has been overcome by connecting the brake circuit through a resistance in shunt with the first running position of the controller, by which means a weak current is sent through the brake magnets as soon as the handle is moved to start the car. The shunted current flows in the reverse direction to that sent round the magnet coils by the motors, and overcomes any residual magnetism that may be present in the discs.

The electric brake is intended for all service stops, as well as emergency stops, but will not hold the car stationary on an incline. The hand-brakes must be applied for this purpose.

I am indebted for the details of the limit switch to a paper read by Mr. Baylor before the Institution some time ago.—W. A. T.

Answer to No. 604 (*awarded 7s. 6d.*).—There are numerous advantages attending the use of the rheostatic brake on electric tramcars, which may be briefly summarised as follows: the application of the brake requires no exertion of the motorman; the brake is automatic, as far as "skidding" of the wheels is concerned, for if the latter

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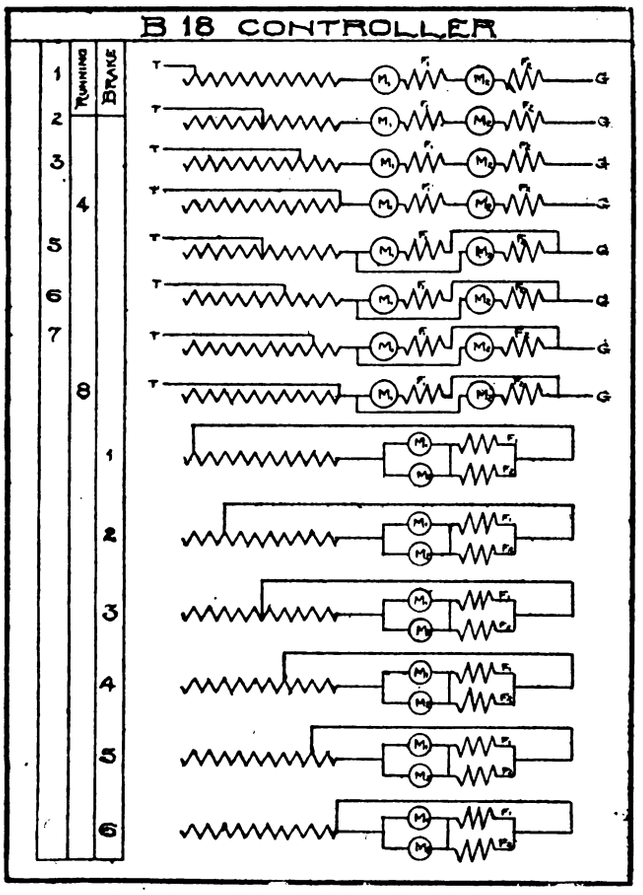
"skid" the brake ceases to act, provided, of course, that they are not locked by the hand-brake; the motorman can bring the full braking force into operation in a very short space of time, thereby being of great service in cases of emergency. The controllers for use with the rheostatic electric brake are very similar to the standard controllers for a two-motor equipment without brake. The "power" notches are exactly the same, but there are some additional notches after the controller has been thrown into the "off" position. These additional notches constitute the rheostatic brake, which is brought into operation by moving the controller handle backwards beyond the "off" position. The motors are then connected up as generators working on resistance, the latter being gradually cut out until the former are short-circuited. The motors are thus made to absorb the momentum acquired by the motion of the car, and exert a very powerful braking effect.



Connections made by a B 18 Controller of the British Thomson-Houston Company.

The accompanying diagram shows the combinations made by a "B 18" series-parallel controller of the British Thomson-Houston Company, Limited. This type of controller is made for a car equipment of two 35-h.p. 500-volt motors, and is in operation on the London United Tramways and also on numerous other tramways. There are eight "power" notches and six "brake" notches. The diagram shows the connections for "power" as well as for "brake." The numbers in the first column are the "resistance" notches, those in the second the "running" notches, and those in the last the "brake" notches. On reference to the diagram it will be observed that, in braking, the motors are connected up as series generators in parallel, the full starting resistance being inserted in the external circuit on the first brake notch. The value of this resistance is reduced to one half at the third notch, and this is gradually reduced until, at the sixth notch, the motors are short-circuited. With a four-motor equipment the resistance connections are the same as shown in the diagram, and the four motors are connected all in parallel. The No. 5,915 controller for two 30-h.p. 500-volt motors of the Westinghouse has only five "brake" notches, arranged similar to those shown above, but this controller has also only seven "power" notches.

It should be mentioned that the letters G and T in the diagram refer to "ground" and "trolley" connections, and in braking the motors are entirely independent of the trolley connection. The field coils of each motor are represented by F_1 and F_2 respectively.

It is of great importance when using the rheostatic brake to have the hand-brake "off," so that the wheels cannot become locked, thereby rendering the rheostatic brake inoperative. The cause of the recent accident on the Chatham tramways was attributed to inattention to this point, the hand-brake in this case being "hard on" and three notches of the electric brake also. The wheels were locked by the hand-brake, and thus the "electric" brake was rendered useless

When the rheostatic brake is applied suddenly a liberal supply of sand should be given to the wheels, otherwise "skidding" will result. By giving careful attention to this and the previous point, the rheostatic brake can be relied on, especially in cases of emergency. It has one very great advantage over mechanical brakes—viz., that no exertion on the part of the motorman is required for its application—and this is a great feature for cases of emergency. Continual use of this brake certainly gives the motors a "hard time," but considerable weight ought not to be attached to this considering the way tramway motors are now standardised by the leading manufacturers. A. D.

PERSONAL.

Mr. J. M. Keenan, A.M.I.C.E., who for about 12 months has been chief assistant engineer at the Taunton Corporation electricity works, has obtained the appointment of chief assistant engineer at the Torquay Corporation's electric lighting works.

The salary of Mr. H. B. Pooley, gas and electricity manager, Stafford, has been increased from £400 to £450 per annum.

FORTHCOMING EVENTS.

Iron and Steel Institute.—Summer meeting, Barrow-in-Furness, September 1-4.

Institution of Civil Engineers.—Birmingham Students' visit: September to Rhayader.

Municipal and County Engineers.—Meetings: Aberdeen, Aug. 20, 21, and 22; Hastings, September 11 and 12.

British Association.—Seventy-third annual meeting, September 9, Southport.

APPOINTMENTS VACANT.

Chief Assistant Engineers, Hull Corporation, £200 per annum. See advertisement.—Ipswich, salary to commence at £160 per annum. See advertisement in last issue.

Assistant Electrical Engineer, Londonderry, £130 per annum. See advertisement.

Lecturer, Hull Municipal Technical School, £150 per annum. See advertisement in last issue.

Mains Superintendent, Bury, £120, rising to £150 per annum. See advertisement in last issue.

Pupil or Junior Draughtsman. See advertisement in last issue.

Canvassers. See advertisement in last issue.

Three Charge Engineers, Ipswich, salary to commence at £90 per annum. See advertisement in former issue.

Two Switchboard Attendants, Ipswich, salary to commence at £60 per annum. See advertisement in former issue.

Instructor in Mathematics, Governing Body of the Northampton Institute, Aug. 24.

Assistant in the Distribution Department, Croydon. Salary to commence 20s. to 25s. per week, according to qualifications. See advertisement.

Switchboard Attendant. Salary, 10s. per week. See advertisement.

City Electrical Engineer, Bradford. Salary, £600 per annum, by 27th inst.

Imperial Tramways Co.—The directors have declared an interim dividend on the ordinary shares at the rate of 8 per cent. per annum for the half-year ended June 30 last.

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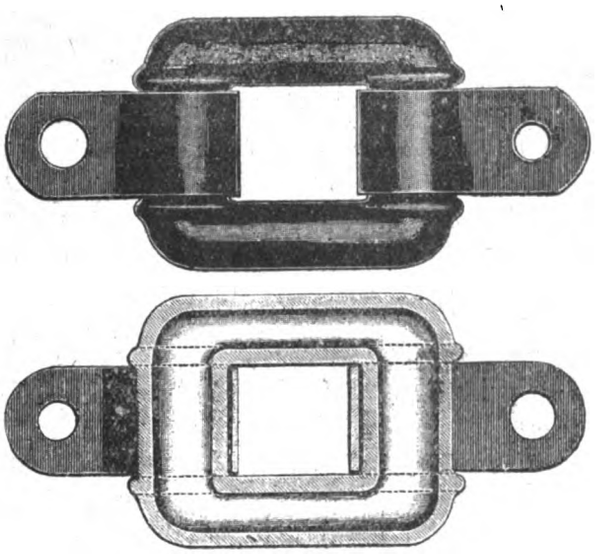
TRADE NOTICES AND NOVELTIES.

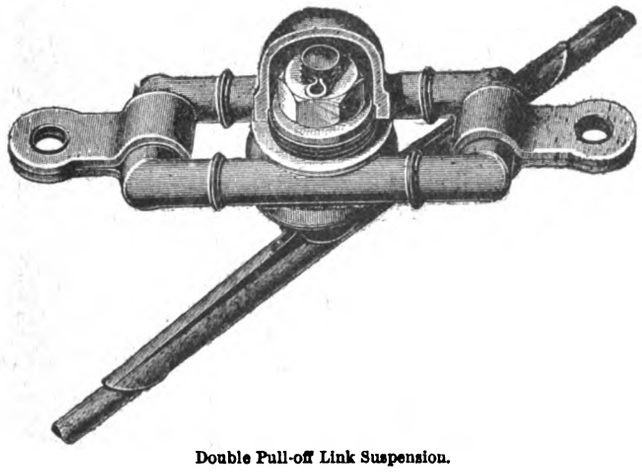
Griffin Insulators.

We illustrate herewith a new type of insulator for overhead trolley wires which has been brought to our notice by Messrs. George Hill and Co., Trafford Electric Works, Cornbrook, Manchester. The single-link strain insulator is designed to replace the globe strain type of insulator, while the double



Single-Link Strain Insulator.

pull-off link suspension replaces at the same time the insulating support for the overhead conductor—*i.e.*, the cap or cone insulator or the insulating carrier bolt, and also the two globe insulators, whereby it is claimed the cost of insulation can be considerably reduced, more especially for single-track roads. It is further claimed that these insulators have an almost unlimited life, since the metal parts are covered with Griffin insulating material, a special kind of ebonite which is extremely



Double Pull-off Link Suspension.

tough and resistant to atmospheric influences. Another advantage claimed for them is that each link provides a double layer of insulation. For further information regarding this type of insulator we must refer the reader to a couple of leaflets on the subject issued by the above firm. A third leaflet emanating from the same source describes the patent comb lightning arrester suitable for use with low and medium pressures.

G.E.C. Leaflet.

From the General Electric Company, Limited, 71, Queen Victoria-street, London, E.C., we have recently received a copy of their "Progress" leaflet for August, in connection with which attention is directed to the reduction the firm are able to make in the prices of their well-known "Peel" switches and other electrical accessories. The "Little Geeko" telephone, which the firm supply for connecting to existing bell wires, is illustrated among other apparatus. This telephone, in every sense a serviceable instrument, may be obtained at prices ranging from the remarkably low one of 7s. 6d. upwards. It represents the capability of British enterprise in regard to the production of such apparatus at a low cost. The special lines of traction supplies listed should commend themselves to tramway engineers. Particular reference may be made to the "Acme" patent splicing sleeve, illustrated herewith. This sleeve was invented by Mr. R. Humphries, chief engineer and manager of the Isle of Thanet Tramways and Lighting Company, Limited, and is claimed to be the most efficient emergency splicer in the market, being equally suitable for temporary or permanent joints. By its means a thoroughly good joint can be made in the trolley wire in the course of a few minutes, and the splice can be permanently soldered up at any convenient time. Directions for using this splicing sleeve are given in the leaflet.

Acme Patent Splicing Sleeve.

New Railway Level.

An improved type of railway level has recently been brought to our notice by Messrs. W. F. Stanley and Co., Limited, Great Turnstile, Holborn, London, W.C. In this level the centre is cast in one piece with, and directly upon, the telescope body and object end. The cast telescope body is cored out to a suitable thickness, so that, although of vastly greater strength and rigidity, it does not weigh as much as the old form of tubular body, collars and stage, while it does away with many separate pieces which are usually soldered and screwed together. The rack is fixed under the drawtube and the pinion is fitted from side to side of the outer cast body, and spindled at each end, so that the pinion has a double bearing in the cast body, which adds greatly to its strength. The level is fitted with clamp and tangent adjustment, tribrach levelling, and patent locking plate so that the level can be used on a wall or masonry as well as on the tripod. The diaphragm is fitted, at the option of the purchaser, with (*a*) webs, (*b*) platinum-iridium points or (*c*) lines on glass. The two latter are set for stadia reading, 1 : 100, so that the distance of the staff is read in the telescope without other measurement. The points do not cover up the divisions of the staff, are permanent in all climates, and may be dusted with a brush. It is claimed that this level is the strongest and most compact yet made.

Electric Bells and Accessories.

From Mr. G. Braulik, 217-218, Upper Thames-street, London, E.C., we have received a copy of the eighth edition of his catalogue (Section B) of electric bells and accessories. This catalogue has attained considerable dimensions, running into some 80 odd pages, and its contents comprise electric bells in great variety, also accessories—such as relays, terminals, indicators, pushes, switches, contacts, staples, wires, jointing materials, wireman's tools, insulators, batteries, magneto machines, battery lamps, holders, etc. We have also received recently from Mr. Braulik a copy of his new list, E M, in which full particulars are given regarding "Eclipse" electricity meters.

The Stirling Boiler.

The Stirling Company, 53, Deansgate-arcade, Manchester, have sent us a copy of their new pamphlet (No. 12), entitled "Economical Steam Raising," which gives some interesting information relative to the Stirling water-tube boiler. We understand that the company will be pleased to send a copy of this pamphlet to any of our readers on application.

Cables, Etc.

We have received from the St. Helens Cable Company, Limited, Warrington, a copy of their new catalogue. In this catalogue full particulars and prices are given of the various types of vulcanised-rubber cables, paper cables, and vulcanised-dialite cables manufactured by the firm. Separate sections are devoted respectively to mechanical rubber goods, asbestos goods, belting, etc.; indiarubber hose, etc.; coachbuilders' requisites, such as "Diallte" mats, carriage tyres, brake blocks, etc.; cycle specialities, including outer covers, pedal rubbers, etc.; and last, but not least, tramway overhead equipments. In the latter section some particulars relating to "Diamant," the firm's new insulating line material, are included. We are told that "Diamant" insulation is tough, resonant when struck, can be dropped on to stone or iron from a height of 25ft. without break or fracture, and is non-hygroscopic, practically non-absorbent, and unaffected by temperature changes. Excellent figures are quoted as the result of severe tests to which the material has been subjected experimentally. It is not necessary to enumerate the various types of pull-offs, hangers,

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insulators, cars, etc., illustrated. Sufficient has already been said to indicate the diversity of the manufactures turned out by the St. Helens Cable Company. It may be mentioned, however, that the list under notice contains also some excellent interior views of the company's works. We understand that the company is now under entirely new management. Only the most skilled hands are employed in the factory. With regard to cables, these are never sent out of the works unless they have passed the guaranteed test after 24 hours' immersion in water, records of all tests being kept for reference.

Large Order.

In connection with the description of a patent serrated type of oil-can which appeared in our issue of May 29 last, it may interest our readers to know that the makers, Messrs. Joseph Kaye and Sons, Limited, Leeds, have 7,600 of these cans on order for his Majesty's navy.

Steam Accessories.

A new catalogue of steam accessories for central power plants recently issued by the Sir Hiram Maxim Electrical and Engineering Company, Limited, 65 to 67, Gracechurch-street, E.C., contains illustrations of some of the numerous installations of steam-pipes and condensing apparatus, etc., erected by the firm; also full particulars of the "Warwick" detartariser, the "Berryman" improved feed-water heater, the "Berryman" surface condenser, Wright's improved water softener and filter, Paterson's system of condensed water purification, etc.

NEWCASTLE CORPORATION TRAMWAYS.

The following summary of information regarding the tramways as at March 25, 1903, is taken from the report of the general manager and engineer, Mr. A. E. le Rossignol, M.I.E.E.

Single miles of line open for traffic	38½
Passengers carried during year	33,474,122
Population of Newcastle	219,150
Average journeys *per capita* per annum	153
Car mileage run during the year	3,379,119
Average number of passengers per car mile	9·9
Average fare per passenger	1·08d.
Traffic revenue for the year	£150,334. 5s. 8d.
Average traffic revenue per car mile	10·675d.
Total revenue for the year	£153,822. 1s. 8d.
Average total revenue per car mile	10·93d.
Total working expenses for the year (including street-lighting)	£89,313. 2s. 2d.
Average total working expenses per car mile	6·344d.
Average net working expenses per car mile (excluding proportion of costs chargeable to street-lighting)	6·174d.
Percentage of net working expenses to traffic receipts	57·84 per cent.
Total capital expenditure at March 25, 1903	£903,594. 0s. 6d.
Total number of cars in stock at March 25, 1903	148
Number of cars in course of construction	17

HALIFAX ELECTRICITY ACCOUNTS.

The accounts of the Halifax electricity undertaking for the past year show that the expenditure on capital account on March 31 last amounted to £214,056. Below we give abstracts of the revenue account and the general balance-sheet, together with a statement of the electricity generated, sold, etc.

REVENUE ACCOUNT.

Dr. Expenditure.	£	s.	d.
Coal	5,979	8	4
Oil, engine-room stores, etc.	977	11	3
Wages at station	2,172	18	7
Repairs to generating plant, etc.	2,132	13	3
Wages of meter inspectors, etc.	600	19	4
Materials	337	2	8
Paving and coke	22	6	7
Rates	1,425	13	10
Income and property tax	114	1	3
Rents and easements	7	1	0
Management expenses—salaries	830	0	10
Joint expenditure	897	4	5
Printing and stationery	56	17	2
General establishment charges	250	3	10
Law and parliamentary charges	175	0	0
Special charges	136	19	8
Accident insurance fund—1 per cent. on wages and salaries	77	0	0
	16,193	6	0
Balance carried to net revenue account	12,967	19	6
	£29,161	5	6

Cr. Income.	£	s.	d.
Sale of current	12,076	0	2
Discounts overestimated, 1901-2	219	8	11
Tramways	16,377	1	4
Arrears	5	3	11
Meter and motor rents, etc.	483	11	2
	£29,161	5	6

BALANCE-SHEET.

Dr. Liabilities.	£	s.	d.
Loans	191,616	9	10
Treasurer, due to him	10,539	3	7
Sundry creditors	960	10	0
Total liabilities	203,116	3	5
Surplus—mortgage debt redeemed	7,915	19	3
Accident insurance fund	47	13	1
Renewal fund	7,698	6	5
	£218,778	2	2

Cr. Assets.	£	s.	d.
Expenditure on capital account	212,578	12	10
Stock of meters and sundries	2,562	7	4
Sundry debtors	3,525	14	1
Other debtors	111	7	11
Total assets	£218,778	2	2

ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T. units			3,715,895
Quantity sold: Public lamps	99,294		
Quantity sold: Tramways	2,329,183		3,187,369
Quantity sold: Private consumers by meter	758,892		
Quantity used on works			409,015
Total quantity accounted for			3,596,384
Quantity not accounted for			119,511

Number of public lamps, 65.

PARTICK ELECTRICITY ACCOUNTS.

From the accounts of the Partick electricity department for the year ended May 15, 1903, it appears that the total expenditure on capital account amounts to £49,993. Below will be found an abstract of the revenue account and statement of electricity generated, sold, etc.

REVENUE ACCOUNT.

Dr. Expenditure.	£	s.	d.
Coal and steam from destructor department	554	19	9
Oil, waste, and stores	152	3	4
Wages at station	499	6	5
Repairs and maintenance	33	14	5
Distribution of electricity	3	4	11
Attending and repairs to public lamps	202	10	3
Rents and feu duty and rates and taxes	352	2	0
Salaries—engineer's department	284	9	6
Stationery and printing	32	17	1
General establishment charges	98	17	6
Special charges—insurances	44	3	1
	2,258	8	3
Balance carried to net revenue account	1,470	10	8
	£3,728	18	11

Cr. Receipts.	£	s.	d.
Sale of current by meter	2,202	14	3
Stair and clock lighting	55	15	6
Public street-lighting	1,465	11	1
Rental of meters, etc.	3	2	6
Received from Law Accident Insurance Company	1	15	7
	£3,728	18	11

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T. units			454,356
Quantity sold: Public lamps	169,167		
Quantity sold: Private consumers	173,757		342,924
Quantity used on works			27,748
Quantity used for testing			13,010
Lost in battery			12,466
Total quantity accounted for			396,148

LINCOLN ELECTRICITY ACCOUNTS.

Below we give abstracts of the revenue account and general balance-sheet of the city of Lincoln electricity department for the year ended March 31, 1903.

BALANCE-SHEET.

Dr. Liabilities.	£	s.	d.
Redeemable stock	40,749	15	11
Sundry creditors	5,177	18	7
Balance of assets	2,161	4	1
	£48,088	18	7

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Cr. Assets.	£	s.	d.
Land, buildings, and plant	45,512	13	5
Stores on hand	601	13	7
Sundry debtors	1,974	11	7
	£48,088	18	7

REVENUE ACCOUNT.

Dr. Expenditure.	£	s.	d.
Generation of electricity	1,492	9	5
Distribution of electricity	60	12	4
Public lamps—wages, etc.	32	13	9
Management expenses	578	19	1
Rates, taxes, etc.	189	10	5
Insurance, legal expenses, etc.	76	2	3
Balance—gross profit	2,978	2	4
	£5,408	9	7

Cr. Income.	£	s.	d.
Sale of current for lighting and power	4,662	9	5
Public lighting	701	12	3
Profit on sales of lamps	44	6	11
Wayleave for telephone poles	0	1	0
	£5,408	9	7

STEPNEY ELECTRICITY ACCOUNTS.

The accounts of the Stepney electricity department for the year ended March 31, 1903, show a total expenditure on capital account of £153,291. 1s. 4d., of which £2,833. 3s. 3d. has been written off. Abstracts of the revenue account, general balance-sheet, and statement of electricity generated, sold, etc., are appended.

REVENUE ACCOUNT.

Dr. Expenditure.	£	s.	d.
Coal or other fuel	2,710	1	10
Steam from dust destructor	2,034	6	5
Oil, waste, water, and engine-room stores	327	18	0
Wages at generating station	1,162	12	3
Repairs, etc., of buildings and plant	369	18	0
Distribution of electricity—wages	19	13	10
Maintenance and renewals of mains	154	15	5
Repairs of apparatus on consumers' premises	220	10	10
Repairs and maintenance of other apparatus	24	7	3
Attending and repairs to public lamps	1,107	11	4
Rates and taxes	291	13	10
Salaries—engineer's department	369	13	1
Salaries—accountant and staff	919	6	9
Wages—meter readers	52	8	11
Stationery and printing	170	5	2
General establishment charges	137	6	3
Law and parliamentary charges	17	6	6
Special charges—insurances	36	1	1
	10,125	16	9
Balance carried to net revenue account	9,499	14	0
	£19,625	10	9

Cr. Receipts.	£	s.	d.
Sale of current for private lighting	15,126	0	4
Sale of current for public lighting	2,923	3	4
Rents of meters and other apparatus	264	14	4
Work done for customers, less cost	19	18	3
Public lamps, attending and repairs	1,107	11	4
Special law expenses refunded	184	3	2
	£19,625	10	9

GENERAL BALANCE-SHEET.

Dr. Liabilities.	£	s.	d.
Balance of loans borrowed	126,542	14	7
Temporary loan from bank	10,000	0	0
Due to treasurer, less cash in hand	3,998	13	4
Sundry creditors	17,453	4	7
Surplus of assets	2,010	5	5
	£160,004	17	11

Cr. Assets and Capital Outlay.	£	s.	d.
Land, including law charges	13,084	15	1
Buildings, furniture, fixtures, etc.	37,883	17	4
Machinery and accumulators	22,921	1	7
Mains and house services	68,674	10	8
Meter and demand indicators	3,310	19	1
Electrical instruments	1,170	16	9
General testing instruments	227	14	8
Tools	390	1	8
Consulting engineer's fees (less written off)	2,794	1	3
Stores on hand	3,768	3	1
Sundry debtors for current, etc.	5,778	16	9
	£160,004	17	11

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T. units			1,948,906
Quantity sold	Public lamps	437,996	1,759,349
	Private consumers by meter	1,321,353	
Quantity used on works			44,034
Total quantity accounted for			1,803,383
Quantity not accounted for			145,523
Total maximum supply demanded (kilowatts)			952

Number of public lamps: 19 arcs, 170 incandescents.

LEGAL INTELLIGENCE.

DAMAGES AGAINST LONDON COUNTY COUNCIL CONTRACTORS.

On Wednesday at the City of London Court, Judge Lumley Smith, K.C., and a jury sat upon the claim of Mr. Arthur Richards, a painter, of Church-road, Mitcham, against Messrs. White and Co., contractors to the London County Council, for damages for injuries sustained during a tram ride.

The defendants have charge of the work of electrification on the South London tram routes, and on the morning of June 25 the plaintiff, while riding on a car between Waterloo and New Cross, leaned over the side, and his head was struck by a street lamp. The track had been diverted from the centre of the roadway to close to the kerb during the laying of the electric conduit system.

The jury found for the plaintiff with £20 damages and costs.

CLAIM FOR WORK DONE.

At the Liverpool Assizes on Monday, before Mr. Justice Bigham, Jenkins Bros., engineers and boilermakers, of Birkenhead, brought an action against James W. Bennett to recover £124. 13s. 8d. for work done.

The case for the plaintiffs was that the defendant, who had been a director of the Leasowe Castle, asked for a price for the removal of an engine used for electric lighting purposes from the palace at New Brighton, and for fixing it in a concrete bed at Leasowe Castle. Plaintiffs agreed to tender to defendant and to look to him for payment. Defendant said it would be all right, but when the account was sent in he declined to pay, on the ground that the contract had been undertaken with the directors of the Leasowe Castle. The defendant, in his evidence, said he purchased the engine for £84 odd, and subsequently there was a sale by him to the Leasowe Castle Company of the engine. He denied that he was liable for plaintiffs' account.

His Lordship decided that there had never been any discharge by plaintiffs of the defendant for his liability, and found for the plaintiffs for the full amount.

A TELEPHONE POINT.

In the City of London Court on Wednesday, Judge Lumley Smith delivered a considered judgment in the action brought by Mr. Henry Lazarus, of the Hermitage, Bushey Heath, against the National Telephone Company for damages for wrongfully cutting off his telephone service.

Plaintiff became a subscriber three years ago to the defendants' service for one year, and he paid a fixed rent charge of £3. 10s. a year. The arrangement had gone on from year to year, but last month, five days before the next payment was due, the defendant company required him not only to pay the £3. 10s., but 30s. in addition for calls and to sign a fresh contract. At first he refused to pay the 30s., but afterwards sent a cheque for £5, and declined to sign the fresh contract. His cheque was returned and the service disconnected.

Judge Lumley Smith said in his opinion the approval of the Telephone Company was requisite at the commencement of each year to enable the hiring to continue. The defendants did not approve of a continuance after the third year, and were not bound to continue. The action failed, but he would give leave to appeal. As the legal aspect was doubtful, he should order each party to pay their own costs.

COMPANIES' MEETINGS AND REPORTS.

ISLE OF WIGHT RAILWAY.

At the half-yearly general meeting on Monday, Mr. Horace F. Tahourdin, the chairman of the Company, presided.

The **Chairman**, in moving the adoption of the report and accounts, which were carried, made a sympathetic reference to the loss that the Company had sustained in the death of Captain H. F. Twynam, who had been a director of the Company for a period of 20 years. It was not proposed at the moment to fill up the vacancy. He also said it might, at a not far distant date, be of advantage to them to adopt electric traction, but the result of their enquiries, so far, was such that they did not at present see their way to recommend anything of the kind. It was a matter that needed very careful consideration. If all the railways in the island were under one management it would, undoubtedly, be very desirable to work the entire system in some such manner. But the present position with the goods traffic, and the delays in connection with the sea traffic, were such that he did not see that there would be any present advantage or economy in working by electricity. There were some electric works in the island from which it might be possible to derive power, but their capacity was very small, and it would require a very great deal of consideration to utilise it to advantage. The shareholders could rest assured that the matter was receiving the constant attention of the Board, and so soon as they saw anything beneficial they would not hesitate to seize the earliest

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opportunity of adopting the cheapest method of working, whatever it might be, having, of course, due regard to the advantage and safety of the public.

NORTH METROPOLITAN TRAMWAYS.

Mr. George Richardson, who presided at the half-yearly meeting last week, said, referring to the sale to the Metropolitan Electric Tramways, it had not yet been decided what system of electric traction should be adopted, but the London County Council favoured the very costly conduit rather than the overhead system, which only cost one-third as much to instal, and which provincial centres like Birmingham and Glasgow had adopted with success. The long-standing negotiations with the West Ham Corporation had at last been concluded. An agreement was entered into with the Corporation by which the latter agreed to buy the whole of the lines within their district, and also the two depôts at Stratford. The purchase money of the lines was fixed by agreement at £5,000 per mile of single line for the lines authorised by the Act of 1870, and at £5,500 per mile of single line for the remaining lines. The value of the depôts was to be referred to arbitration in the event of their being unable to agree with the Corporation. The sale of the lines was carried into effect as from June 30 last, and since that date the Company had by arrangement continued to work the line on behalf of the Corporation as part of the through system from Aldgate to Stratford. The report was adopted, and the directors were authorised to enter into an agreement of sale with the Metropolitan Electric Tramways.

BAKER STREET AND WATERLOO RAILWAY.

At the half-yearly general meeting of shareholders in the Baker-street and Waterloo Railway Company on Tuesday, **Mr. T. J. Hare,** who presided, said the total expenditure on the line since its commencement amounted to £1,255,000. The western running tunnel between Waterloo and Baker-street was through, and the eastern tunnel would be through in about seven weeks. The running tunnels had been commenced on the extension to the west of Baker-street. An agreement with the Crown had been made for a station site in the Marylebone-road, and the purchase money paid. On the southern, or Elephant and Castle extension, certain work had been done. All possible steps were being taken to push on with the completion of the works, and as there were no financial or physical difficulties in the way, the date of opening could not be very far distant.

The report was adopted, and a further resolution passed authorising the directors to dispose of the forfeited shares in such a way as they thought would be best in the interest of the Company.

BELFAST STREET TRAMWAYS.

At the half-yearly meeting on Tuesday, **Mr. George Richardson** (the chairman), in moving the adoption of the report, said the receipts had increased £2,451 and the expenses £252, the net revenue being £8,238 against £430. The purchase of the Sydenham and Ligoniel tramways, which had been completed, would not impose additional charge upon the revenue account, as the Company had been paying 5 per cent. upon the capital of these enterprises for some years. He ridiculed the draft agreement submitted by the Belfast Corporation to be included in the schedule to the Bill to be promoted next session for compulsory acquisition of the undertaking. He said it would be confiscatory and unjust, and would give the Company worse terms than if the lease had expired and the Corporation were left to their legal rights. The Company asked £445,000, while the Corporation offered £380,000. He did not think that for the sake of saving the difference, Parliament would assist the Corporation to break an agreement solemnly entered into and confirmed by Parliament itself. The report was adopted.

NEW COMPANIES REGISTERED.

Motor Livery, Limited.—Capital, £500. Objects: to carry on the business of manufacturers, etc., of vehicles, whether horse-drawn or propelled by steam, electricity, or other power, and garage proprietors, electricians, engineers, etc. Registered office: 6, Old Jewry, E.C.

COMPANY LIENS REGISTERED.

Electrical Supplies, Rubber, and Ebonite Company, Limited, Sheffield.—Lien registered Aug. 6 for £1,500 debentures; charged on the undertaking and all the property.

Guildford Electricity Supply Company, Limited.—Lien registered Aug. 7 for £1,000 6 per cent. debentures, part of £15,000. No trustees. Charged on the undertaking and all the property, including the uncalled capital.

Bradford.—The tramway employés are still agitating to be allowed to take their meals away from the cars. The men held a midnight meeting on Saturday, when the matter was discussed and delegates were appointed from the various sections to wait upon the Tramways Committee to place a scheme before them. The delegates are not empowered to come to any decision binding the men, but they have to report the result of their interiew to another mass meeting. There was also some discussion on the matter of split turns, a method which does not find favour with the men, but nothing definite was decided.

CONTRACTS FOR ELECTRICAL SUPPLIES.

Harrismith.—The Town Council require tenders for the electric lighting of the town.

Macao.—The Colonial Office at Lisbon invite tenders for the elect lighting of Macao. Tenders by Oct. 21.

Hackney.—The Borough Council invite tenders for arc lamps and pillars and distributing mains. Tenders by 31st inst.

Lisbon.—The Public Works Department require tenders for the public electric lighting of Macao. Tenders by Oct. 21.

Canea.—The Mayor of Canea invites tenders for the lighting by electricity of part or the whole of the town of Canea. Tenders by Aug. 28.

King's Norton and Northfield.—The Council invite tenders for the construction of about three miles of electric tramway permanent way. Tenders by Aug. 29.

Beszterczebanya (Neusohl, Austria).—Tenders are required by the municipality for installation, buildings, etc., of a central station of a minimum capacity of 600 h.p. Tenders by Aug. 31.

Madrid.—The Post and Telegraph Department require tenders for a telephone system in communication with the principal central station in San Lorenzo del Escorial and sub-central stations in Cercedilla. Tenders by Sept. 6.

Glasgow.—The Town Council invite tenders for the supply of 10-ampere arc lamps for street electric lighting. Specifications, etc., may be had at the office of the Lighting Department, 52, College-street. Tenders by 27th inst.

Dublin.—The Port and Docks Board invite tenders for the supply of a 100-ton electric crane. Specification can be obtained at the office of the engineer to the Board, Mr. John P. Griffith, M.I.C.E., Eastwall, Dublin. Tenders by Oct. 5.

Hackney.—The Council invite tenders for arc lamps and pillar and distributing mains. Forms of tender, etc., may be inspected at the office of Mr. Robert Hammond, M.I.C.E., 64, Victoria-street Westminster, S.W. Tenders by 4 p.m. on 31st inst.

Worthing.—The Corporation invite tenders for the reconstruction of their storage battery at the electricity works. Specification of the work can be obtained from Messrs. Burstall and Monkhouse, 14, Old Queen-street, Westminster. Tenders by Sept. 7. See advertisement.

Madrid.—The Posts and Telegraph Department require tenders for installation and working of a telephone system in Gerona for twenty years, and also for installation of telephone between Gijon and Pola de Siero. Tenders by Aug. 25. Specification may seen at this office.

Shanghai.—The French Colony propose to instal motor-propelled tramways. Tenders may be sent by Oct. 31, 1903, to Secrétariat de la Municipalité Française de Shanghai. Particulars may be obtained from l'Office National du Commerce Extérieur, Rue Feydeau, 3, Paris.

Utrecht.—The Town Council will receive tenders for supply and erection of a central electric establishment for lighting, power supply, and working tramways. Contract, conditions, etc., to be obtained at the "Gemeente Secretaire" of Utrecht, on payment of 5fl. (8s. 4d.). Tenders by Oct. 1.

Radcliffe.—The Urban District Council invite tenders for the supply and laying of tramway and lighting feeders, distributing and pilot cables, conduits and accessories. Specification, etc., may be obtained from Mr. S. Mills, clerk to the Council. Tenders by Sept. 5. See advertisement.

Swindon.—The Corporation invite tenders for the supply, delivery, and laying of all the rails, points, crossings, and accessories for the permanent way of the Corporation's tramways. Particulars from the engineers, Messrs. Lacey and Sillar, Manchester and Westminster. Tenders by Aug. 26. See advertisement.

Bermondsey.—The Borough Council invite tenders for the erection of buildings in connection with extensions to the dust destructor house, electric light station, boiler-house, etc., at the Council's works rear of town hall. Specifications, etc., can be obtained at the Town Hall, Spa-road, S.E. Tenders by Sept. 8.

Launceston (Tasmania).—The Mayor and Aldermen invite tenders for the supply of 500 or more electric meters. Particulars may be obtained on application to Mr. William Corin, city electrical engineer, Launceston, Tasmania, or to Messrs. John Terry and Co., 7, Great Winchester-street, London, E.C. Tenders by Sept. 28.

Pietermaritsburg.—The Corporation invite tenders for the supply, delivery, and erection of the necessary poles and overhead equipment for about 5¼ miles of tramway route. Specifications may be seen at Messrs. Mordey and Dawbarn, 82, Victoria-street, S.W. Tenders to Messrs. Ford Bros., 12, Southampton-street, Fitzroy-square, W., by Sept. 7 (noon).

London, S.E.—The London County Council invite tenders for the supply, delivery, and erection in the electricity generating station to be established by the Council at Greenwich of four 5,000-h.p. vertical-horizontal steam-engines, each suitable for driving a three-phase generator. Particulars, etc., may be obtained at the County Hall, Spring-gardens, S.W. Tenders by 10 a.m. on Oct. 6.

Portugal.—The "Diaro de Governo" of Aug. 5 contains a notice granting to the Conde de Vizella for 15 years the exclusive concession for automobile service on various roads in the districts of Loanda and Lunda, in Portuguese West Africa, with a preference, under equal conditions, of the establishment of other automobile services in the same districts upon conditions which are stated in the "Diario.""

Ipswich.—The Corporation invite tenders for specification No. 15: arc and incandescent lighting and power circuits and fittings in

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generating station, offices, car-shed, workshop, and refuse destructor house. Specification, etc., can be obtained from Mr. Will. Bantoft, town clerk, and may be seen at (but not obtained from) the offices of Messrs. Kennedy and Jenkin, 17, Victoria-street, Westminster. Tenders by Aug. 28. See advertisement.

Batley.—The Corporation invite tenders for the mason, joiner, plumber, plasterer, slater, painter, heating engineer, and electric lighting engineer's work respectively, in erection and completion of additions to the present town hall. Plans and specifications, etc., can be seen, and bills of quantities obtained at the offices of Messrs. Walter Hanstock and Son, architects, Branch-road, Batley. Tenders to be sent to Mr. J. H. Craik, town clerk, by noon on Sept. 4.

Birmingham.—The Tramways Committee require the names of contractors who are desirous of tendering for the supply and delivery of materials and fittings as follows: (Section A) manganese steel points and crossings; (B) tapered steel side poles and bracket arms; (C) suspension ears, pull-offs, section insulators, and other overhead materials; (D) hard-drawn copper trolley wire and stranded steel span wire. Mr. John Price, city engineer, Council House, Birmingham.

RESULTS OF TENDERS.

West Ham.—The order for the tramway cable has been placed with the British Insulated and Helsby Cables, Limited.

Reigate.—The Town Council have accepted the tender of Nightingale and Sons, Reigate, at £2,023, for additions to the electric lighting station, Wray Common-road.

Hove.—The Hove Electric Lighting Company have placed an order with W. T. Henley's Telegraph Works Company, Limited, for the supplying and laying, on the solid system, of paper-insulated feeder cables.

Radcliffe (Lancs.).—The Urban District Council have accepted the tender of W. Brierley, Church-street, Radcliffe, at £55, for fitting the existing market hall with electric lighting wires and other appendages complete.

Colchester.—W. T. Henley Telegraph Works Company have secured the contract for the supplying and laying of tramway feeders for the Colchester tramways as sub-contractors to Messrs. J. G. White and Co.

Bradford.—A tender has been accepted for the works and materials necessary for the electric lighting at the Cartwright Memorial Hall, Lister Park, Bradford, by the Corporation, of G. H. Woods, Slacke, and Co., Corporation-street, Blackburn.

Dewsbury.—A tender has been accepted for the supply and delivery of steam coal at the Corporation Electricity Works, Bradford-road, by the Electricity Committee, of Crawshaw and Warburton, Limited, Dewsbury, 1,000 tons screened nuts and 2,000 tons pea slack.

Ipswich.—The Corporation have accepted the following tenders for the supply and delivery of electricity meters: Reason Manufacturing Company, Lewes-road, Brighton, for 2½, 5, 10, and 15-ampere meters; Ferranti Limited, Hollinwood, Lancashire, for 20, 30, and (if required) 50, and 100-ampere meters.

Cheadle and Gatley.—The Town Council have accepted the tender of Messrs. Steel, Peech, and Toyer as follows: fishplates, £6. 8s. 4d.; rails, £6. 8s. 4d.; tiebars, £8. 17s. 6d.; and bolts, £18. 10s.; and the tender of Messrs. Askham Bros. and Wilson for points and crossings, No. 2 contract, at £34. 15s.

Derby.—The Town Council have accepted the following tenders: Chloride Electrical Storage Company, Trafford Park, Manchester, accumulators, £2,812. 15s.; Lancashire Dynamo Company, Clifton Junction, near Manchester, balancers and reversible boosters, £791; Johnson and Phillips, Victoria Works, Old Charlton, Kent, switchboard, £1,276.

Egypt.—The Allgemeine Electricitäts-Gesellschaft, of Berlin, recently established an underground telephone line between Cairo and Alexandria for the Société Egyptiennes des Telephones, while Messrs. Siemens and Halske, of Berlin, installed the necessary electrical apparatus at the great Assouan dam, and have secured the contract for the electric lighting of the barracks at Khartoum.

Weymouth.—The Town Council have accepted the following tenders: E. Danks and Co., boilers, £1,850; International Electrical Engineering Company, engines and dynamos, £3,192; J. Hitchen and Sons, crane, £280. 10s.; International Engineering Company, switchboard, £1,860. 9s.; Tudor Accumulator Company, storage battery, £156; Oliver and Co., arc lamps and posts, £704. 3s.; Aiton and Co., pipework, £3,195; Johnson and Phillips, mains and feeders, £11,321. 17s. 10d.

BUSINESS NOTES.

TRACTION.

Brighton.—Application is to be made for a loan of £20,000 for electric tramways along Preston-road to Preston Village.

Salford.—Lieut.-Colonel von Donop on Wednesday last week made an inspection of three new sections of the Salford tramways, which are shortly to be opened for traffic.

Lowestoft.—The last weekly traffic returns of the electric trams showed that 82,883 passengers had been carried, and that the receipts had been £378. 19s. 10d.—this with only about 11 of the 15 cars in use.

Rotherham.—For the week ending Aug. 12 the receipts on the Corporation tramways amounted to £598. 1s. 8d., or an average of £85. 8s. 9d. per day. Of the total, the Tinsley section contributed £315. 18s. 2d.

Yeadon.—The Leeds and Guiseley tramways scheme having been dropped, a general meeting of the Rawdon, Guiseley, and Yeadon Council is to be arranged to decide upon the mode of procuring tramways for the district.

Alpine Railway.—A German syndicate is at present making surveys for an electric funicular railway from Grindelwald to the Gleckstein cabin on the Wetterhorn. Negotiations for procuring the necessary land are now in progress.

Manchester.—A deputation has been appointed in connection with the Tramway Committee to wait upon the officials of the Manchester Carriage Company with a view of arranging terms for the taking over of the horse cars and tramway track within the borough.

Darlington.—So much advance has been made with laying the new electric line that consequently the old service has now been stopped. Mr. O'Dowd is the lessee of the old tramways, and will have a like position in connection with the new electric system.

Halifax.—Great satisfaction is said to prevail in the Brighouse district at the decision of the Corporation to extend their tramway system from Hove Edge into the centre of Brighouse. The extension, which will measure 1 mile 6 furlongs, is to be completed in two months' time.

Porth and Pontypridd.—The Rhondda Urban District Council have declined to receive a deputation from the Pontypridd Council with a view to the working of the whole of the Porth-Pontypridd tramway by the Pontypridd Council, because they are at present negotiating in reference to the tramway.

Wednesbury.—An arrangement has been arrived at between the Corporation and the tramways company on terms by which the electrification of that portion of the South Staffordshire line between Wednesbury Bridge and the White Horse Hotel will be commenced this week and completed before Christmas.

Swansea.—The plans and specifications for the construction of the new lines to Sketty, Bryn-road, and Brynhyfryd have been completed by Mr. Prussman, the borough electrical engineer, and Mr. Geo. Bell, the borough surveyor, and will be submitted to a meeting of the Corporation Tramways Committee on Sept. 2.

Ossett.—The Town Council have decided to apply to the Board of Trade for an order under the Tramways Act for power to make and construct tramways within the borough, and a sub-committee has been empowered to act with the joint committee of the Dewsbury and Soothill Nether Councils in any further arrangements.

Wakefield.—The construction of the electric overhead tramways which will eventually connect Wakefield with Leeds in the one direction, and Wakefield with Horbury and Ossett in the other, was on Thursday last week commenced almost immediately opposite the Vine Tree Inn, Newton, by the contractors, Messrs. Dick, Kerr, and Co.

Scarborough.—The Corporation propose to purchase the system of electric tramways about to be established in the borough by the tramways company. The company are understood to be favourably disposed towards the transaction, which will involve an outlay of about £6,000. It is sought to settle the question prior to the commencement of the work of construction, which is fixed to begin on Oct. 1, 1903.

Battersea.—The widening of Falcon-road, by taking away the front gardens of several houses along that thoroughfare, has already commenced, and no doubt a great improvement will soon be effected. A few houses along Battersea-rise are also being pulled down, as a part of the London County Council scheme for laying a tramway along North-side, Clapham Common, and Battersea-rise to Wandsworth.

Liverpool.—The tramway traffic returns for the fortnight ending Aug. 1 shows receipts of £21,516, as compared with £20,993 for the corresponding period last year, the passengers carried numbering 4,620,000, against 4,510,000 for the same fortnight in 1902. The last horse car of the old service was discontinued on Saturday. The Bank Holiday receipts were £5,560 for the three days this year and £5,500 for the same period 1902.

Ashton-under-Lyne.—At the last meeting of the Town Council, the Chairman of the Tramways Committee (Councillor Andrew) said he was sorry that his expectation that the new electric cars would be running by Ashton Wakes could not be realised. The cause of the delay was that the order for track work had been sent to America by the Manchester Corporation because they thought that the American firm could supply them in the shortest space of time.

Upper Norwood.—Proposals have been made to the local authorities in favour of the introduction of trams into Upper Norwood. A canvass of the districts through which the proposed line would pass has been taken, and the returns show a majority of 3 to 1 in favour of the system being introduced. Demands will be made to the Croydon and Lambeth Councils urging the extension of the existing lines from Thornton Heath and Herne-hill to Upper Norwood, and from Herne-hill to the Crystal Palace.

Light Railways.—The Board of Trade have confirmed the following light railway orders made by the Light Railway Commissioners: (1) Gloucester Corporation Light Railways Order, 1903, authorising the construction of light railways in the city of Gloucester; and (2) County of Gloucester (Gloucester and Brockworth) Light Railways Order, 1903, authorising the construction of light railways in the parishes of Wotton St. Mary (Without), Barnwood, Hucclecote, and Brockworth, in the county of Gloucester.

Newcastle.—At the last meeting of the Tramways Committee plans and estimates were presented for the further extension of the tramway system. The engineer's estimate for the track is £108,000, and the electrical engineer's estimate for equipment, etc., £132,000. The report will be circulated among the members for presentation to the Council. It was agreed to ask the Council to give the committee sanction to proceed immediately with the line from Heaton-road down

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to Benton-road, with a single track laid across Armstrong Bridge, joining the line at the Jesmond-road section.

Nelson.—The construction of the tramways is now completed, and the cars are running regularly over the whole length from the Colne boundary on the one hand to the Higherford Bridge at Barrowford on the other. The work has been completed expeditiously and greatly to the credit of the electrical engineer, Mr. W. A. Fraser. The total capital cost of the line will be something like £15,000, and the lines will pay if the fares reach £65 per week. With the shorter length only at work that at present has been far exceeded.

Dundee.—In the estimates of income and expenditure of the tramways for the current year the total income is put down at £44,050, and the expenditure at £44,670, leaving an adverse balance of £620. The expenditure is expected to be slightly over £2,000 more than last year, for which wages, electricity, maintenance of permanent way, interest, sinking fund, and depreciation are mainly responsible. Rents, rates, and taxes are down by more than £100, but most of the other items show slight increases. The payment of £2,100 to the tramway company appears as in former years. The revenue is wholly received from tramway receipts and advertising.

Burton-on-Trent.—On Monday the tramways were opened to the public, and a very successful start was made. The receipts amounted to close upon £100. The scheme for laying about 5¾ miles of lines, connecting the centre of the town with Branstone, Horninglow, Winshill, and Stapenhill, was prepared by the borough engineer (Mr. Lynam) and Messrs. Kincaid, Waller, and Manville, of London, the cost being estimated at £85,000. The contractor for laying the lines was Mr. Finnigan, of Northampton, and 20 cars were supplied by Messrs. Dick, Kerr, and Co., of Preston. The power is generated at the Corporation electricity works, and sold to the Tramways Committee at a rate of 2d. per unit for the first hundred thousand units, and 1½d. per unit afterwards. Should the car receipts come up to 9d. per car mile, an annual profit of £2,250 is anticipated.

Leeds.—Mr. Smithson, who resigned the chairmanship of the Tramways Committee because the City Council declined to accept his recommendation respecting the tramway manager's salary, has forwarded to the committee the following letter: "Gentlemen,—The Lord Mayor has conveyed to me, in terms which I greatly appreciate, your expression of confidence, and your desire that I should withdraw my resignation of the chairmanship of your committee. I have most carefully considered your request, together with various representations made to me as to the inconvenience that might be caused by a change in the chairmanship of your committee at a period so near to the end of the year, and have decided that, if it is still your general wish that my resignation should be withdrawn, I will at once resume my duties as chairman for the unexpired period of this year." The committee subsequently passed the following resolution: "That this committee learns with pleasure of the decision of Mr. Councillor Smithson to withdraw his resignation of the chairmanship."

Withington.—The Manchester Corporation Tramways Committee have offered to enter into an agreement with the District Council to take a 30 years' lease of the proposed tramway lines, paying the Council a sufficient rental to cover the interest and sinking fund payments in respect of the capital expenditure incurred by the Council in constructing the permanent way of such tramways, the Corporation to undertake at their own expense the repair and maintenance of the lines during the period of the lease. The Council have replied that they consider after their experience of the working of the tramways that all future lines should be double lines, and that in order to provide double lines it would be necessary to carry out works of road widening, for which the Council had not obtained powers. Further, the Withington Committee were not prepared to recommend for consideration any proposals for a lease of the tramways unless the Corporation agreed to pay the cost of constructing the tramways, as well as the total cost of carrying out the necessary road improvement and the cost of obtaining the necessary powers, the Corporation to undertake at their own expense the repair and maintenance of the lines during the period of the lease.

London County Council Tramways.—On the South London lines from the bridges to Brixton and Streatham the County Council are endeavouring to combine electricity with the existing cable system from the upper end of Brixton-road, and in carrying this out several difficulties appear to have arisen, especially the question whether the cable would stand the strain of the new cars, which, although smaller than those used on the Balham and Tooting line, are yet much heavier than the ordinary two-horse cars. A trial is being made with seven cars between the Streatham terminus and Westminster Bridge, and the result appears to be satisfactory so far. It is stated that the "transformation" at Brixton-road transforming station is being effected in two minutes. The electrification is practically completed between the Elephant and the northern end of Camberwell-green, and a big gang of men are at work laying down the network of conduit and rails at the southern end. In Peckham-road the conduit has been laid for a considerable distance, and the horse cars are stopped short at Pomeroy-street, Queen's-road, in order that the work at the New Cross end may be expedited. The line from Camberwell-green to Vauxhall, which was opened a fortnight since, promises to be the best paying of the whole system.

The Tramways Act.—The report of the Board of Trade of their proceedings under the Tramways Act, 1870, during the session of 1903, states that 14 applications were made to the Board of Trade in December, 1902, for provisional orders under the Tramways Act, 1870—namely: Barrow-in-Furness, Burton-upon-Trent Corporation, Bury Corporation, Cardiff Corporation Extensions, Halifax Corporation, Horsforth Urban District Council, Huddersfield Corporation, Ilford Urban District Council, Keighley Corporation, Leeds Corporation, Leeds and Guiseley, Newcastle-upon-Tyne Corporation, Portobello and Musselburgh, and Ramsbottom Urban District Council. All the applications included power to construct new or extension tramways, and all except three were promoted by local authorities. The aggregate length of the proposed tramways was 14 miles 5 chains of double line and 21 miles 56 chains of single line, and the estimated expenditure was £447,922. The Halifax and the Ilford applications were withdrawn by the promoters. Twelve applications were granted by the Board of Trade and provisional orders made. The Leeds and Guiseley order was not, however, proceeded with owing to the failure of the promoters to make the prescribed money deposit. The remaining orders were submitted to Parliament for confirmation in two Confirmation Bills, which received the Royal assent on Aug. 11.

Paris Metropolitan.—Acting on the recommendation of the commission of enquiry into the recent disaster on the "Metro," the Prefect of Police has advised the company of the new measures of reform and the precautions for safety of passengers which will be required to be introduced on its system. The modifications are divided into three series. First, those to be put into immediate execution; second, those to be introduced before Sept. 5; and third, those to be begun by Nov. 1. The first series includes the appointment of inspectors, one for every five stations; every short-circuit is to be reported to an inspector, who shall thereupon determine the measures to be adopted. Independent petrol lights are to be placed in every station to indicate the way out, and all needless barriers and the penny-in-the-slot machines, etc., which now encumber the passages and platforms are to be removed. In the second series the company is required to isolate completely the motorcar from the other cars composing the train. All offices and installation boxes at the stations are to be constructed of incombustible material, an independent system of lighting is to be installed, special fire-alarms are to be placed in telephonic communication with the nearest fire station. The third series contains a recommendation to study other systems of traction possessing fewer dangers of fire or panic than the one at present in use. The third rail carrying the electric current is to be properly guarded, so as to protect passengers who may be obliged to walk along the track from danger of electrocution. All the stations are to have at least two exits, and air-shafts are to be constructed between the stations.

Ramsgate Enquiry.—Lieut.-Colonel von Donop held an enquiry on Wednesday into the circumstances attending the tram accident at Ramsgate last Wednesday, by which 21 persons were injured. John Collins, the driver of the runaway car, said all went well until the top of the hill into Bellevue-road was reached, when he noticed that something was wrong. He immediately applied all three brakes. The car got beyond his control, and ran into another car standing on the interlacing lines. Albert Coppen, the conductor, stated that the car was not proceeding at more than walking pace when it reached the top of the hill. Then it appeared to suddenly shoot forward. Witness at that time was busy taking fares, and before he could do anything the collision occurred. He was certain the sand-box was in good order when they started from Margate. It was untrue that passengers were thrown over the top of the runaway car. Knell, the driver of the other car, said, when he saw that a collision was unable, he shut off power. At the moment of the impact he estimated the speed of the runaway car at 20 miles an hour. The rails were very greasy through rain. He admitted that bogie cars like those involved in the accident were difficult to control when descending gradients. The manager of the company, Mr. Humphries, thought the slipper brake was useless as an emergency brake. The inspector disagreed with this view, saying brakes of that type were being used all over the kingdom. Mr. Humphries said he found nothing to account for the accident. From the driver's evidence he thought that the electric brake was so applied as to be inoperative, causing the wheels to skid. That was the only cause to which he could attribute the accident. Replying to the town clerk, witness said slipper brakes were impracticable with their bogie cars. The company had gone fully into the matter. The inspector said it appeared that the sanding arrangements arrangements were perfectly in order, but he thought the weakness was in the brakes, and to that point he should refer in his report. There was no doubt the trolley arm came off first, rendering the electric brake useless. He recommended that in future all cars should stop at the top of the hill. This concluded the enquiry.

Taunton.—The Street and Highway Committee are considering the following report of Colonel von Donop in regard to his inspection of the tramways on July 19: "I was accompanied at the inspection by representatives of the Corporation and of the tramway company. The lines are about 1¼ miles in length, and they were opened for traffic not two years ago. Over a portion of the route where the line is on a gradient, and the roadway on that account keeps fairly dry, the condition of the track is satisfactory, but the greater part of the route is along a flat road at a low level, and on this portion the track is undoubtedly in an unsatisfactory condition, though I am not prepared to say that it is at present actually dangerous. The company, however, fully admit that the method of construction has not been a success, and they are prepared to reconstruct it, the only point in dispute being what the form of construction shall be. The present form is as follows: each rail is laid on a separate concrete base, 1ft. 9in. in width, and there is one granite block on each side of each rail; the space between the rails is filled in with tar asphalt. The company now propose to make the concrete base continuous between the two rails, and to pave for the whole distance between the two rails and for 18in. on the outside of each rail with granite setts. The Corporation are, however, desirous that wood blocks should be substituted for granite setts, and this is one point of difference between them and the company. The Corporation are of opinion that wood blocks would be a more lasting form of construction and would be less noisy. The company, on the other hand, point out that the roadway outside the track is macadam, and that the maintenance of a wood track in the centre of a macadam roadway would

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be both expensive and unsatisfactory. I informed the Corporation that it was my opinion that the track as proposed by them would not be found a satisfactory arrangement, that it would not wear well under the conditions which obtain at Taunton, and that its condition would be a constant trouble both to them and the company. On the other hand, the form of construction now proposed by the company is what has been in use over a very large number of lines in England for several years, and has been found to give general satisfaction. I therefore recommend them in their own interests to agree to the company's proposals."

Tramways Assessment.—The Assessment Committee of the Brentford Union have, on the advice of their rating surveyor, Mr. Cook, fixed the total value of the London United Tramways in their district for rateable purposes at £18,551, with a gross of £40,456. These figures are split up between the parishes in the following way, care being taken as near as possible that the apportionment should be on the basis of mileage of line: Acton—rateable value £2,020, and gross value £4,419; Ealing, £1,725 and £4,189; Hanwell, £1,540 and £2,784; Chiswick, £9.706 and £15,123; Old Brentford, £611 and £1,755; New Brentford, £91 and £375; Isleworth, £774 and £3,832; Heston, £1,018 and £3,682; Twickenham, £1,067 and £4,297. Chiswick naturally takes premier position because in it are situated the main stations of the company, the power-house, the offices, and the great car-sheds. Acton has also some car-sheds, and so have Hanwell and Heston, which accounts for the preponderance of value in these parishes over Ealing and Isleworth, the value of the buildings having been added to the length of line and cables. These figures apply to the rates of March, 1902, September, 1903, and March, 1903, except so far as Isleworth, Heston, and Twickenham are concerned. Prior to 1903 Isleworth and Heston pay on £308 and £960 respectively, the reason being that the Twickenham-road lines and the extension to Hounslow Heath, though open and securing large profits, had not been brought into the assessment. As regards the Twickenham lines, they have not been brought into any assessment prior to April last, although they had been open to Cole's Bridge in August, 1902, and from Richmond Bridge to King-street a few weeks later. The arrangement of these figures was not arrived at without considerable trouble. The tramway company have now given notice of appeal to quarter sessions against the decision. The Assessment Committee have decided to recommend the Guardians to allow them to defend the appeals.—In the year 1900 the borough treasurer brought before the Bolton Tramways Committee the question of the income-tax assessment on the tramways undertaking, and the claims of the surveyor of taxes to tax the profits to a much larger extent than the borough treasurer considered fair and legal. Up to that time the revenue account had not been debited with more than the annual instalment of loans repaid, or sinking fund as it is sometimes called. Then a statement was submitted allowing for depreciation on capital at the rate of 8 per cent. on the construction of tramlines, 3 per cent. on buildings, old lease, goodwill, etc., 5 per cent. on electrical equipment, 10 per cent. on cars and rolling-stock, tools, machinery, office fittings, etc., the depreciation being £16,298, which included £6,336. 17s. 2d. loans repaid. After a lengthy appeal before the local commissioners of taxes this sum was admitted, with the exception of the allowance for buildings, goodwill, etc. The committee authorised the treasurer not to charge the loan repayment to tramways revenue account as he had hitherto done, for it was understood that the item loans repaid was really depreciation, and that the loans ought to be repaid out of the depreciation allowed. This was a very important decision, and was a new departure in municipal accounts. It saves the committee income tax on the amount of loans repaid yearly, which has gone up from £6,000 in 1901 to nearly £13,000 for last year, for the Inland Revenue department had always charged income tax on this sinking fund item previously. The accounts for the year ended March 31, 1902, were prepared on similar lines, but the treasurer went further in his income-tax appeal this year, and claimed a rebate tax on the cost of relaying the permanent way, which in 1901-2 had cost an outlay of £51,919, and this was allowed, with the exception of £10,031, which was for doubling the track, and that this was consequently new capital. This important income-tax appeal has been largely adopted by the municipalities of the kingdom, and we understand that Glasgow especially has saved the tax on over £100,000 by following in the wake of Bolton. Glasgow is charging full depreciation against tramways revenue account, in addition to the sinking fund.

LIGHTING AND GENERAL.

Dover.—The Corporation Electricity Purchase Bill has received royal assent.

Wednesbury.—Sanction has been received to the electric lighting loan of £11,000.

Stewat Electrical Syndicate.—Mr. G. S. Pitt, liquidator, has been appointed receiver and manager.

Walmer.—The Council have confirmed a resolution applying for a provisional order to supply electrical energy in Walmer.

St. Pancras.—It is stated that the Council have made £46,612 profit on their electric lighting plant within the last 10 years.

Fulham.—The Guardians' estimate of the cost of the provision of a new nurses' home includes £300 for electric lighting installation.

Thetford.—Messrs. Burrell and Sons have obtained permission to extend their electric cable underground to premises on London-road on the usual conditions.

Carlisle.—The Electricity Committee have appointed a sub-committee to consider the charges at present made for the supply of current to private consumers.

Bo'ness.—The Town Council have appointed Mr. Ogilvie, of King Bros., Leith, consulting engineer in connection with the proposed electric light and power scheme.

Rawtenstall.—The Corporation will supply the Rossendale Valley Tramways Company with the necessary electrical energy for the working of their undertaking within this borough.

Accrington.—Mr. H. Ross Hooper has held an enquiry into an application of the Corporation for sanction to borrow £550 for the provision of additional machinery at the electricity works.

Kingswinford.—The laying of the electric lighting cables is progressing rapidly, and Messrs. Parsons and Sons have delivered 24 lamp columns. The work of setting the columns has commenced in Wall Heath.

National Telephone Co.—With the object of focussing all the business in connection with new orders, this Company has formed a contract department, with offices situated at Salisbury House, London-wall, E.C.

Pontypool.—The Callender Cable Company, Limited, are now laying down the cables for supplying electrical power to the collieries and other industries of the town for the South Wales Electric Power Distribution Company.

Loughborough.—The Town Council have empowered the town surveyor to act with Mr. C. H. Gadsby, engineer to the electricity scheme, in preparing the architectural work in connection with the electricity power station.

Stalybridge.—Mr. Gibbings is preparing a general statement as to the lighting of the generating station. The generators are now ready for testing at Preston, and four motor-generators are to be ready for testing about the 8th prox.

Blackheath and Greenwich District Electric Light Co.—The directors have resolved that an interim dividend at the rate of 7 per cent. per annum be paid upon the cumulative preference shares for the half-year ended June 30.

Govan.—The Corporation have obtained sanction to make large additions to the electricity station in Helen-street. The buildings are to cost £10,000, and within the next two years the Corporation will lay down plant to the value of £40,000.

Taunton.—The charge for current to the free-wired consumers will be reduced 1d., or 5d. instead of 6d. per unit, for current consumed between Oct. 1 and March 31 next, but the charge is to stand at 6d. for the following six months or summer half.

Sowerby Bridge.—The offer of the Northern Counties Electricity Company, Limited, to light the street lamps for 1,266¾ hours, and to provide and fix the necessary poles and lamps, at a charge of £1. 8s. 6d. per lamp of 40 c.p. per annum, has been accepted.

Brighton.—The accounts of the Lighting Committee of the Town Council for the year ended March 31 show that the year's working of the electric light undertaking has resulted in a net profit of £7,984, upwards of £3,000 of which will be applied to the relief of rates.

King's Lynn.—The Council have resolved to extend the plant at the electricity works at an estimated expenditure of £5,500, and to apply for sanction to a loan of £11,320 to cover the cost of the extension, and also previous excess and technically unauthorised expenditure.

New Branch.—Owing to rapidly increasing business, the British Westinghouse Electric and Manufacturing Company, Limited, have opened a new branch, under the management of Mr. W. S. Doran, at York City and County Bank-buildings, Sheffield, for the Sheffield district.

London Electric Supply Corporation.—The directors have declared an interim dividend for the half-year ended June 30 last at the rate of 6 per cent. per annum on the preference shares, payable on Sept. 1. The transfer books will be closed from the 17th to 31st inst. inclusive.

Berwick.—The sanitary authority have entered into an agreement with the Urban Electric Supply Company for the lighting of the streets. Arc lamps are to be erected of 1,000 nominal candle-power, and to be fixed on standards supplied by the company, while the incandescent lamps are to be of 25 c.p.

Isle of Man.—The Isle of Man Steam Packet Company are having Marconi installations made on their vessels. The first installation is on the "Empress Queen," which almost daily carries 2,000 passengers each way between Douglas and Liverpool. It is expected the first test will be made on to-day's passage to Douglas.

New Canadian Cable.—It is stated that a syndicate will shortly be formed to arrange for the establishment of a direct independent cable service between England and Canada, with a tariff of 6d. per word for ordinary cablegrams and 3d. per word for Press messages. We understand that Mr. Roland Belfort, Anglo-Canadian Cable Syndicate, 34, Great St. Helen's, E.C., is one of the movers in the scheme.

Greenock.—Mr. James Robertson, burgh electrical engineer, in his last report, states that 37,534 units of electricity were generated in Greenock for private and public supply during the five weeks ending Aug. 1, an increase compared with this period last year of 9,237 units, and 78,477 units were generated for traction supply, an increase of 5,636 units. The number of consumers has increased from 275 to 346. Only 40 private houses in Greenock have introduced electric light, which is somewhat unsatisfactory. The engineer is of the opinion that the reason electric light has made such little headway amongst private householders is because the "flat" rate has been too high. He proposes, therefore, that it be reduced from 5½d. to 4½d. per unit, a figure which is still 15 per cent. in excess of the average price obtained last year from all consumers. The pumping station at West Quay in connection with the condensing plant is now in operation, and the results are reported as in every way satisfactory. The accounts for the past year show a credit balance of £649. 11s. 9d.

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Imperial Tramways Co.—For the half-year ended June 30 last the directors of this Company have declared an interim dividend on the £10 ordinary shares of 8 per cent. per annum. The dividend warrants will be payable on and after the 20th inst.

W. T. Henley's Telegraph Works.—An interim dividend at the rate of 12 per cent. per annum for the half-year ended June 30, 1903, will be paid on the ordinary shares of this Company on Sept. 1 next. The half-year's dividend on the preference shares at the rate of 4½ per cent. per annum will also be paid on the share date as usual.

Canada.—Some time ago the Radial Electric Company unsuccessfully tried to secure the right of way through the streets of Toronto, and endeavoured to have a measure passed by the Ontario Provincial Legislature giving them this privilege. They have now appealed to the Dominion Government for the franchise. The case is exciting considerable local interest.

Manufacture of Electric Accumulators.—The Home Secretary has issued draft regulations, under Section 79 of the Factory and Workshops Act, 1901, dealing with the manufacture of electric accumulators. They are intended to come into force on Oct. 1, and will be in substitution for the special rules for electric accumulator works made under the Factory Act of 1891.

Parkfield Works, Stockton-on-Tees.—We are informed that Messrs. Ashmore, Benson, Pease, and Co.'s works will close on Saturday, Aug. 15, until Monday morning, Aug. 24, for stocktaking, that no goods can be received or dispatched between these dates, and that material forwarded to arrive between these dates will be refused, and senders made liable for any demurrage that may be incurred.

Willesden Polytechnic Electrical Engineering Society.—At the last meeting of the society, Mr. Frederic H. Taylor, A.M.I.E.E., in the chair, a paper was read by Mr. T. Lawrence on the subject of the "Nernst Lamp." The author showed some interesting diagrams illustrating the various types and also the working parts of this lamp, and the excellent description given evoked considerable discussion.

Morley.—Mr. J. E. Ellis, borough electrical engineer, in his last report, states that the output from the electricity works during the four weeks ending July 14 was 6,223 units, as against 4,193 units for the corresponding period of last year. The lamps connected to date was 10,312. The borough engineer has been instructed to report to the next meeting as to the construction of Park-street sub-station and as to the repair of the same.

Thames Boat Building.—The Thames Valley Launch Company, Limited, who are building a number of boats for foreign orders, have just sent off from their Weybridge works the first of a series of special service inspection steamers for the use of the Egyptian Government on the Nile. There will be altogether 10 or 12 of these small screw steamers, and each will be in charge of an inspecting officer, for whom every comfort is provided on board in the way of sleeping and living accommodation.

Tottenham.—At the last meeting of the Urban District Council the Electricity Committee submitted an amended scheme for the carrying into effect the provisional order obtained by the Council in 1902 for the lighting of the district by electricity. The committee recommended the adoption of the scheme, and that application be made to the Local Government Board for sanction to a loan of £70,000 to defray the cost of the work. After a long discussion the further consideration of the scheme was postponed.

Llandovery.—At a meeting of the Town Council and three representatives of Llangadock district on Monday, the question of placing Llandovery and Llangadock in telephonic communication with other towns was considered. A communication from the Postmaster-General was read to the effect that this could be done provided a guarantee for £72. 10s. per annum would be forthcoming. It was resolved that Llandovery Town Council become guarantors to the extent of £50 a year, and that Llangadock provide the balance of £22. 10s. per annum.

Bristol.—We note from the annual report of the city engineer, Mr. T. H. Yabbicom, M.I.C.E., that during the year ended March 25, 1903, the Electrical Committee laid 28·56 miles of cables, and formed 10·58 miles of trenches for them. The total expenditure was £2,910, including £419 for laying private services, alterations to sub-stations, etc. Amongst other works, we note the building of a new coroner's court and mortuary at a cost of £2,248, and 10 workmen's dwellings, which give accommodation to 42 persons, and which entailed an expenditure of £2,256.

Newton Abbot.—The Newton Urban District Council have refused to grant permission to the Urban Electric Supply Company to lay cables to Kingsteignton. Mr. H. C. Pay, engineer and manager, has agreed to give the Council an undertaking that the granting of their approval to allow the company to extend to Kingsteignton could not in any way affect the Council's option to purchase so much of the undertaking as was in the urban district of Newton Abbot when the opportunity to purchase arrived. The matter is before the Lighting Committee of the Council.

Change of Name.—The New British Arc Lamp Company, Limited, Horsell-road Works, Holloway-road, London, N., have changed the name of their company to New British Engineering Company, Limited. The company have opened a department for the manufacture of switchboards and for every kind of electrical and mechanical work, and have secured the services of Mr. William Thomas Burbey as works manager, under whose supervision the whole of the work will be carried out, and of Mr. Ernest Paine, who will act as the company's commercial representative.

The Temple.—There has been a difference of opinion for some time past between the authorities of the Inner Temple and the Post Office respecting the introduction of the latter's telephone service into the Inner Temple, the benchers wishing to have the overhead whilst the Post Office contended for the underground system of pipes and wires. The benchers have now given their consent, and the work of laying the underground wires was commenced in the Inner Temple yesterday. The Post Office telephone has been in operation in the Middle Temple on the underground plan for some months past.

Bilston.—Since the introduction of the electric trams the progress of electricity in Bilston has been very rapid. Mains were laid by the Electric Corporation for Power Distribution, and many of the leading tradespeople at once had their premises attached. The District Council also supported the Corporation, and as quickly as possible arranged terms for the lighting of their main buildings. This work was practically completed on Saturday, and the town has now its market, baths, free library, reading-room, town hall, Council chamber, and offices all illuminated with electricity. The result is a great improvement.

Catalogues Received. — Allgemeine Elektricitäts - Gesellschaft Berlin, Mitteilungen aus dem Kabelwerk, No. 30. Insulation Materials: I. Hartgummi.—Berliner Telephone Mfg. Company, 117, Queen Victoria-street, London, E.C., Leaflet No. 62, automatic telephones for reply and call system.—Geoffroy and Delore (manager, A. H. Hunt), 115-117, Cannon-street, London, E.C., single and twin lead-covered cables, standard lighting and power cables, cables for town mains, steel-armoured cables, concentric cables, flexible cords, aerial cables, motorcar flexibles. — Walsall Electrical Company, Limited, 115 117, Cannon-street, E.C., arc lamps and accessories, also pocket price-list of "Walsall" open-type dynamos and motors.

Accumulator Manufactories.—We have just received from the Home Office at Whitehall draft regulations which have been prepared under the Factory and Workshop Act of 1901 for regulating the manufacture of electric accumulators. These regulations, issued in draft form, will come into operation on Oct. 1, unless any parties interested succeed in convincing the authorities that there are valid objections to the same. These objections have to be sent to the Secretary of State within 40 days from the 10th inst. A casual glance through the draft now before us tends to the belief that the regulations are reasonable, and that if properly enforced they will do much to prevent lead-poisoning occurring amongst the workmen in our electrical accumulator manufactories.

Wireless Telegraph Conference.—The members of the recent international wireless telegraph conference were entertained by the Gesellschaft für drahtlose Telegraphie. The arrangements included visits to the works of the companies which were the founders of the new company—viz., Siemens und Halske Aktiengesellschaft and the Allgemeine Elektrizitäts-Gesellschaft. The apparatus of the new company, made according to the "Telefunken" system, were then shown and explained by Count Arco (technical manager), Herren Dr. Seibt (chief engineer), Herren Schmidt and Schloemilch, the latter showing for the first time his new polarisation cells, which are said to be simple of construction and effective in preventing electrical disturbances to wireless telegraphy apparatus.

Boston.—The Paving and Lighting Committee reported at the last Council meeting of the Town Council that they had received communications from two firms to the effect that, as the Corporation had not taken advantage of the electric lighting order adopted some time ago, they intended to apply to the Board of Trade for powers to light the town by electricity. The consideration of the matter was adjourned for a month. The question of lighting the new municipal buildings by electricity was again considered, and having regard to the fact that an electric lighting installation may shortly be erected in the town, the Council, by 13 votes to 7, abstained from affixing the borough seal to the contract for £715, accepted at the last meeting.

Gravesend.—The resident engineer's report for the three months ending June 30 is as follows: units supplied to private consumers, 15,777; units supplied to public lighting, 14,070; units supplied to tramways company, 96,280—total, 126,127; approximate works costs—fuel, £642; oil, water, stores, etc., £25; wages, £148; repairs, £12. 11s.—total, £327. 11s.; approximate revenue per unit sold, 2·26d.; approximate works cost per unit sold 1·56d.; number of consumers supplied 98; increase since March 31 last, 17; equivalent number of 8-c.p. lamps supplied (private lighting), 5,875. It is proposed that a small generating set of 100 kw. be obtained at a cost of about £1,250. Sanction has been obtained to the borrowing of the sum of £1,070 for electric lighting purposes.

Birkenhead.—The demand for electricity from the Corporation's undertaking for the quarter ending June shows a great increase as compared with the corresponding quarter of last year. The figures were 94,787 units by 512 consumers, as compared with 71,568 and 371 consumers. To ordinary lighting consumers were supplied 25,768 units at 6d., 15,263 at 3d., and 14,572 at 1½d. for full quarters, and for incompleted quarters 893 units at 6d., 354 at 3d., and 223 at 1½d. Power and heating consumers took 3,159 units at 2½d., 1,976 at 2d., and 174 at 1½d. Craven-street generating station took 240 units each at 4d. and 3d., and 2,002 at 1½d.; Woodside Ferry obtained 12,417 units at 2·2d.; the Watch Committee, 14,904 units for street-lighting; and Bidston and Nocturum consumers, 2,572 units at 7d. The average price obtained in the quarter from all classes was 3·99 per unit, as compared with 4·23 per unit for the corresponding quarter last year. From the list of average prices for energy, it appears that public-houses paid the least, 2·67d. per unit, and churches and chapels the most, 5·97d. per unit.

Surbiton.—The formal opening of the new electric lighting station at Tolworth will not take place for a few weeks yet, but the premises are practically completed, and there is sufficient plant to supply light and power to the whole of the district where the cables are laid. The current was turned on for the first time last week by Mrs. Patrick Shaw, wife of Mr. P. G. C. Shaw, chairman of the Parliamentary Committee of the Surbiton District Council, who was also present, together with the Rev. J. F. Medley, Mr. F. Packham, Mr. R.

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Thirlby, Mr. F. J. Bell (deputy clerk to the District Council), Mr. S. Mather (surveyor), Mr. Petersen (Callender's, Limited). Mr. Wickham (Edmundson's Electric Corporation), Mr. Talbot (of Messrs. Hopkinson and Talbot, consulting engineers to the District Council), Mrs. Talbot, Mr. H. M. Gill (manager of the works), and Mr. C. P. Medley (assistant manager). The plant at present consists of a Bellis-Morcom 120-h.p. high-speed steam-engine direct coupled to a 90-kw. Fowler dynamo. Steam is supplied by two Babcock and Wilcox water-tube boilers, and the switchboard is by Fowler and Co., Limited.

Glasgow.—The quantity of electricity sold during the last year to private consumers was 10,419,488 units, being an increase of 24¼ per cent on the preceeding year. The number of consumers at May 31 was 7,013, being an increase of 1,639 during the year. The number of motors in use was 1,059, with a total horse-power of 4,597, compared with 682, with a total horse-power of 3,086, on the corresponding date. The number of units consumed for power purposes was 1,560,509. The maximum load or demand made upon the generating stations was on Dec. 22, when it was 9,371 kw., compared with 7,950 kw. in the previous year. The telephone accounts for the year ending May 31 show a total revenue of £55,723 and working expenses £15,967, making the net revenue £39,761, out of which the following requirements had to be met: interest, £6,642; sinking fund, £5,806; Post Office royalty, £3,405; and terminal fees, £1,497—a total of £17,352, leaving a balance of £22,408. Adding the surplus of £398 from the preceding year the balance is £22,807, which is dealt with as follows: proportion of rental applicable to year 1903-4 carried to suspense account, £20,714, leaving a surplus of £2,092, which the sub-committee recommend should be carried to a reserve fund. The expenditure on capital account for the year was £78,556.

Redditch.—The Urban District Council have received a supplementary report from Messrs. Burstall and Monkhouse, of London, the experts engaged to report upon the town's electric supply undertaking. As to the present value of the plant compared with the original cost, the experts considered that, taken as a going concern, the value of the engines was 80 per cent. of the original cost, and the rest of the plant 88 per cent. of its original cost. Provided the plant was maintained out of revenue and insured against accident, it was not necessary to create a depreciation fund. They could not actually tell the condition of the cables without taking them up, which it would be inadvisable to do. The engineers expressed the opinion that it was wise to push the sale of current for power purposes, even at present prices, as the plant at the generating station had to be run during the day whether the current is sold for power purposes or not. Redditch compared favourably with 14 other towns having an approximately similar output. The cost of adapting the present gas-producing plant for the use of bituminous instead of anthracite coal would be £500. Properly speaking, there should be spare plant equivalent in output to that of the largest unit, and on that basis the output at the Redditch station, supposing the new plant to work satisfactorily, should be about 200 kw.

London Gazette.—An order has been made out in the estate of Edward Baldwin Pym, lately carrying on business at Bar-chambers, Scarborough, York, now residing at 29, Bramham-gardens, South Kensington, London, electrical engineer, as follows: discharge suspended for two years; bankrupt to be discharged as from July 10, 1905. A dividend is to be declared in the estate of William Scholes (trading under the style or firm as Scholes and Son), electrical engineer and contractor, residing at 49, Main-street, Failsworth, Lancaster, and carrying on business at 39, Corporation-street, Manchester, Lancaster, and occupying portion of a shop at 10, Rochdale-road, Middleton, Lancaster, as a branch store. The last day for receiving proofs is Aug. 29, 1903. Christopher Jenkins Dibb, official receiver, Byrom-street, Manchester. An order for discharge has been made out in the estate of Alfred Carlton Blyth, Avenue House, Hill-street, St. Albans, Herts, lately carrying on business with William Turvey, under the style or firm of Turvey and Blyth, at the Standard Electrical Works, St. Stephen's-hill, St. Albans, Herts, engineers and contractors. A dividend of 13s. 11½d. in the £ has been paid. Date of order, July 20, 1903. The partnership heretofore subsisting between Edward Roberts and Arnold Roberts, carrying on business as electrical engineers and contractors, at 15 and 17, Lee-street, Thornton-road, in the city of Bradford, under the style or firm of Roberts Bros., has been dissolved by mutual consent as and from Aug. 1, 1903. All debts due to and owing by the said late firm will be received and paid by Arnold Roberts.

Private Bills.—The private Bills passed during the last session include 218 private Bills, seven Electric Lighting Order Bills (confirming Board of Trade orders in respect of 52 districts), and two Tramway Confirmation Order Bills (confirming Board of Trade orders in respect of tramways). For railway purposes new capital is required to the amount of £10,500,000, including increase of capital in the case of most of the large companies, notably the City and South London, £600,000; Great Northern and City Railway, £450,000; Great Northern, Piccadilly, and Brompton (Various Powers), £250,000; Ulster and Connaught Light Railway, £117,000; and the Metropolitan District Railway (Various Powers), £900,000. New tramway capital required is as follows: Manchester Southern Tramways, £250,000; Mid-Yorkshire Tramways, £372,000; Coventry Electric, £18,000; Chatham and District Light Railways, £240,000; Notts and Derby Tramways, £750,000; Preston and Horwich, £500,000; Gosport, Fareham, and Cosham, £18,000; Harrow-road and Paddington, £60,000; Hastings, £60,000; Stroud and Cheltenham, £200,000; South Lancashire, £200,000. Altogether there were 54 Tramway Bills introduced, but 23 of these were promoted by the London County Council, various borough councils, and urban district councils. Electric power companies account for £4,500,000 as follows: Scottish Central, £600,000; Carmarthenshire, £600,000; North-Western Electricity and Power Gas, £1,500,000; Fife, £600,000; Shropshire and Worcestershire, £450,000; Somerset and District, £750,000. First, however, amongst the Bills that have either been dropped by the promoters or suspended or rejected by Parliament we note: *Metropolitan District Railway (Works), £2,100,000; Luton, Dunstable, and District Tramways, £140,000; Macclesfield and District Tramways, £240,000; Rochester, Chatham, and Gravesend Tramways, £180,000; Wakefield and District Tramways, £100,000; Antrim, Down, Armagh, and Belfast Electric Power, £400,000; City and North-Eastern Suburban Railway, £4,450,000; *Central London Railway, £3,150,000; *Clapham Junction and Marble Arch Railway (1), £1,500 000; *Clapham Junction and Marble Arch Railway (2), £2,040,000; *North-West London Railway, £700,000; London and Brighton Electric Express, £450,000; *Great Northern, Piccadilly, and Brompton Railway (Extensions), £2,400,000. * These Bills were suspended owing to the appointment of the Royal Commission on London Locomotion, but altogether schemes involving capital expenditure of over £30,000,000 fell through.

German Electrical Companies.—The annual reports of two of the principal German electrical companies—the Schuckert Company and the Continental Company for Electrical Enterprises, both of Nuremberg—have just been issued. The Schuckert Company, which, it may be remembered, was amalgamated last April with the Siemens and Halske Electrical Company, of Berlin, has now succeeded in making the income meet the expenditure on a capital exceeding £2,000,000. The accounts show an available surplus of £6,300, which is to be carried forward, as against the enormous deficit of £769,000 in 1901-2. The Continental Company for Electrical Enterprises—the so-called financial trust of the Schuckert Company—does not make so good a showing, and for the third year in succession does not pay a dividend. The balance-sheet shows a loss of £21,000 for the year, and a total deficit of £58,900. The *Financial Times* says: On the question of the amalgamation with the heavy electrical departments of the Siemens and Halske Company under the title of the Siemens-Schuckert Works Company, with a capital of £4,500,000, the report of the Schuckert Company states that during the three months which have elapsed since the fusion, the new company has worked satisfactorily, and that the orders received have exceeded those booked by the original firms during the corresponding period of last year. This indicates a notable improvement in the economic situation, which it is hoped will make further progress, although a recovery from the prevailing low prices is still desired. As far as the British Schuckert Electrical Company is concerned, the directors of the German parent company, which holds shares in its offspring to the extent of £18,000, state that they hope, as a consequence of the close relations with the Siemens and Halske Company (whose light electrical engineering branch was not included in the fusion, and is being continued by the original company), that they will be able to associate the English interests with those of the Siemens and Halske Company. This seems to point, a correspondent adds, to a possible amalgamation of the British Schuckert Company and of Siemens Bros. and Co., Limited, of London. Among the numerous electric lighting, tramway, and railway enterprises in which the Continental Company for Electrical Enterprises is interested as owner, constructor, or shareholder, is the suspended high-level electric railway which the company built between Barmen and Elberfeld, and extended to Vohwinkel two months ago. The two years' working of the greater portion of this railway have proved the advantages of the system, which is also being proposed for Berlin and Hamburg, and has been suggested, if a detailed scheme has not already been prepared, as a means of transport by the construction of an overhead line across London.

COLONIAL NOTES.

Durban.—The Durban Corporation have completed their "outer" circle of tramways, and passengers are now able to make a complete circuit of the town without disembarking. Since the installation of electric trams some 15 months ago the old horse cars have almost fallen into desuetude, and at the present time only about half a dozen are running. In a few months the horse trams will be entirely replaced by electric cars, which, by the way, cost £1,000 each.

Potchefstroom.—The latest phase in the progress of Potchefstroom is the decision of the Government to at once proceed with a scheme of electric lighting for the whole of the town. This step has been hastened by the formation of a local company, with the announced intention of pushing forward a lighting scheme, but as the Government has decided that no permission shall be given to any private company to either erect wires or cross streets, its operations must necessarily be confined to a single block. Up to the present the town, which has progressed at an unprecedented rate, has been without any street-lighting, so that there has been vigorous agitation for the electric scheme.

PROVISIONAL PATENTS, 1903.

AUGUST 10.

17307. Improvements in and relating to electric tramways and means for propelling vehicles. James Townsley Pearson, 8, St. James's Hall, Burnley.

17367. Improvements in safety devices for strong current overhead conductors. Christian Cornelius van der Valck, 18, Southampton-buildings, Chancery-lane, London. (Complete specification.)

17374. Improvements in magneto-electric machines and appurtenances for cooling and pumping. James Harding Lancaster, 114, Liberty-street, New York.

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AUG. 11.

17399. Process of decomposing water by electrolysis. George Thomas Fuery, 11, Burlington-chambers, New-street, Birmingham. (William FitzMason McCarty and Winfield Scott Beebe, United States.) (Complete specification.)

17451. Improvements in or relating to electric joints or connections for railway trains. Simon Savelsohn, 111, Hatton-garden, London.

AUG. 12.

17466. Improvements in or connected with incandescent electric lamps. George Davis, 15, Victoria-street, London.

17464. Improvements in electric signalling mechanism. Percy Richard Julius Williss, Fife House, Kingston-on-Thames. (Albert E. Caughey, United States.)

17482. Improvements in electric arc lamps. William Squire, 51, Deansgate-arcade, Manchester.

17488. Improvements in electric railway trains or railway vehicles. Arthur Petzenbürger, 15, Took's-court, Cursitor-street, Chancery-lane, London. (Complete specification.)

AUG. 13.

17564. Improvements in junction or inspection boxes and like inspection fittings used with electric wiring. Ernest White and James Waldron, Prince's-chambers, Wolverhampton. (Complete specification.)

17568. Improvements in electrical heating devices. David Huntley, 115, Cannon-street, London.

17587. Improvements in the manufacture of electrodes for electrolytic purposes. George William Johnson, 47, Lincoln's-inn-fields, London. (The Chemische Fabrik Griesheim Elektron, Germany.)

AUG. 14.

17597. Improvements in electric or steam or other pile-driving apparatus. Herbert Thomson Garvie, 69, Victoria-street, Westminster, London.

17601. Improvements in system of electric lighting. Henry Leitner and Richard Norman Lucas, Rose Villa, Byfleet.

17602. Improvements in reversing mechanism for dynamos. F. Webb Manley, Rose Villa, Byfleet.

17605. An improved trolley head and arm for electric traction wires. Jasper James Carter, 1, Anglesea-villas, Ballsbridge, County Dublin.

17632. Improvements in electricity meters. Hadyn Thies Harrison, 46, Lincoln's-inn-fields, London.

17643. Improvements in the arrangement of steel magnetic armatures for electromagnet pairs. Luigi Cerebotani and Albert Silbermann, 111, Hatton-garden, London. (Complete specification.)

17644. Means for electrically operating from a distance typewriting machines, type-printing, telegraphic apparatus, and the like. Jacob Pilsatneeks, 36, Chancery-lane, London.

17663. Improvements relating to electric accumulators. Barthélémy Becker, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

AUG. 15.

17702. Improved electric battery. René Hubert Edmond Phillippart, 52, Chancery-lane, London.

17721. Improvements in or connected with coin-freed electricity meters. Frederick John Beaumont, 173, Fleet-street, London.

COMPLETE SPECIFICATIONS ACCEPTED.

To be published September 3, 1903.

1902.

17460. Regulating lever and instantaneous brake applicable to machines driven by electric motors. Bradbury and Co., Limited, and Drybrough.

17663. Method of and means for securing shades, reflectors, or the like used in connection with incandescent electric lamps. Morrison and Butterworth.

17676. Electric lamp globes. Böhm and Böhm.

17690. Electric arc lamps. Lake. (General Electric Company).

17841. Methods of and means for producing, shaping, and employing electric current pulses. Loring.

18816. Commutators for dynamo-electric machines. British Thomson-Houston Company, Limited. (Erben.)

18923. Direct-current electricity meters. Lake. (General Electric Company.)

19563. Electrical switch devices applicable to rheostats, commutaters, and the like. Lake. (General Electric Company.)

19572. Trolley wheels for electric traction. Lake. (General Electric Company.)

19665. Electricity meters. British Thomson-Houston Company, Limited, and Holden.

20240. Electric conduit railways or tramways. Hadfield and Galbraith.

20647. Construction of electrical transformers, choking coils, and the like. Siemens Bros. and Co., Limited. (Siemens und Halske Aktiengesellschaft.)

21229. Automatic electric switches. Offord and Marsh.

21631. Electric arc lamps. Davy.

22023. Insulators used for electrically dividing into sections trolley wires as used on electric railways. Brecknell, Munro, and Rogers.

22783. Electrical switches. Cox.

24031. Overhead guards for electric cars. Hindle.

24033. Oiling vertical electric motors which are worked intermittently as in the case of driving centrifugal machines direct by an electric motor. Macfarlane.

1903.

1514. Clockwork-operated electromagnetic circuit controlling apparatus. Danziger.

5693. Lamps with electric lighting device and supplemental wick. Lind and Carlsson.

7481. Controllers for electric motors. Stuart. (Date applied for under International Convention, April 2, 1902.)

8690. Electrical burglar alarm for the protection of safes, vaults, and the like. Weatherby.

9932. Treating materials by radiated or reflected heat in electric furnaces. Howorth. (Trollihättans Elektriska Kraftaktiebolag.)

12467. Impedances for telephone and other electric circuits. Warren and Campbell.

14566. Means for electrically driving centrifugal machines. Haddan. (American Tool and Machinery Company.)

14930. Electricity meters. Aron.

15065. Keyboard telegraphic transmitters. Kotyra.

15266. Electrical switches. Dorman and Smith.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.		Last price
Commercial and Industrial.—	£		£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1	..	¼-⅜
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1	..	⅜-½
British Insulated and Helsby Cables, Ord., 1-100,000	5	..	6¾-7¼
—— 5 per cent. Cum. Pref., 1-100,000	5	..	5¼-5⅜
—— 4½ per cent. Mortgage Debentures	100	..	102-106
British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red.	100	..	104-106
British Westinghouse Elec. and Manuf., 6 per cent. Pref., 275,001-375,000	5	..	5⅜-6
—— 4 per cent. Mortgage Debenture Stock	100	..	100-102
Brush Electrical Engineering, Ordinary, Nos. 1-105,731	2	..	¾-1¼
—— Non. Cum., 6 per cent. Pref.	2	..	1-1¼
—— 4½ per cent. 1st Debenture Stock	100	..	99-102
—— 4½ per cent. 2nd Debenture Stock	100	..	85-90
Callender's Cable, Debentures	100	..	106-110
—— Ordinary	5	..	11¼-12¼
—— 5 per cent. Pref.	5	..	5¼-5⅜
Crompton and Co.	3	..	2-2¼
—— 5 per cent. Debentures	100	..	101-105
Edison and Swan United, "A" Shares, 1-99,261	3	..	¼
—— "A" Shares, 01-017,139	5	..	1¼-2¼
—— 5 per cent. Debentures	100	..	75-80
—— 4 per cent. Deb. Stock, Red.	100	..	71-75
Electric Construction, Limited, Nos. 1 to 112,100	2	..	1¼-1⅜
—— 7 per cent. Cumulative Pref.	2	..	2¼-3
—— 4 per cent. Perp. 1st Mort. Deb.	100	..	99-102
Ferranti Limited, 5 per cent. 1st Mort. Deb. Stock, Red.	100	..	90-95 xd
General Electric Company (1900), 5 per cent. Cum. Pref.	10	..	9¼-10
—— 4 per cent. 1st Mort. Deb. Stock	100	..	99-102
W. T. Henley's Telegraph Works, Ordinary	5	..	14-15
—— 4½ per cent. Preference	5	..	5-5¼
—— 4½ per cent. Debentures	100	..	108-112
India Rubber, Gutta Percha, and Telegraph Works	10	..	18¼-19¼
—— 4 per cent. Debentures	100	..	100-103
Parker, Thos., Limited, Ordinary	10	..	14¼-15¼
Telegraph Construction and Maintenance	12	..	32-36
—— 5 per cent. Bonds	100	..	100-103
Electric Lighting and Supply.—			
Blackheath & Greenwich District Ordinary 1,201-101,200	1	..	⅝-¾
—— 4½ per cent. Deb. Stk. Certs., Red. and Conv.	100	..	118-121
Bournemouth and Poole, Ordinary	10	..	12¼-13¼
—— 4½ per cent. Cum. Pref., 7,501-15,000	10	..	10-11 xd
—— 6 per cent. Cum. Second Pref., 15,001-22,500	10	..	10¼-11¼
—— 4½ per cent. Debenture Stock, Red.	100	..	103-106
Bromley (Kent) Electric Light and Power Co., 4½ per cent. 1st Debenture Stock, Red.	100	..	102-105
Brompton and Kensington, Ordinary	5	..	10¼-11 xd
—— 7 per cent. Preference	5	..	10¼-10⅜
Calcutta Electric Supply Corp., Ordinary, Nos. 1-40,000	5	..	6¼-7¼
—— Nos. 20,001-30,000	5	..	7-8
Cambridge Electric Supply Company, Ltd., £10 Ord.	8	..	14¼
—— " " £10 Ord.	6	..	10⅜
Central Electric Supply, Ld., 4 per cent. Guar Deb. Stock	100	..	106-109
Charing Cross and Strand, Nos. 1-70,000	5	..	9-9⅛ xd
—— 4½ per cent. Cum. Pref.	5	..	5¼-6
—— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000	5	..	4⅜-5
—— 4 per cent. Debenture Stock, Red. (Prov. Certs.)	100	..	104-106
Chelsea Electricity Supply	5	..	5¼-6¼
—— 4½ per cent. Debentures	100	..	108-111
City of London, Ordinary	10	..	10¾-11¼
—— 6 per cent. Cumulative Pref.	10	..	13-14
—— 5 per cent. Debenture Stock	100	..	122-127
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100	..	102-105
County of London and Brush Provincial, Ordinary	10	..	8-9
—— 6 per cent. Cum. Pref.	10	..	11¼-12¼
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	100	..	109-112
Edmundsons' Electricity Corporation, Ordinary, 1-50,000	5	..	6¼-7
—— 6 per cent. Cum. Pref.	5	..	6-6¼
—— 4½ per cent. First Mort. Deb.	100	..	107-110
Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-30,000	5	..	3¼-4¼
—— 5 per cent. Debenture Stock, Red.	100	..	95-98
Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000	5	..	6-6¼
—— 4½ per cent. First Deb. Stock, Red.	100	..	100-103
Hove Electric Lighting, Limited, Ord., 1-13,000	5	..	8-9
Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000	5	..	10¼-11¼
—— 4 per cent. Debenture Stock Red.	100	..	103-106

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Name.	Amount paid.	Last price.
	£	£
Kensington and Knightsbridge and Notting Hill	100 ..	103-106
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10 ..	9½-10¼
London Electric, Ordinary	3 ..	2-2½
—— 6 per cent. Pref.	5 ..	5½-6
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100 ..	100-102
Metropolitan, Ordinary	10 ..	17-18
—— 4½ per cent. First Mortgage Debenture Stock	100 ..	108-112
—— 3½ per cent. Mortgage Debenture, Red.	100 ..	97-100
Newcastle-upon-Tyne Electric Supply, Ordinary	5 ..	8-8-101
—— Preference	4 ..	100-103
Notting Hill Electric Lighting	10 ..	13-14
—— 4 per cent. First Mort. Debs., Nos. 1-500 (Reg.)	100 ..	99-102
Oxford Electric, Ordinary, 1-96 and 407-14,310	5 ..	5-6
—— 4 per cent. Debenture Stock	100	98-101
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100 ..	100-102
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5 ..	3¼-3½
—— 4 per cent. Debenture Stock	100 ..	88-90 xd
South London, Ordinary	5 ..	3½-4½
St. James's and Pall Mall, Ordinary, 101-20,080	5 ..	15½-16½
—— 7 per cent. Pref.	5 ..	8-9
—— 3½ per cent. Deb.	100 ..	98-101
Urban Electric Supply Co., Ordinary, 8-30,007	5 ..	5-5½
—— 5 per cent. Cumulative Preference, 50,001-80,000	5 ..	5-5½
Westminster, Ordinary	5 ..	12½-13½ xd
—— 5 per cent. Cum. Pref., 110,101-138,251	5 ..	6-6½

Electric Railways.—

Central London, Ordinary	100 ..	98-101 xd
—— 4 per cent. Pref.	100 ..	99-102 xd
—— ,, ,, deferred	100 ..	101-104 xd
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100 ..	116-119
City and South London, Consolidated Ordinary	100 ..	59-61
—— 4 per cent. Debenture Stock	100 ..	116-119
—— 5 per cent. Pref. Stock '91	100 ..	127-130
—— ,, ,, ,, '96	100 ..	126-129
—— ,, ,, ,, '01	100 ..	125-128
Liverpool Overhead, 5 per cent. Pref.	— —	13-13½
—— Ordinary, 1-50,000	— —	7½-8
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	— —	102-104
Waterloo and City, Ordinary	100 —	95-98

Electric Tramways.—

Anglo-Argentine, 1-260,007	5 ..	4¼-4⅜
—— Permanent 6 per cent. Debenture Stock, 1888	100 ..	125-130
Blackpool and Fleetwood Tramroad	10 ..	13½-14½
Brisbane Tramway Invest., Lim., Ord., 1-75,000	5 ..	2⅜-3½
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5 ..	4-4⅜
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100 ..	100-103
British Columbia Electric Railway Co., Ord., Nos. 1-20,000	100 ..	71-74
—— Non-Cum. 5 per cent. Pref., Nos. 25,001-38,600	100 ..	91-94
—— 4½ per cent. 1st Mt. Debs., Nos. 1-6,250, of £40 each	40 ..	104-106 p.c

Name.	Amount paid.	Last price.
	£	£
British Electric Traction, Ord., 1-300,000 & 60,001-90,000	10 —	11½-12
—— 6 per cent. Cm. Pf., 30,001-60,000	10 —	11½-12½
—— 5 per cent. Perpetual Debenture Stock	100 —	122-125
Buenos Ayres and Belgrano Tram., Ord., 1-100,000	5 —	2⅜-2⅝
—— "A" 6 per cent. Cm. Pf., 1-40,000	5 —	5-5½
—— "B" 6 per cent. Cm. Pf., 1-27,500	5 —	4⅜-5⅛
—— 5 per cent. Deb. Stock, Red.	100 —	105-108
—— Prov. Cert., all paid	100 —	98-101
Cape Electric Tramways, Nos. 1-480,000	1 —	1⅛-2⅛
City of Birmingham Tramways, 5 per cent. Cum. Pref.	10 ..	5-5½
—— 4 per cent. 1st Mortgage Deb., 1-3,000 (1917)	100 ..	99-102
Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red.	100 ..	102-105
Cork Electric Tramways and Lighting Co., Ordinary	10 —	13-14
—— 5 per cent. Cum. Pref.	10 —	11-12
—— Debentures	100 ..	96-99
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10 —	12-13
—— 6 per cent. Pref., Nos. within 1-60,000	10 —	14½-15½
—— 3½ per cent. Mort. Debs., 1-3,000, Red.	100 —	94-97
Imperial Tramways, Ordinary	all —	22-23
—— 6 per cent. Cum. Pref.	all —	14½-15½
—— 4½ per cent. Deb. Stock	100 ..	112-114
Isle of Thanet Electric Tramways and Lighting, 5 per cent. Cum. Pref., Nos. 30,001-60,000	5 —	4-4½
—— 4 per cent. Debenture Stock	100 ..	92-95
Kidderminster and District Lighting and Traction, Pref.	5 —	5½-6
London United Trys. (1901), 5 per cent. Cum. Pref.	10 —	11½-12½
—— 4 per cent. 1st Mt. Db. Stock, Red.	100 ..	105-107
Metropolitan Electric Trams., Deferred, 1,000,001-1,314,016	1 —	3/16-5/16
—— 5 per cent. Cum. Pref., 500,001-814,016	1 —	⅛-¼
New General Traction, Ordinary	5 —	2-3
—— 6 per cent. Cum. Pref.	5 —	2-3
—— 5 per cent. Mortgage Debentures, 1-1,713 (Regd.)	100 —	88-93
Oldham, Aston, and Hyde Tramway, Ordinary	10 —	10½-10¾
—— 5 per cent. Cum. Pref.	10 —	11½-12½
Perth Elec. Tramways (W.A.) 5 per cent. 1 Mort. Deb. Stk.	100 —	99-102
Potteries Electric Traction, Ordinary, 20,001-40,000	10 —	9-10
—— 5 per cent. Cum. Pref., 1-20,000	10 —	9½-10½
—— 4½ per cent. Debenture Stock	100 —	102-105
South Lancashire Electric Traction and Power Company—		
—— £250,000 Ordinary	1 —	1
—— £101,132 6 per cent. Preference	1 —	1
—— £528,093 4½ per cent. Debenture Stock	100 p.c. —	90 p.c.

Telephones.—

National Telephone, Preferred	100 —	99-102
—— Deferred Stock	100 —	79-81
—— 6 per cent. Cum. First Pref.	10 —	13-14
—— 6 per cent. Cum. Second Pref.	10 —	13-14
—— 5 per cent. Non. Cum. Third Pref.	5 —	5-5½
—— 5½ per cent. Deb. Stock, Red.	100 —	96-98
—— 4 per cent. Deb. Stock, Red.	100 —	101-103
Oriental Telephone and Electric Company	1 —	13/16-15/16

TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Traffic Returns for week			Increase or decrease.		Miles of single track open.		Accounts for past year.				Receipts per			Cost per car mile.
	Ending	1903.	1902.	Week.	Current year.	1903.	1902.	Ending	Total receipts	Passengers carried.	Car miles run.	Pas-s'nger	Car mile.	Mile of track.	
		£	£	£	£				£			d.	d.	£	d.
Aberdeen Corporation	Aug. 13	1,372	1,154	+ 217	+ 1,713	19¼	17¼	May 31	37,931	9,099,715	794,641	0·98	13·02	1,970	6·14
Ayr Corporation	—	—	—	—	—	8	6	Sept. 25	12,503	2,979,276	290,099	1·00	10·34	1,560	4·7
Birmingham Tramways	,, 15	4,817	4,742	+ 75	+ 7,703	6½	6½	—	—	—	—	—	—	—	—
Blackburn Corporation	—	—	—	—	—	24	24	March 25*g*	40,964	7,234,105	826,558	1·36	11·87	1,705	7·44
Blackpool Corporation	—	—	—	—	—	17½	16½	,, 31	211,168	6,169,121	784,443	1·52	10·8	—	—
Blackpool-Fleetwood Tramways	,, 15	2,071	2,132	− 61	+ 677	16½	16½	Dec. 31	30,923	2,043,677	584,989	3·62	12·68	1,932	6·99
Bolton Corporation	,, 16	1,803	1,655	+ 154	+ 5,249	38	25	March 31	85,704	17,761,605	1,896,247	1·15	10·75	3,430	5·87
Bournemouth Corporation	,, 12	1,438	—	—	—	10½	—	—	—	—	—	—	—	—	—
Bradford Corporation	,, 16	3,910	3,441	+ 479	+ 9,477	41	—	—	—	—	—	—	—	—	—
Brighton Corporation	,, 16	1,234	1,063	+ 171	—	6½	—	,, 31	—	10,432,508	1,031,928	1·00	10·10	—	—
Bristol Tramways Company	,, 14	4,977	5,425	− 448	—	51½	51½	Dec. 31	223,480	41,192,899	5,724,114	1·30	9·38	4,348	—
Burnley Corporation	,, 15	924	827	+ 97	—	—	—	—	—	—	—	—	—	—	—
Cardiff Corporation	,, 1	2,133	1,535	+ 598	+12,345	—	—	—	—	—	—	—	—	—	—
Carlisle Tramways Company	—	—	—	—	—	—	—	,, 31	—	2,216,583	320,129*h*	—	—	—	—
Central London Railway	,, 15	5,539	6,659	−1,130	− 1,609*h*	6	—	,, 31	367,225	45,305,110	1,276,971*a*	1·87	66·6*a*	59,076	35·6*a*
City and South London Railway	,, 16	2,332	3,222	− 890	− 2,232	6⅝	—	,, 31	165,003*a*	19,069,319*a*	—	—	—	—	—
Cork E. T. and L. Company	,, 13	646	885	− 239	− 677	—	—	—	—	—	—	—	—	—	—
Darwen Corporation	July 10	220	243	− 23	− 113	7·23	—	March 31*g*	12,341	2,360,735	254,279	1·25	11·65	1,707	9·36
Dover Corporation	Aug. 15	299	311	− 12	+ 102	3	—	—	—	—	—	—	—	—	—
Dublin & Lucan Electric Railway	,, 16	163	132	+ 31	+ 92*h*	—	—	Dec. 31	5,796	364,796	102,087	3·81	13·62	859	7·68
Dublin U. T., electric cars	,, 14	4,072	4,116	− 44	—	46	46	March 31	126,121	24,553,133	3,429,356	1·23	8·82	2,741	5·06*h*
Dublin S. District, Electric	,, 14	1,189	1,113	+ 76											
Dundee City Tramways	July 15	834	718	+ 116	—	22	22	May 15	35,874	9,084,522	752,814	0·93	11·276	1,630	—
East Ham Corporation	Aug. 15	715	506	+ 209	+ 4,407	10·75	7·52	March 31	25,341	9,971,337	650,224	0·61	9·35	2,357	—
Farnworth U.D.C.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Glasgow Corporation	,, 15	12,796	12,442	+ 354	+15,261	124	101	May 31*g*	656,572	177,179,549	14,008,750	0·88	11·25	5,489 *b*	7·40*d*
Halifax Corporation	—	—	—	—	—	30½	27⅔	—	—	—	—	—	—	—	—
Huddersfield Corporation	—	—	—	—	—	34	35	March 31	56,631*h*	9,758,213	1,218,539	1·4	11·14	1,618	6·38
Hull Corporation, E. S.	,, 15	1,845	1,839	+ 6	+ 1,713	19	19	,, 31	87,707*h*	21,065,999	2,218,696	1·00	9·49	5,004	5·07
Ilkeston Corporation	,, 13	194	—	—	—	—	—	—	—	—	—	—	—	—	—
Kirkcaldy Corporation	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Leeds Corporation	,, 15	5,724	5,258	+ 466	+ 6,867	77	—	March 25	262,656	57,239,779	5,773,651	1·11	10·91	3,283	—
Liverpool Corporation	,, 15	11,762	11,347	+ 415	+11,446	101	95	Dec. 31	504,304	108,906,472	11,705,425	1·11	10·34	5,000	6·88
Liverpool Overhead Railway	,, 16	1,647	1,604	+ 43	+ 710	15½	15½	June 30	79,252	10,466,726	986,185*a*	1·82	19·30*a*	5,110	— *a*
Metropolitan District Railway	,, 16	6,231	7,051	− 820	− 2,859	—	—	—	—	—	—	—	—	—	—
Newcastle-on-Tyne Corporation	,, 15	3,425	2,754	+ 671	—	38½	36	March 25*g*	150,334	33,474,122	3,379,119	1·08	10·93	4,175	6·17
Portsmouth Corporation	—	—	—	—	—	29	29	Sept. 30	47,651	9,168,137	868,157	1·24	13·17	1,643	—
Rochdale Corporation	July 20	157	164	− 7	—	4½	—	March 31	5,416	925,281	127,456	1·38	10·27	—	7·66
Salford Corporation	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Sheffield Corporation	Aug. 16	4,395	—	—	—	53½	46½	Mar. 25*g*	216,709	56,812,049	4,926,083	0·904	10·428	7,510	7·0
Southampton Corporation	,, 13	1,270	1,270	—	—	11	11	,, 31	35,874	9,084,522	752,814	0·946	11·436	3,760	—
Sunderland Corporation	,, 16	1,404	1,370	+ 34	+ 1,092	18·48	17·18	,, 31	69,930	13,987,121	1,270,957	1·03	11·3	3,243	6·43
Wallasey U.D.C.	,, 15	827	743	+ 84	+ 2,032	10·5	10·5	,, 31*g*	31,307	5,690,378	654,553	1·32	11·47	2,981	6·97

* Includes maintenance of permanent way and proportion of profits paid to the tramway companies for term of unexpired lease. *a* Train mile.
b Per mile of single track. *c* Include rail and tram. *d* including depreciation. *f* Including one section of horse traction. *g* 1903. *h* Half-year's figures.

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NOTES.

Cheap Electric Light.—A German contemporary states that, commencing on Jan. 1, 1904, the price of electric light in Berlin will be reduced 27 per cent.—*i.e.*, from 55 pfennigs to 40 pfennigs (about 6½d. to 5¾d. English money) per kilowatt-hour—and that the price for electric light in that city will then be cheaper than in any other large city. This reduction is being made with a view to competing more closely with gaslight.

Marconi Experiments.—Signor Marconi is ever at work. The eminent inventor left Liverpool on Saturday for New York on the "Lucania," and intends during the voyage making some important experiments. An independent apparatus has been fitted up on the aft mast of the vessel, and Signor Marconi will direct his experiments to ascertaining the actual power required to transmit messages a certain distance on a moving ship. He promises to publish his results on arrival at New York should they prove sufficiently interesting.

Electric Alarms. — At Hampstead the public swimming-baths have been equipped with a system of electric alarms as a precaution against accident to the bathers. In the event of a bather getting into difficulty the attendant rings an electric bell in the office and in each of the other baths. A disc is at once displayed indicating at which of the four baths help is needed, and the attendants are able to go to the spot without delay. In a surprise test made by the Baths Committee it was found that five men were brought to give aid to an apparently drowning person in just 35 seconds.

Hertzian Waves in Navigation.—An American inventor, Mr. H. W. Ladd, claims to have discovered a means for using Hertzian waves in obtaining bearings at sea when the objects, owing to a fog or storm, are invisible. This consists of a coherer circuit electrically connected with an upright conductor, so shielded that waves are only received from a transmitter on another vessel or at a shore station when a lateral opening of the shield is in proper range radially with the vessel or station. The shield is movable, and at its lower end has a pointer moving over a compass card. When the coherer in circuit gives a signal the range is determined.

Books Received.—"New Instruments of Precision from the Ryerson Physical Laboratory," by Robert A. Millikan. This is a full description of some new pieces of apparatus devised by members of the department of physics: (1) a substitute for the Attwood machine; (2) a "moment of inertia" machine; (3) a Young's modulus apparatus; (4) a vapour-tension device. It is published by the University of Chicago Press. We have also to acknowledge "Practical Physics of the Steam Boiler," by Mr. Frederick J. Rowan, A.M.I.C.E., M.I.E.E. The book, published by Messrs. P. S. King and Son, Westminster at 21s., contains over 300 illustrations, and runs into 600 odd pages.

Radium and Blindness.—A case is reported from New York in which the sight of a child who had been totally blind for eight years has been partially restored, as the result of a combination of the use of radium and the X-rays. Dr. Amon Jenkins and Mr. Wm. J. Hammer were responsible for the experiment, which consisted principally in holding against the forehead, the base of the brain, and the temples of the child, several tubes of radium, ranging from 75 to 7,000 radioactivity. A momentary sensation of light was the result. According to the correspondent who sends the information, the child an hour afterwards was able to distinguish objects in the street. He does not go so far as to say that the cure is permanent, but adds that the sensation produced is that of a shadow being cast over one whose sight is normal.

Electricity in India.—The Government of India, under the present Viceroy, seems anxious to take full advantage of electricity so far as the conditions existing in that country will permit. A useful Act has been passed for the controlling of the use of electricity for light and power purposes in India, and the Government itself has been among the first to adopt electricity for light and punkah-pulling, and is now extending its application to the driving of machinery in the State workshops. In connection with this work we hear that the Government has accepted in principle a scheme for establishing a central workshop and store at Rurki for the repair and testing of electrical appliances, and for the issue of stores required in connection with electrical installations in cantonments. Several such installations have been made, and the satisfactory results obtained have doubtless been the dominant factor in urging the Government to energetically pursue its work in this direction.

Wave Motor.—Information reaches us of a trial of Millar's wave motor, which took place recently at a small seaside place near Dunedin, in New Zealand. The contrivance consists of a wooden float about a ton in weight, to the four corners of which ropes are attached. The ropes are taken up over loose pulleys and joined by four chains to ratchet wheels on a shaft. As the waves rise the weights pull the chains down, and are so held by cogs. As the float goes down with the fall of the sea it exerts a pulling force on the spindle, which drives a countershaft with a pulley attached. The power thus obtained was used to drive a small dynamo with a 25-c.p. lamp, and also a circular saw. With the ton float used about 3 h.p. is stated to have been obtained. Unfortunately, all attempts to harness the power of the sea are met by the difficulty that there is no protection against rough weather, and we are afraid the above device is no exception to the general rule. It is thus obviously impossible to invent an arrangement which will serve efficiently except under favourable conditions, such as would naturally be selected for the trial of a new invention.

Artificial Graphite.—The manufacture of artificial graphite at Niagara Falls has assumed a very prominent position in the graphite industry in the last two or three years. The production in 1902 amounted to 2,358,828lb., as compared with 2,500,000lb. in 1901 and 860,750lb. in 1900. The sole producers are the International Acheson Graphite Company, who began operations in 1897 with a product of 162,382lb. The output of last year consisted of 885,591lb. of graphitised electrodes, and 1,475,237lb. of artificial graphite in the granular or powdered form. The electrodes were used in electrolytic processes for the production of caustic soda and of chlorine and metals in chlorine solution, also in electro-metallurgical processes, such as the production of calcium carbide, the electric smelting of copper and iron ores, and the manufacture of various iron alloys. The artifical graphite in the form of grains and powders was used chiefly in the manufacture of paint, dry batteries, and commutator brushes, although a considerable quantity was used in the manufacture of lubricants, in electroplating work, and in certain chemical processes requiring a carbon of exceptional purity.

The Earth as a Condenser.—In the "Digest" of the *Electrical World* for Aug. 15 an abstract of a paper by Koepsal is given discussing the rôle of the earth in wireless telegraphy, in which two interesting points are brought

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into prominence. One of these is the small electrical capacity of the earth, and, therefore, the improbability of its playing any part, as has been suggested, in the transmission of large quantities of electrical energy by utilising it as an element in a resonant circuit. The author calculates a special case, assuming conditions that might be approximated in practice, though a vertical conductor extending 2,700 yards in the air is scarcely a practical assumption. With resonance established, the maximum current rush would then not exceed 15 amperes, and the total flow of current would be only ·0009 coulomb. An important conclusion of the investigation is, however, that in wireless telegraphy the capacity of the earth may be utilised to great advantage. If the premises of the author are correct, the conditions of resonance can be satisfactorily met without great difficulty by proper design of apparatus, in which case sending signals half around the earth could be as readily accomplished as sending them over short distances.

Rubber-Producing Creeper.—Mr. W. A. Hearsey is stated to have discovered the rubber-producing creeper, Rhynchodia Wallichii, growing abundantly in the Nyanglabin division of the Pegue district, in India. The rubber obtained from this creeper is said to be clean and of good quality, and could no doubt be cultivated with advantage both to the planters and the rubber-using trades. From an Australian journal we hear of a renewed effort which is being made to cultivate the rubber plant in Queensland, Australia. Some successful attempts were made a short time ago to obtain and prepare rubber in Queensland, and samples were sent to England, obtaining a fair price. The sap was obtained by making incisions in the bark of the white mangrove trees, which grow plentifully in the swampy lands along the coast of Central Queensland, and was allowed to run into tins that were fastened on the trees. It was afterwards placed in earthenware jars, put in boiling water, and then worked up by hand until the rubber was produced. In this simple, crude manner very good elastic rubber was obtained, which fetched 4s. per pound in this country. The demand for rubber is ever increasing, and it is surprising that this trade has not been more fully developed by planters. For many years to come enterprising Colonials might find in the cultivation of the rubber tree a source of indigenous wealth.

Electric Light and Power Plants of the United States.—Some of our American contemporaries have published a valuable report issued by the United States Census Offices giving statistics of the electric light and power plants of the United States for the year ended June 30, 1902. This report includes central stations only. It does not embrace isolated plants, plants operated by electric railway companies, or plants that were idle or in course of construction. Thus we find that there are 3,619 such establishments in operation, of which 2,804 are private and 815 in municipal hands. The total capital expenditure represented by these stations is the huge sum of £100,436,302, while the total earnings from operation during the year under review were £18,717,082. On the other hand, the total expenses amounted to £13,537,615, and it is noticeable that under this heading the salaries and wages bill is very nearly as heavy as the supplies and materials item, the respective totals being £4,110,398 and £4,562,951. Under the heading of power plant equipment, we are somewhat surprised to find that the total horse-power of the waterwheels is less than a fourth of that of the steam-engines. The figures in each case respectively are: number 5,921, horse-power 1,377,041; number 1,378, horse-power 381,134. A mass of figures is given further on in the report, from which we gather that the total output for the year was 2,437,218,732 kilowatt-hours. A final report is promised, which will give an analysis of the above totals and present statistics for other phases of the industry.

A Second Mosely Commission.—Hardly has Mr. Mosely concluded the work in connection with his recent Labour Commission to America than he is engaged in making arrangements for dispatching an Education Commission across the Atlantic. Both the United States and Canada will be toured by the commission, and the various universities and schools inspected. About 30 delegates, forming the commission, will leave these shores early in October; each delegate represents a different branch of education. Among the delegates will be representatives of the county councils of England, Scotland, Ireland, and Wales, from whose presence Mr. Mosely expects to achieve great results. The commissioners also include Prof. W. E. Ayrton, F.R.S., professor of physics in the Central Technical College; Mr. R. Blair, M.A., B.Sc., representing the Department of Agriculture and Technical Education in Ireland; Mr. Magnus Maclean, M.A., D.Sc., professor of electrical engineering in the Glasgow and West of Scotland Technical College; and Mr. W. Ripper, professor of engineering, University College, Sheffield. The delegates will be required to make separate reports, which will be published in a collective form in the spring. It may be safely anticipated that the volume when issued will reveal information of the highest importance with regard to the progress of technical education on the other side.

Improved Galvanic Battery.—A recent German patent relates to improvements in galvanic batteries of that class which are constituted by or composed of a series or plurality of separate dry cells. The improvements refer to the production of a battery which is capable of being kept in store and transported in an absolutely dry condition, and of being rendered fit for use at a moment's notice by the addition of a suitable liquid or electrolyte into the separate cells constituting the battery. The object aimed at is claimed to have been secured by the introduction of certain novel features of construction and combinations of parts. The dry cells consist each of a zinc or other metallic cylindrical electrode, or of a carbon electrode having a cylindrical or prismatic cross-sectional area, and placed within the metallic cylinder. The space between the two electrodes is filled up with blotting-paper or other suitable material capable of sucking up the electrode. A plurality of these cells is arranged within a suitable socket or frame-shaped casing, the individual cells being separated from one another, and the surrounding casing by some suitable insulating material. When required for use one has only to remove the covers from the cells and to fill them up—that is to say, to soak the blotting-paper with any convenient electrolyte, such as ammonia solution. The covers are then replaced and the battery ready for use. Insulating rings at the open ends of the cells or zinc cylinders respectively prevent any short-circuiting of the cells by any overflowing electrolyte.

Schmidt Superheater.—We are able to give the results of an interesting trial carried out this month of a Schmidt flue-fired superheater which Messrs. Heaton and Co., Limited, have supplied to the Greenbank Corn Mills, Preston. The superheater, which is of 500 square feet heating surface, is fitted to a 7ft. 6in. by 21ft. 3in. Lancashire boiler, and the steam is used for driving a single-cylinder non-condensing engine of 13in. diameter by 36in. stroke, 67 revolutions per minute. The trial lasted five hours, and the following satisfactory results were

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obtained. The boiler pressure by gauge was 66lb. per square inch. The temperature at the superheater was 570deg. F., and at the engine 436deg. F. Using superheated steam, the coal burned per hour was 2·5cwt., whereas a previous trial with saturated steam required 3·5cwt. of coal; so that the saving of coal equals 1cwt. per hour, or 28·5 per cent. The indicated horse-power being 67·3, the steam consumption per indicated horse-power was with superheated steam 22lb., with saturated steam 36lb. This represents a saving of water with superheated steam equal to 14lb. per i.h.p. hour, or 39 per cent. It is estimated that the total weekly saving of coal and water using the superheater is represented by 31s., an annual saving of £77. 10s. The cost of the complete superheater installation was £270, and allowing 10 per cent. for depreciation, the net saving due to the superheater comes out at £50. 10s., or 18½ per cent. interest on the capital outlay. The above figures are taken from the official results of the trial, and may be regarded as accurate.

Central-Station Development. — Prof. Elihu Thomson contributed a paper to the recent convention of the National Electric Light Association of America, in which he reviewed central-station development during the past 25 years. At that date dynamos were of exceedingly small capacity, when one using 25 h.p. or 50 h.p. had a very large output. The evolution of steam practice in central stations from high-speed belted engines to slow-speed direct-connected units was reviewed, bringing the author down to modern steam-turbine practice. Looking to the future, the author put aside as improbable the conversion of fuel into electrical energy, inasmuch as no promising signs of its possibility were forthcoming; but it seemed that it would be necessary at last to turn to those forms of prime movers which had inherent possibilities of developing much higher efficiencies in the use of fuel than the steam-engine. At present in relatively very small units the internal-combustion engine, such as the oi or gas engine, had shown efficiency nearly double that of the best steam-engine plants. It seemed probable that an efficiency of heat conversion about three times better than was attained with steam would some day be practicable in large units. The engines would naturally be of the large reciprocating type and comparatively slow speed, unless some form of gas-turbine was developed, a matter upon which serious doubts might be expressed. Such a machine would demand the pumping of the air and gas prior to their combustion. Various other matters in connection with gas-engine practice were briefly discussed. In the considerations advanced in the paper the use of water power was purposely neglected.

Electrodes.—Three English electrochemists (Messrs. J. Hargeaves, J. W. Stubbs, and J. Kearsley) have patented recently a method for a peculiar construction of anodes or electrodes, consisting partly of carbon for use in electrolytic cells, and probably designed more particularly to be used in Mr. Hargreaves's own apparatus. From a description in *Electrochemical Industry*, we gather that the object in view has been to get an electrode which offers little resistance to the electric current, and the parts of which may be readily renewed when worn or broken. The arrangement consists of a bar of metal connected to the source of electricity. The bar may be made of two strips riveted together in such a way as to form openings at intervals, or these openings may be worked out in a solid bar. Passing through these openings, but not fitting closely into them, are nipples or bars of carbon. In order to make electric contact between the bar and nipples, melted lead or another suitable metal is cast into the openings between the bar and the nipples. This also holds the nipples firmly in position. In order to still further reduce the resistance and improve the contact, indentations or perforations may be arranged into or through the nipples, which are also filled with melted lead. The bars are then preferably coated with tar pitch or similar impervious insulating material, after which they are covered with Portland cement or any other insulating compound. The coating of impervious material prevents the access of the electrolyte to the metal bar and its corrosion. The ends of the nipples project through the cement covering and are fitted closely into openings in the blocks or pieces of gas or retort carbon, from which the current passes into the electrolyte. The extremities of the nipples are covered with cement or similar material, to prevent wearing at those points. The nipples may also be covered with sheaths of insulating material, in order to further protect them.

Radiation from the Nernst Lamp Glower.—In the August number of the *Physical Review* Hartman contributes a long article giving the results of a spectrophotometric investigation of the luminous radiation from the Nernst lamp glower under varying current densities. The apparatus used was a Kirchoff spectrometer, having a callimeter with two unilateral micrometer slits, which was adapted for the purpose of the investigation. The arrangement and standardisation are described in detail. As a standard source of light an acetylene flame burning under constant pressure was used. The Nernst lamp employed was a 104-volt alternating-current lamp. The diaphragmed acetylene flame used as a standard was determined in terms of the Hefner standard. Currents from 0·2 ampere to 1·5 ampere were used. The author arrives at a number of conclusions, from which it appears that at the rated normal current strength the radiation from the glower of the Nernst lamp is relatively rich in the more luminous waves of the spectrum. It exhibits no marked selective radiation. Its light intensity apparently increases with age, and is relatively less rich in the short, but richer in the long waves, than that from the acetylene flame, but its radiation rapidly becomes more like that from burning acetylene with increasing current strength. At current strengths below the rated normal value, the increase in intensity with increasing current strength is most marked in the long waves, and above this rated normal value of current strength the increase in intensity is most rapid in the short waves. At current strengths below the rated normal value the Nernst lamp is relatively less rich in short waves than the flame of the Hefner lamp, while above this current strength the opposite is true. At rated normal current strengths, or slightly above this, the colour of the Nernst lamp radiation is very similar to that of the Hefner lamp. The luminous radiation from the Nernst lamp corresponds very closely to that from incandescent calcium.

Deposition of Zinc.—In a paper on this subject read before the American Chemical Society, Dr. E. H. Patten describes some experiments made in electrolysing a saturated solution of zinc chloride in acetone between platinum electrodes three square centimetres in area, and approximately 0·7cm. apart, at 25deg. C. The current E.M.F. curve shows a decomposition point at two volts. A large residual current was observed. At 0·9 volt 0·0014 ampere passed, remaining fairly steady. At 1·02 volts 0·0019 ampere steady current passed, no gas bubbles being visible on either electrode. A battery point was found at 1·27 volts during the first stage of electrolysis, but after electrolysing perhaps one half hour the battery point obtained was 1·32 volts. During the whole course of this electrolysis no gas bubbles appeared at either electrode.

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Chloroform, chlor-acetone, or other alkyl chloride were formed at the anode, and a smooth, compact coating of zinc was deposited upon the cathode. The zinc may be deposited steadily with a current density of 2·25 amperes per square foot. The experimenter also used a current density as high as 40 amperes per square foot, but the zinc trees out from the edges of the cathode in long streamers; nevertheless, the zinc deposited upon the main portion of the cathode is smooth and dense. As one of the chief difficulties in the electrodeposition of zinc consists in avoiding the liberation of hydrogen upon the cathode and a consequent pitting of the coat, the availability of a solution such as this, where no hydrogen or other gas is liberated at a high current density, will readily be seen. The thickness to which zinc may be deposited from this solution has not as yet been determined. The author proposes to investigate this further, and also to make careful analysis of the zinc obtained from this solution. The difficulty of obtaining chemically pure zinc certainly warrants such an investigation. The apparent lack of carbonisation of the salt, the lack of gas formation at the cathode, and the comparatively complete fixation of the chlorine at the anode, taken together, look promising.

Porous Diaphragm for Electrolytic Cells.—For many electrolytic operations it is necessary to hold the anodic and cathodic departments separated by porous diaphragms in order to prevent any reaction between the anodic and cathodic products of electrolysis, as such reactions mean decreased efficiency of operation. A patent described in detail in the *Electrical World* has been granted to Dr. E. A. Byrnes for improvements in the construction of such porous diaphragms. Many substances of high specific conductivity afford a body of low conductivity when finely divided; such a poorly-conducting granular body may be used as diaphragm, the size of the grains depending on the requisite porosity and conductivity of the diaphragm. These grains may either be mixed with an inert binder (like silicate of magnesium or calcium or ferrous hydrate) and moulded into a self-supporting diaphragm, or they may be used without binder, and are then enclosed between perforated metal sheets, if used for a vertical diaphragm. For cells with a horizontal cathodic surface a floating diaphragm may be employed. For the electrolysis of brine with a mercury cathode, the inventor places a sheet of amalgamated copper or iron wire gauze upon the mercury, and upon this wire gauze rests the granular diaphragm. In the same way in the electrolysis of molten sodium chlorine with a molten lead cathode, the latter is covered with a wire gauze on which the diaphragm rests. The diaphragm material should be inert toward the electrolyte and its products. For the electrolysis of alkali chlorides and nitrates, whether in solution or fused, diaphragms of magnetite or ferro-ferric oxide are suitable; ilmenite or chromite are also available. Broken glass or porcelain are suitable in aqueous electrolytes. For the electrolysis of molten sodium chloride with a molten lead cathode, a diaphragm of broken magnetite is suitable. For the recovery of metallic sodium from any of its molten compounds, the inventor proposes to fill a metallic vessel which serves as anode nearly entirely with granular material, a well being maintained at the top by means of a perforated cup placed around the cathode. The sodium rises and floats upon the surface of the electrolyte in the cathode well.

Technical Instruction in London.—Dr. Chas. V. Drysdale has some interesting remarks to offer on the competition for intermediate county scholarships in London which took place recently. Dr. Drysdale is the examiner under the London Technical Education Board in heat and light and in electricity and magnetism. As regards the former subjects the work of the candidates is regarded by him as about up to the average, although the work in heat was more satisfactory than that in light. Few, for instance, had distinct ideas of the nature of curvature, and the majority of the candidates were utterly unable to give the reason for the constancy of the ratio of the sines. An improvement was shown, however, in accuracy of photometric work, several of the candidates making satisfactory use of the spectrometer. We are glad to read that the quality of the work in electricity and magnetism has made a distinct improvement, the candidates showing more knowledge both of practical matters and of the construction of electrical measuring instruments. It may be gathered from the following remarks, however, that the evils of the text-book have fallen upon many of the candidates. Great weakness was shown by the candidates in last year's examination in describing instrument details, and although a very gratifying improvement is shown this year there is room for much more, many of the descriptions given, though fairly correct, being obviously the result of blackboard drawing or of text-book reading rather than of practical acquaintance with the instruments. The magnetic work was not so satisfactory as the electrical, and in electrostatics the answers in nearly all cases were rigidly on the lines of the most elementary text-books. One candidate only, a girl, described satisfactorily an electrostatic voltmeter, the description in this case being particularly good. The practical work was done much better than last year, some of the candidates being able to use commercial forms of Wheastone bridge, reflecting galvanometers, etc. In many cases it was obvious, however, that although the experiments were fairly well done, the candidates had never before performed the experiments set. The candidates in most cases showed very considerable aptitude for their work, and were worthy of having had better facilities in their practical instruction.

Critical Speed of Steam-Turbines.—In a brief communication to the *Street Railway Journal*, Franz zur Nedden, writing from Berlin, draws attention to the great importance of a method of quickly finding the critical speed value of steam-turbines up to a certain degree. This method consists in the exact balancing of the rotors, and he gives the following requirements for balancing as working satisfactorily: (1) that the complete mounted rotor should be supported at the journal bearings, and not at any other points when being balanced; (2) that the rotor be supported at the bearings on cylindrical surfaces, which are cut with absolute exactness in order that there shall be no unevenness of surfaces which would introduce errors when testing; (3) that the shaft be revolved between stationary points; and (4) that the rails for the support of the testing apparatus be placed throughout their entire length on foundations which are free from vibration. By following these requirements it is possible to reduce the radius of gyration to 1/300mm. There is, however, a certain element of danger in the armatures of dynamos Assuming that the apparatus is mounted correctly, yet, owing to the great centrifugal force, the shifting of a winding now and then can hardly be avoided. This, of course, will shift the centre of gravity, which shifting may easily have important effects on the armature. As a matter of fact, in spite of the most careful selection of the proper running speed in comparison with the critical speed, nearly all wire-wound armatures will give trouble. This is particularly true with direct-current machines, which, in addition to an armature, also have a commutator as a rotating element. The following methods are suggested for safely running high-speed turbo-generators: (1) secure

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greatest possible difference between the actual running speed and the critical speed; (2) use alternators in preference to direct-current machines whenever possible; or better still (3) use non-synchronous generators. This latter machine possesses the advantage of having an armature carrying absolutely no wire. In fact, this form permits the use of speeds up to 3,000 and 4,000 revolutions per minute. In the Moabit central station of the Berlin Electricity Works there has been running for several months a non-synchronous 1,800-h.p. turbo-generator using wattless current, and it has given no trouble in the direction mentioned.

Wireless Telegraphy at Sea. — Writing his impressions of the naval manœuvres, a naval correspondent on board H.M.S. "Good Hope" describes some trials which were made with the aeroplane or box-kite, invented by Mr. Cody, in connection with wireless telegraphy. The kite has been tried on land for this purpose on several occasions, but this was the first instance in which it had been tested on board a man-of-war. In shape the kite resembles a box, and is made of a material similar to silk alpaca. As the frame is made of bamboo the result is a singularly light and strong kite, capable of withstanding a great pressure of wind. In its connection with wireless telegraphy the kite takes up an aerial wire which is connected to the wireless telegraph instruments on the vessel. The recent trials abundantly proved that with the aid of these kites it is possible to establish communication at sea over far longer distances than if the aerial wires were suspended from the masts. For instance, the wire was carried up some 300ft. by the kite, and the "Good Hope" was able to exchange wireless messages a distance of 110 miles with the wireless telegraph station at Rame Head, off Plymouth. The average distance of communication between ship and shore by this means is, say, 60 or 70 miles, so that the use of the kite gave a considerable advantage. It may be added that in a short time the wireless system of telegraphy will be extended to all the large British warships; also that the Admiralty is about to construct a large wireless station on the east coast for establishing communication with the North Sea Fleet. It is amusing to see what the correspondent has to say with regard to the possibility of interception of wireless messages. Thus, he tells us that Vice-Admiral Sir Arthur Wilson during the recent manœuvres freely utilised wireless telegraphy for misleading the enemy's ships. He goes on: "This has become a well-recognised means of baffling a foe who tries to utilise this method of communicating news to consorts. Two ships out of sight may have just got into communication, though 50 or more miles apart, and then a foe, overhearing their preliminary calls to one another, will put his spoke in their wheels by sending out aimless messages, humorous or otherwise, or it may be merely a column from some newspaper. Anything suffices which will serve as body for messages. Waves are created and get mixed up with the legitimate signals from ship to ship of the enemy, and the instruments within signalling distance record merely a jumble of dots and dashes which have no rhyme or reason. This is called 'blocking,' and until it is rendered impracticable the wireless system will remain comparatively useless, if not actually dangerous, in time of war."

Motor Specification. — The following are a few clauses extracted from the specification for direct-current motors of the United States Navy Yard Department. They show what this department requires from its contractors, and it is to be noted that the temperature rises allowed are considerably above what is standard practice in this country. Thus 81deg. F. is the lowest rise specified, while armatures of enclosed machines are allowed 99deg. F. rise after six hours' run at full load. In other words, the U.S.A. Navy Yard will take smaller motors for a given nominal output than will ordinary contracting firms in England. The clauses most interesting to our readers are as follows: (4) Brushes are to be of carbon, and not to carry more than 35 amperes per square inch at full load. The brush-holder springs shall not be depended upon to carry current. In motors of 5 h.p. and above brush-holders are to be separately adjustable for tension without tools, and simultaneously adjustable for position. In motors below 5 h.p. these adjustments are not required. Brush-holders to be of such design that by very slight changes in the relative position of their parts the rotation of the armature may be in either direction with equal satisfaction; also the angle of the brush to the commutator not to change as the brush wears down. (7) Dielectric strength of insulation to be tested in accordance with the rules of the American Institute of Electrical Engineers. (8) Open motors must run from no load to full load; semi-enclosed motors from no load to 10 per cent. overload; and enclosed motors from no load to 25 per cent. overload, without sparking and without shifting the brushes. Motors to run at all rated loads and speeds without vibration and without undue noise. (9) Motors are to be tested at the works of the maker in the presence of an inspector, and are to run for a continuous period of six hours at full rated load, speed, and voltage without the temperature rise above the surrounding air exceeding the following limits for the different types of motors:

Part.	Open motors.	Semi-enclosed.	Entirely closed.
Field coils by resistance	50	55	55
Armature, commutator, and all other parts by thermometer ..	45	50	55

All rises are to be in Centigrade degrees. The temperature rise of the field coils is to be measured by the resistance method according to the rules of the American Institute of Electrical Engineers. All other temperatures are to be measured by thermometer. Temperature rise of bearing is in no case to exceed 40deg. Semi-enclosed and enclosed motors are to be run with all their covers on. During the six-hour heat run no adjustment of brushes, cleaning or dressing of the commutator, or similar attentions are to be performed on the motor, but after being once put in proper running conditions it must complete a satisfactory run without further attention. (10) Motors are to stand the following overloads:

Type.	Overload for one hour.	Overload for three minutes.
Open	25 per cent.	40 per cent.
Semi-enclosed ...	35 „	60 „
Enclosed	50 „	100 „

The one-hour overload is to be run without injurious sparking or heating of the commuator more that 15deg. C. above the allowed rise for full load for six hours, and may be started with the motor cold if desired. The three-minute overload is to be run without injurious heating, or flashing over or burning of the commutator or brushes, and is to be made within 45 minutes of the end of the six-hour heat run. (11) The full-load efficiencies of motors to be at least as follows:

Horse-power.	Open. Per cent.	Enclosed and semi-enclosed. Per cent.
2	78	75
5	83	80
10	86	84
15	87	85
25	89	87
40	90	88

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COMBINED LIGHTING AND HEATING PLANT AT DRESDEN.

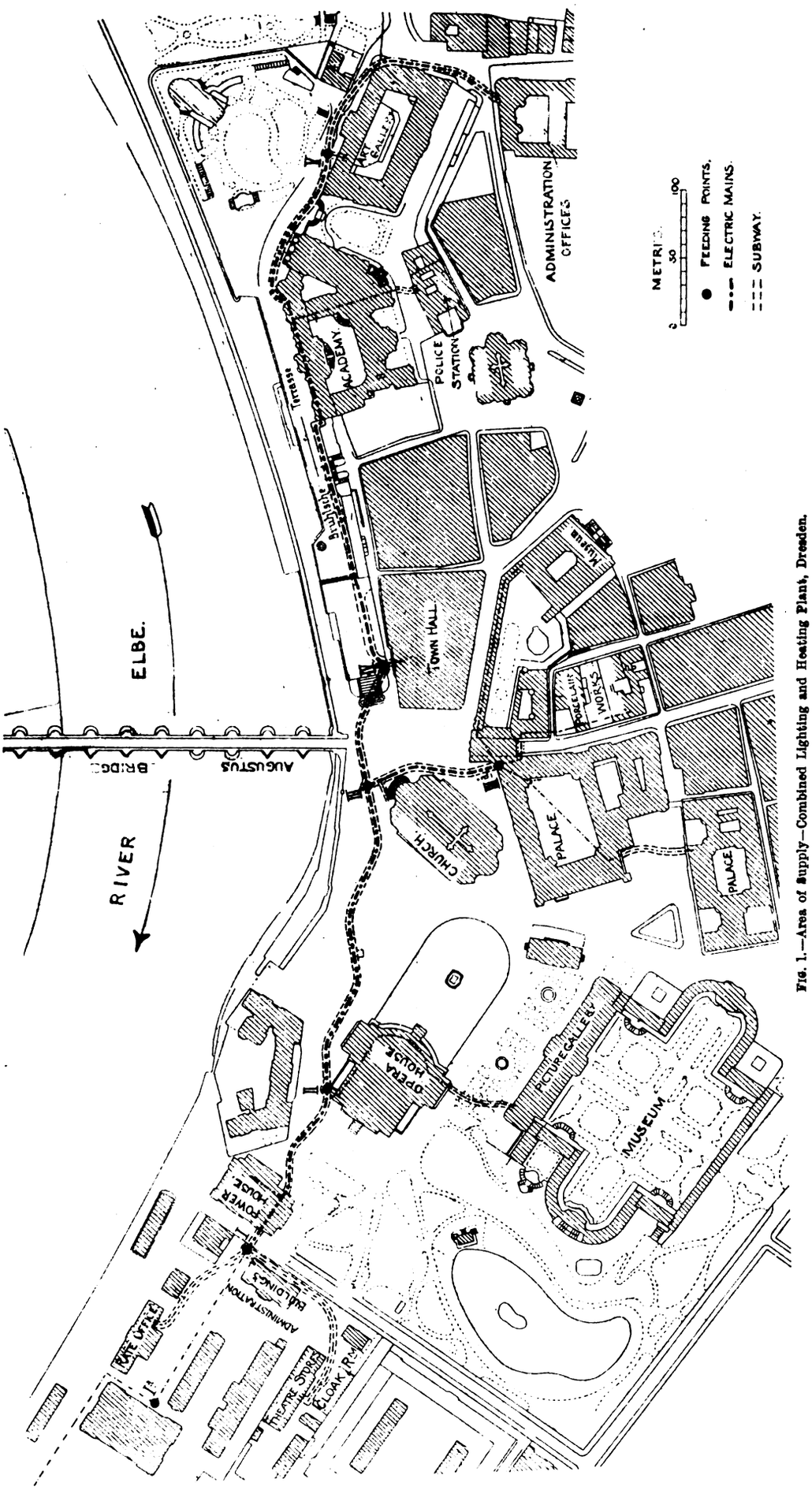

Fig. 1.—Area of Supply—Combined Lighting and Heating Plant, Dresden.

Those of our readers who went with the Institution of Electrical Engineers to Germany in 1901 will doubtless remember that one of the visits arranged in Dresden was to the central station designed to supply heat and light to the King's Palace and various public buildings in the vicinity. The station was then in process of completion, and full particulars were not available, the visitors having to content themselves with a hurried inspection of the

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plant. However, details are now to hand, and we propose to briefly describe what was voted one of the most interesting installations viewed.

Both in regard to electricity supply and artificial heating by means of steam, the conditions pertaining to a central station combining a common boiler plant are favourable in proportion as the number of consumers is greater and the nearer they lie together. Moreover, the erection of a single power-house not only tends to simplicity and reliability in working, but the danger of fire is also very much lessened. In the case of an installation designed to supply electricity principally for lighting purposes, while heat is required for warming rooms in permanent use, then the erection of a central power-house to serve both supplies offers special advantages. The greatest demand on the heating apparatus occurs in the early morning, when the rooms which have cooled overnight have to be brought up to the normal temperature. When this has been attained, the heat units required to maintain that temperature are found by experience to gradually dwindle until they represent a comparatively small amount. Consequently, during the evening hours the demand on the central plant is inconsiderable on this count. The reverse is the case, however, with the electricity supply, since the demand for light is by far the greatest during the late afternoon and evening hours. Hence, during the morning hours the boilers in the power-house are called upon to furnish steam principally for heating purposes, while later in the day they supply power for driving the steam dynamos which generate the lighting current. In connection with such an installation, it is advisable, as in the majority of cases where a purely lighting load has to be dealt with, to instal a battery of accumulators which can be charged during the day or over-night, and to adopt the continuous-current system of supply. In this manner we obtain a good load factor for our boilers, hence economical conditions of working. A further advantage especially affecting public plants consists in that the electric mains may be run in the subways provided for the steam mains. This arrangement enable the use of bare copper instead of conductors of the costly insulated type. The whole of the above conditions existed in respect to the installation with which we are now concerned. On the left bank of the Elbe, on either side of the Augustus Bridge, there are situated, besides the Royal palace, numerous Government and municipal buildings to be provided with heat and light, the line extending a distance of about one mile (see Fig. 1). When the central plant was erected some of these buildings were new, while others were equipped with heating apparatus which had become for the most part obsolete. The opera house, for example, contained no fewer than 24 separate boiler plants. The abolishment of these has incidentally effected a considerable reduction in the premium for fire insurance. But that is of small moment compared with the extra security obtained in respect to the art treasures and collections housed in the Royal palace, museums, and picture galleries within the area of supply, since many of these are of incalculable value.

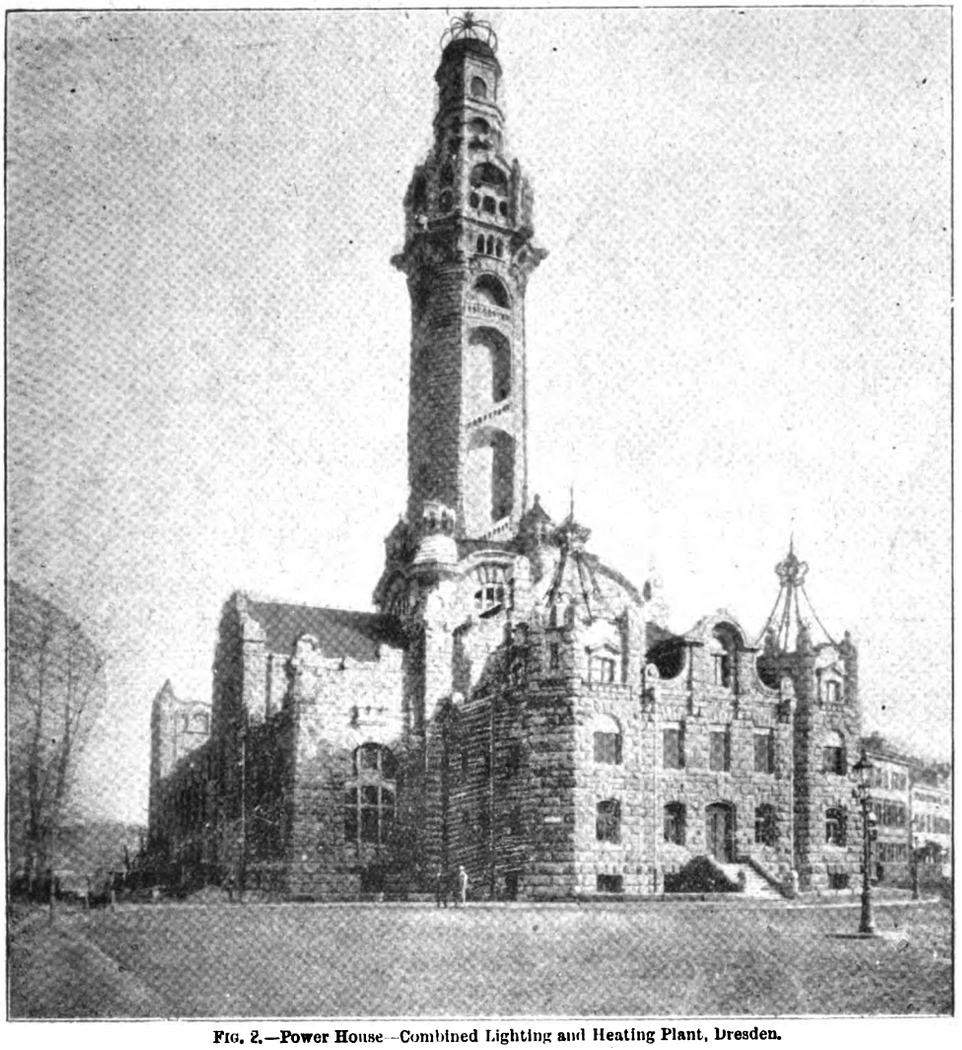

FIG. 2.—Power House—Combined Lighting and Heating Plant, Dresden.

The boilers and steam-pipes were supplied by Messrs. Rietschel and Henneberg, Dresden, while the Allgemeine Elektricitäts-Gesellschaft, Berlin, were responsible for the electrical work, with the exception of two steam dynamos, the battery of accumulators, and the main switchboard in the engine-room, which were supplied by the Elektricitätswerken vorm. O. L. Kummer and Co., Dresden. As regards the site of the power-house, it was essential that this should be as near as possible to the buildings to be supplied and convenient for coaling, etc. A suitable position was found off the opera house square, but having regard to the high architectural merit of the neighbouring buildings it was necessary that the design of the power-house should be carefully adapted. The result is seen in Fig. 2 herewith,

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the architectural treatment of the chimney shaft being an especially noteworthy feature.

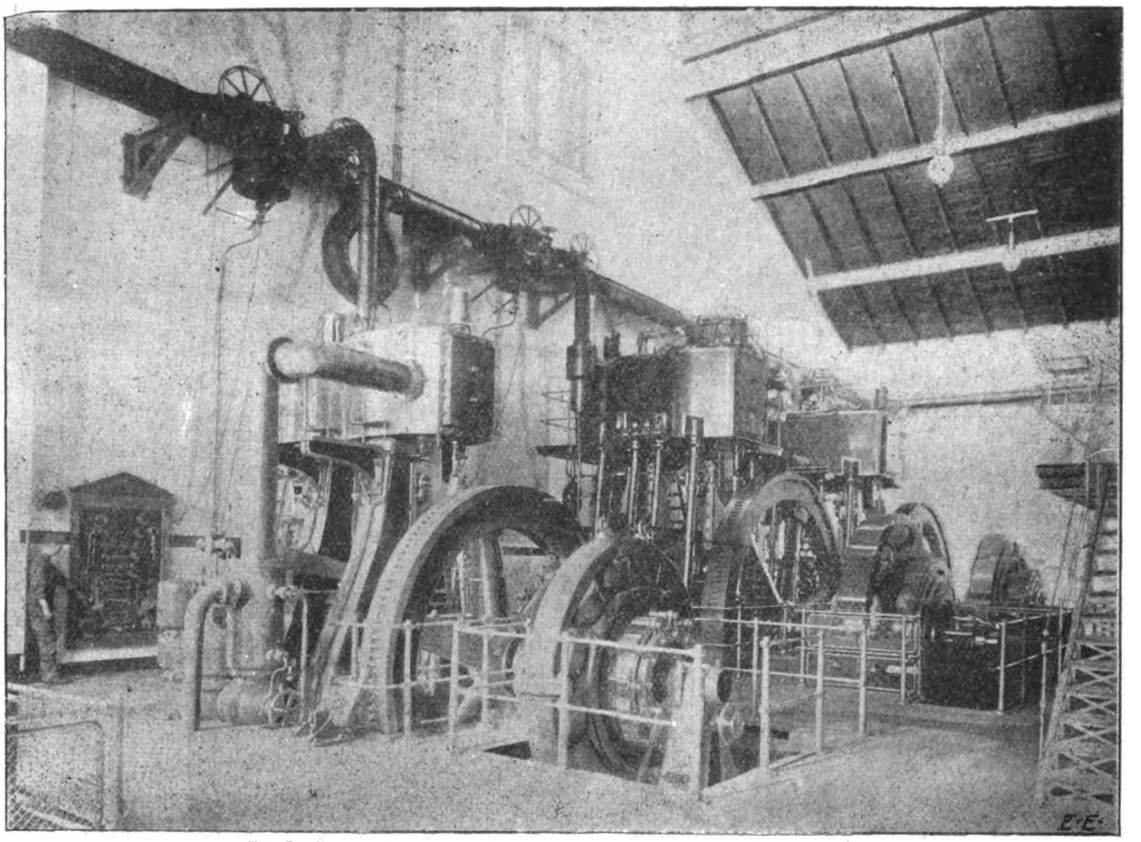

FIG. 3.—Electric Generators—Combined Lighting and Heating Plant, Dresden.

The determination of the most advantageous steam pressure is of primary importance in connection with heat transmission. In this case, having regard to the already existing installations of heating apparatus, it was found

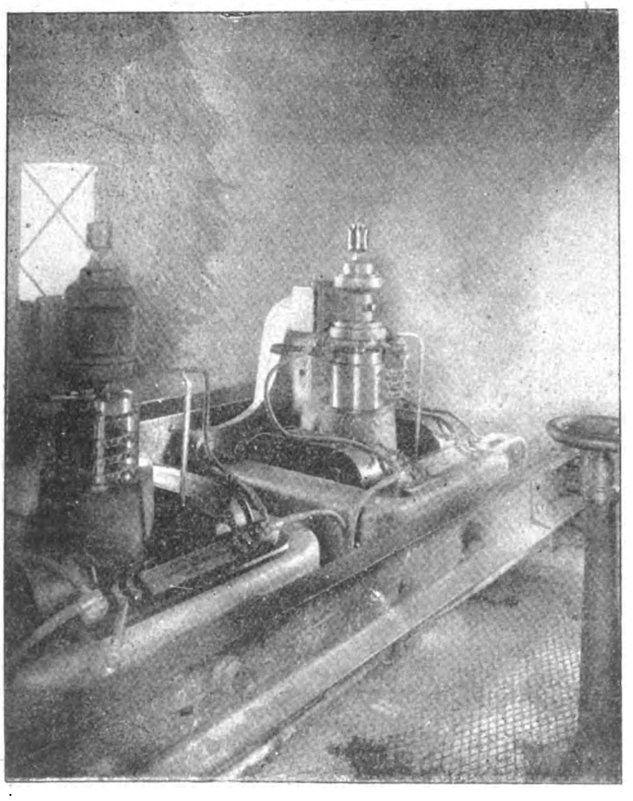

FIG. 4.—Electrically-Driven Centrifugal Pumps—Combined Lighting and Heating Plant, Dresden.

that a pressure of 28·5lb. per square inch would be best adapted for the supply in the buildings themselves. For the transmission of the steam it was, of course, necessary to employ a much higher pressure, since the diameter of the piping used is governed by the pressure, being smaller as the pressure is greater, and the loss of heat through condensation correspondingly less. It is not practicable, however, to increase the pressure beyond a certain limit, determined by the danger of leakage and fractured pipes. In Dresden the main pipeway lies under a very busy thoroughfare, so that an initial excess pressure of

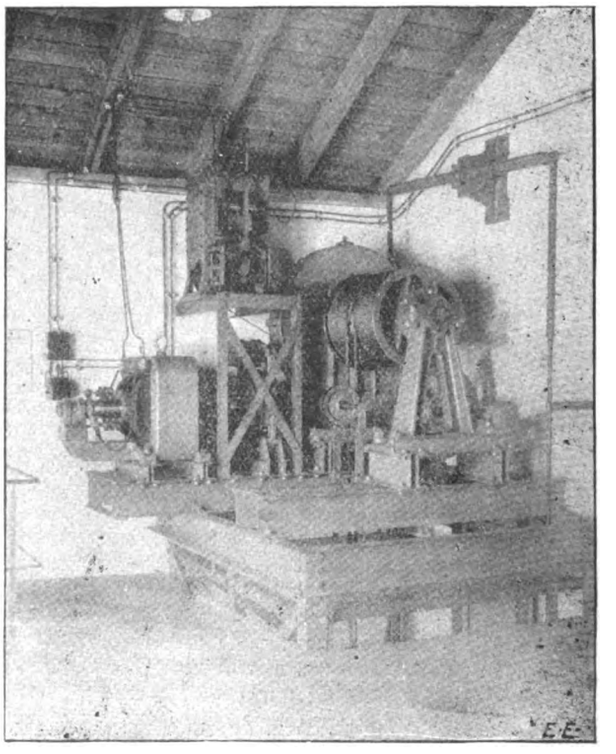

FIG. 5.—Motor-Driven Coal Hoist—Combined Lighting and Heating Plant, Dresden.

85lb. per square inch was adopted, provision being made to increase this to 107lb. per square inch as required. The latter provision will enable further connections to be made to the supply, and also constitutes a certain reserve. For,

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in order to ensure freedom from interruption in the supply, two pipes of equal diameter connected in parallel are employed for the main transmission. Should it be found necessary to temporarily cut one of these pipes off at any time, the efficiency of the other may be increased by raising the steam pressure. Generally speaking, it is during the winter months only that steam is required for heating purposes. But the opera house requires a supply also in the summer, and this is provided for by a special main of correspondingly small diameter, laid direct from the boiler-house. Various means are adopted to compensate the expansion of the pipe mains through heat. To this end, for example, the subway is not straight, but follows a slightly winding course (see Fig. 1) so that the pipes, which rest on roller bearings supported by bracket arms, have room for side play.

this battery, and the balancer previously mentioned at 2 × 110 volts. The current from the dynamos and accumulators is conveyed to the main switchboard in the engine-room. From this board feeders are run to the lighting network; also leads to a motor board erected apart. Through the latter the motors driving the different auxiliary machines in connection with the power plant are supplied. These include two 17-h.p. motors, having vertical shafts, which drive two centrifugal pumps serving the condensers; also a 13-h.p. motor geared to a boiler feed pump. The first-mentioned pumps (Fig. 4) are installed in a special house on the Elbe. Two motors, each of 10 h.p. (Fig. 5), drive the two coal hoists which serve the mechanical stokers in the boiler-house. A crane which is used to unload coal from barges is equipped with two motors, one of 7·5 h.p. for lifting and one of 2 h.p. for

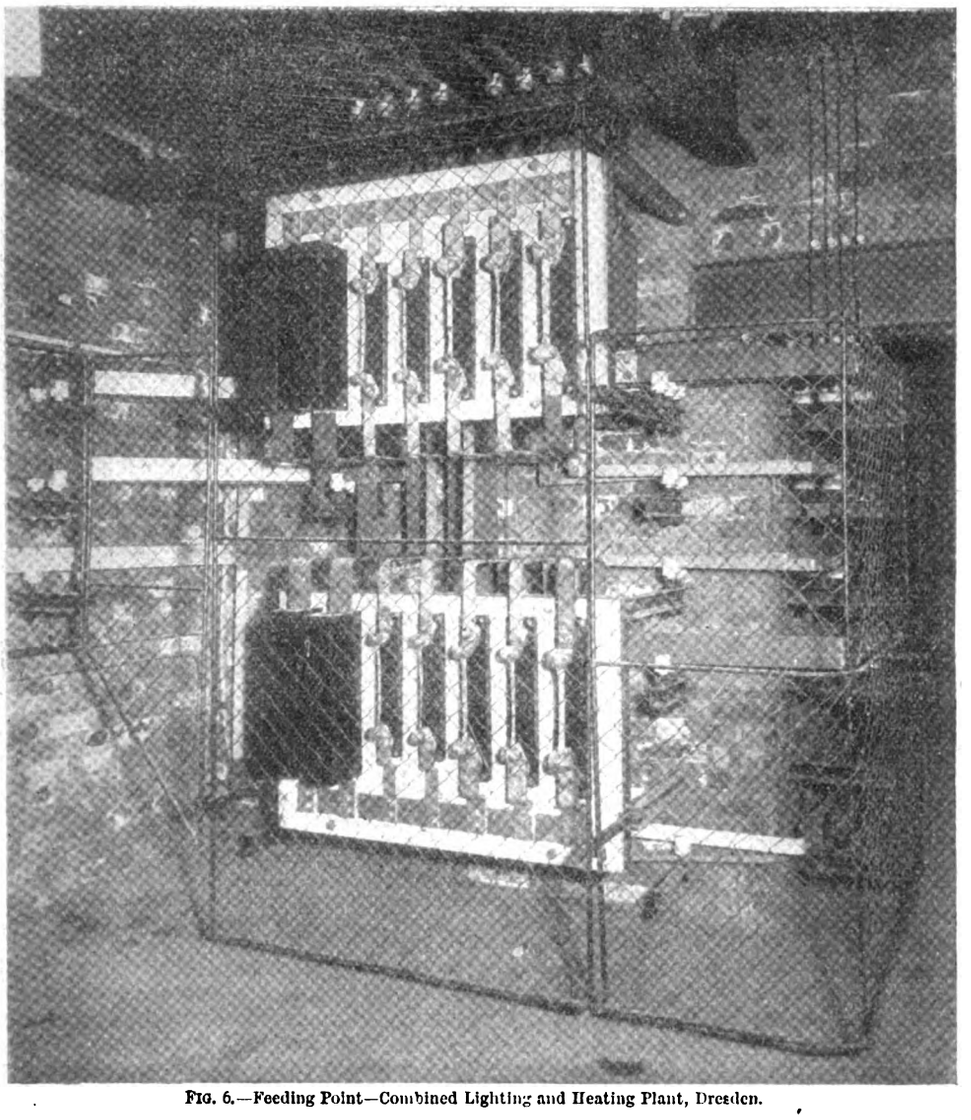

FIG. 6.—Feeding Point—Combined Lighting and Heating Plant, Dresden.

The boiler-house contains 10 boilers—including the necessary reserve—each having 2,151 square feet of heating surface. These boilers, as previously mentioned, supply steam also to the three continuous-current steam dynamos, Fig. 3 comprising the electric lighting plant. Two of these dynamos have a normal output of 260 kw. each and a maximum output of 360 kw. at 220 volts terminal pressure, while the third yields 130 kw. normal and 175 kw. maximum output at the same terminal pressure. A balancer is further provided for the purposes of the three-wire system of distribution adopted. To ensure absolute reliability of the supply, which is especially necessary in the case of the opera house, a battery of accumulators has also been installed. This battery consists of two parts, each of 2 × 132 cells, coupled in parallel. The capacity of each part is 1,080 ampere-hours, the charging current 360 amperes, and the discharging current likewise 360 amperes. The three-wire system of distribution is worked in conjunction with turning. Numerous smaller motors are employed about the station for driving machine tools, etc.

With reference to the electrical transmission line, the feeders are run from the switchboard to a ring main, from which the distributing leads branch. There are in all six feeders and the same number of feeding points. Owing to the elongated form of the area supplied, the ring main consists of two conductors for each outer of the three-wire system connected together at either end and lying close together. A single conductor serves as the neutral wire. Hence at each point of the system the ring is made up of five conductors—*i.e.*, two + outers, two − outers, and a neutral conductor. The two feeders taken to each feeding point are each connected to the two outer conductors of like sign. The negative conductor is doubly earthed at each feeding point. The pressure loss in the mains is regulated by means of resistances connected in series with the feeders at the switchboard. The maximum loss of pressure which can occur in the feeders amounts to 10 per cent.;

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between two points in the ring at any load, 2 per cent.; and in the distributing network, 2 per cent.

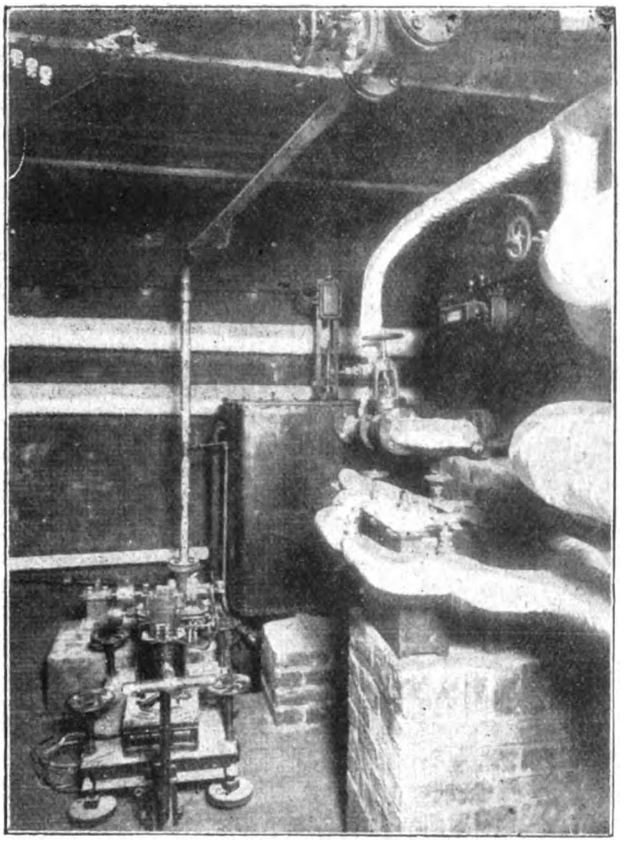

FIG. 7.—Condensation Water Pump driven by Portable Electric Motor—Combined Lighting and Heating Plant, Dresden.

For the most part the conductors are arranged in the subway on the wall opposite the steam mains. They rest on porcelain insulators carried on [iron supports built

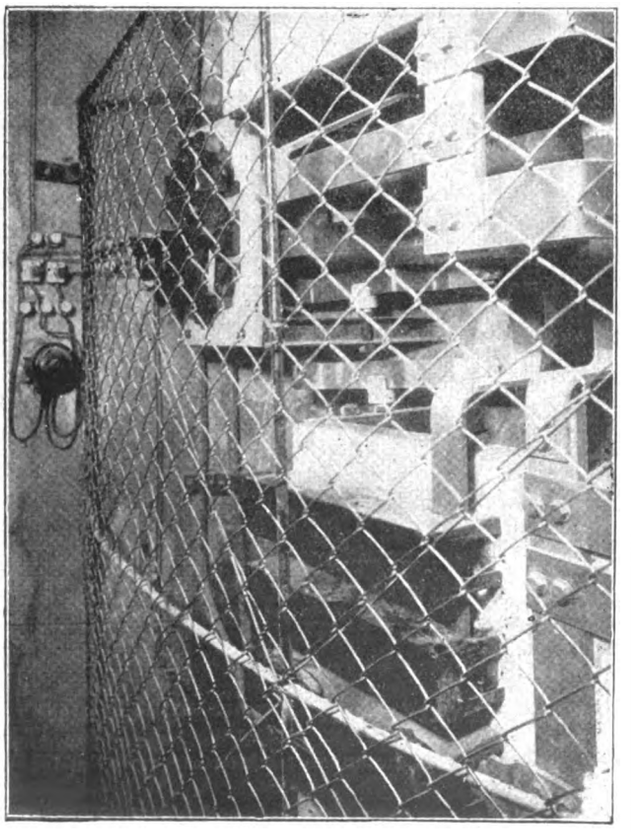

FIG. 8.—Distributing Point—Combined Lighting and Heating Plant, Dresden.

into the wall. The conductors themselves are composed chiefly of bare copper cables, which have proved satisfactory in every respect. Conductors of like sign are grouped together as far as possible, their polarity and purpose being clearly indicated by different colours. The conductors are fenced in by means of wire netting arranged in portable sections.

At the feeding points, which serve at the same time as distributing centres, the stranded cables give place to solid bars of copper (Fig. 6). Referring back to Fig. 1, it will be seen that the distance between the first and second feeding points is considerable. For this reason an emergency exit from the subway has been provided in the opera house square. At this point the conductors are necessarily suspended from the roof of the subway, copper bars being also employed here. The distributing mains from the third feeding point run through a tributary subway, the first entrance into which is situated by the Catholic church. At this point a centrifugal pump (Fig. 7) is provided to remove the condensation water from the pipe system. This pump can be driven as required by means of a portable electric motor. Similar pumps are provided at different points throughout the system, all being actuated by the same motor, which can be easily drawn along the subway. The condensation water is

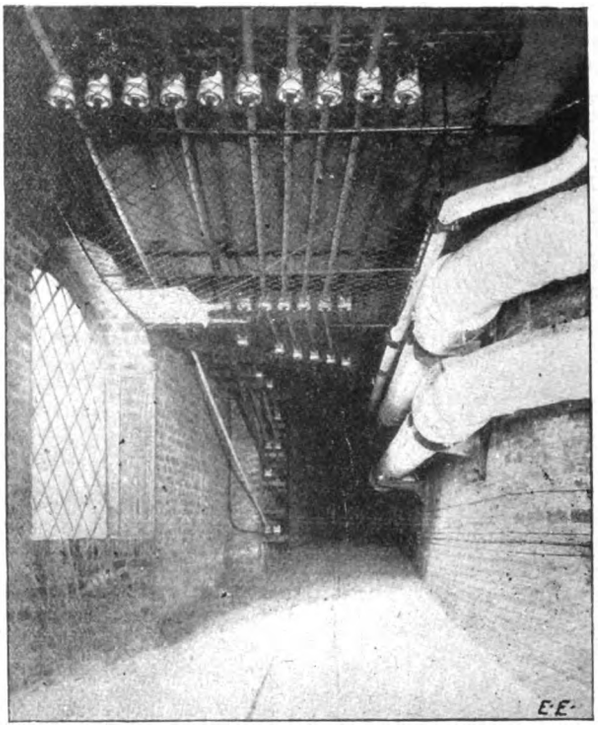

FIG. 9.—Arrangement of Steam Mains and Electric Cables at the Munzgasse Crossing—Combined Lighting and Heating Plant, Dresden.

returned to the boilers through a special pipe line. The above-mentioned tributary subway terminates in a special distributing centre (Fig. 8). A special reserve cable is laid underground to the Royal palace, so arranged that in case of failure in the supply from the subway it is automatically switched in at the third feeding point. A reserve cable is also provided for the opera house.

The arrangement of the steam-mains and electric cables at the Münzgasse crossing is shown in Fig. 9.

The further course of the subway may be traced on Fig. 1.

We are indebted to the Allgemeine Elektricitäts-Gesellschaft for the above particulars, as also for the loan of the photographs from which our illustrations of the installation are reproduced.

THE DESIGN OF EXTRA HIGH TENSION SWITCHGEARS.

BY W. E. WARRILOW.

(Continued from page 231.)

A somewhat similar switch, but depending for its action on the pull obtainable from electromagnets, is shown by Fig. 22, from which it will be noticeable that the arrange-

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ment of the breaking tubes is similar to the foregoing, as also the mounting of the operating motions on the top of the brickwork chamber. Mounted at the top of each compartment are the main contacts, set in insulators, two for

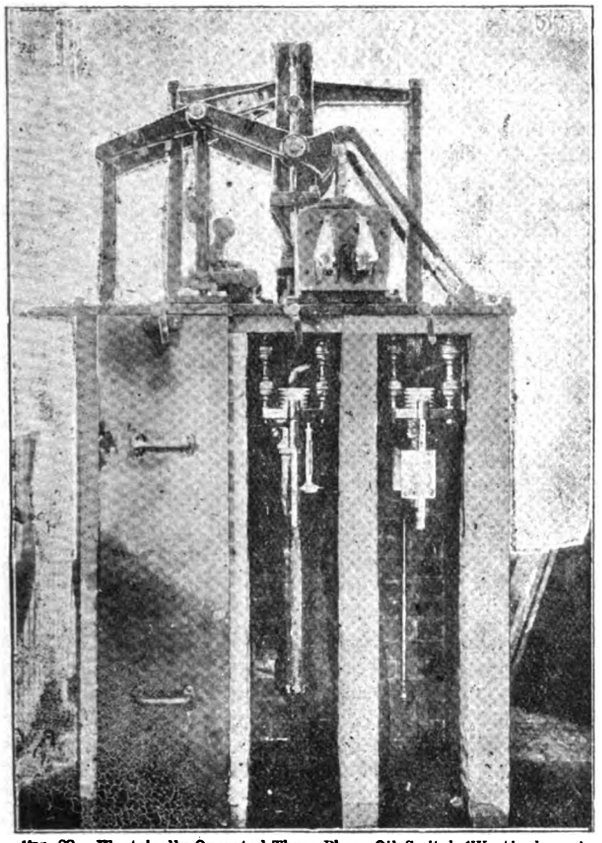

FIG. 22.—Electrically-Operated Three-Phase Oil Switch (Westinghouse).

each pole, these contacts being quite stationary. The circuit is closed by joining these two contacts with a U-shaped copper conductor connected to the operating mechanism above, and this moving conductor forms the "live" portion of the switch travelling in the oil tank.

by balancing springs, both springs and magnets being visible in the upper right-hand corner of the illustration. When the switch is closed, the system of levers is automatically locked by a toggle joint (shown at the left hand of the operating mechanism). For opening the circuit, a tripping magnet is energised, which releases the toggle, and the cross-bar, carrying the moving contacts in the oil-tanks, drops quickly under the influence of gravity assisted by a powerful spring. Any arcing or burning at the main contacts is taken up on a removable plug set in the fixed contacts, this plug engaging with a hole in the moving conductors and leaving them last.

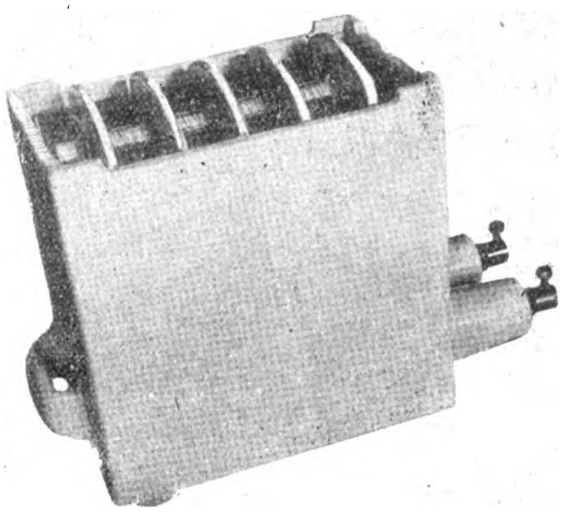

FIG. 23A.—Complete Multi Oil Fuse, showing fuse wires in position (Ferranti).

The operating magnets can be energised from any direct-current source, either in the shape of exciters or storage battery, and, if required, the switch can be actuated by hand without disturbing any portion of the mechanism. The oil containers are constructed of sheet metal lined with an insulating cement, this latter being moulded to fit round the terminals and contact piece. Sufficient room is left for the free movement of the coupling rod, and the amount of oil required is reduced to a minimum. A complete and accurate adjustment of the contacts can be

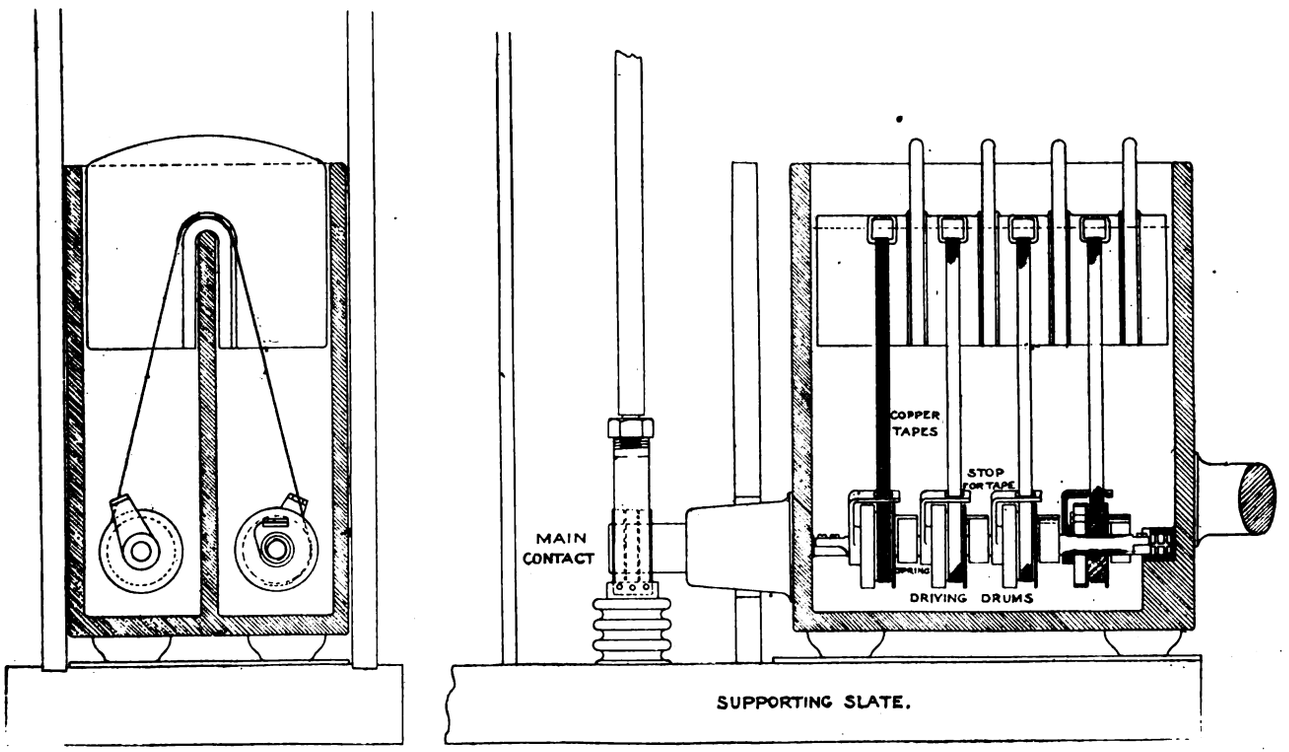

FIG. 23.—Multi Oil Break Fuse (Ferranti).

The couplers for each pole are fastened to a common cross-bar extending the entire width of the masonry compartment, the bar itself bolting to a lever system having a vertical up and down motion. The electromagnets raise the cross-bar, which is aided through the first part of the travel carried out before the oil-tubes are raised into position, and at any time upon lowering these the moving parts can be closely inspected. The automatic opening of the circuit breaker is effected by a polyphase overload relay connected to the secondaries of current transformers in the

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main circuits, the relay being shown in the photo directly above the dividing wall between the oil-tubes. It comprises two sectors swinging between the poles of an alternating-current electromagnet, and part of each pole is surrounded by a short-circuited strip of copper which tends to retard the magnetic flux and produce a moving field. On the principle of the induction motor, the swinging sectors are acted upon, and, following the movements of the field, they close the tripping magnet circuit by bringing two contacts together. Controlling and indicating devices, consisting of a switch, an indicator, and a lamp, are suitably mounted on the main board. The switch is of the drum type, with three positions—"closed," "off," and "open"—and it will remain in the last two of itself. If turned to the "closed" position it will go back to "off" position when the handle is freed, but in the "off" position it closes the control circuit; and if the main switch opens through the medium of the automatic devices, the indicating lamp will light up to attract the attendant's notice. When the oil-switch is opened by the operator placing the control switch in the "open" position, the lamp does not glow. The indicating mechanism comprises an electromagnet which attracts an armature carrying a disc and pointer, showing at a glance the "open" or "closed" positions of the oil switch. A switch of this description will successfully open a circuit of 600 amperes capacity at a pressure of 33,000 volts.

The last form of gear to be described, but by no means the least interesting, is that assembled on what has come to be known as the "cellular" or pigeon-hole plan. This method of construction calls for a distinct departure from the methods of other makers, in that all the parts of the board must be designed to take their respective places in the panels provided for their reception. The construction of the frame is too well known to need a detailed description here, but it is sufficient to state that the features which have made this type of board so prominent for high pressures have been, as much as possible, retained in the equipments got out for the control of extra high pressures. Considerable ingenuity has been displayed in the design of the fuses, switches, and ammeters of the gear, and they merit some fuller description if space permitted. The chief points of interest can, however, be dealt with here, and will serve to show that even extra-high potentials can be manipulated from gears which take up little room. In rupturing the circuit, either with switch or fuse, the breaks in each case are oil quenched; in the switch they are actually under oil, while in the fuse they are above, but plunge quickly down into the oil. Fig. 23 is a sectional illustration of the fuse, and reference to this will make its action quite clear. The oil container is of porcelain, and comprises a large box divided down the centre by a rib reaching almost to the top of the pot, and provided with projecting lugs at the back for the main contacts. A handle at the front also makes provision for the ready withdrawal of the fuse from its panel. The device combines three or more fuses in parallel, each of which is made up of two drums, mounted on a spindle fitted at the bottom of the cells formed by the partition in the box. Each drum contains a powerful clock-spring, fastened at one end to the spindle and at the other to the drum. A length of flexible copper tape reaching to the top of the dividing bridge is also secured to each drum, and when the springs wind up the tape is coiled round the drum, a guide being mounted on the spindle to prevent fouling. This method of construction gives a pair of operating drums and tapes to each fuse, and allows of any number of pairs being assembled in accordance with the capacity of the circuit to be opened. This particular type of oil-break fuse is intended for mounting in position apart from the main gear or underneath the operating gallery, to ensure head room above the pot when the fuse blows. Experiment has shown that a lid is not safe, and that the gases liberated when the arc occurs can only be dispersed with the best result by allowing them a free vertical passage to the air. A porcelain guard separates each fuse from its neighbour, and these guards slip into grooves in a removable bridge resting on the top of the rib dividing the pot. This precaution has been taken to enable the porcelain to be replaced should excessive burning take place on the rupturing of the fuse. The wires forming the fuse are soldered to the ends of the copper tape, which is fitted with a ring for this purpose, and when secure they are kept in tension by the action of the springs. The passage of an excess current causes fusion of all the wires which are immediately drawn under the oil and the arc takes place at one pair only, though not always at the same pair. When putting in new fuses, the ends of the copper tapes are hooked up out of the oil and held in position while the wires are soldered in place, the entire operation being easily performed by a handy switchman. The main contacts project from the back of the porcelain case, and plug into suitable clip connections on the main board provided for the purpose, thus enabling one fuse to be replaced by another in a short time.

(To be continued.)

RADIUM AND OTHER RADIOACTIVE SUBSTANCES WITH A CONSIDERATION OF PHOSPHORESCENT AND FLUORESCENT SUBSTANCES. THE PROPERTIES AND APPLICATIONS OF SELENIUM AND THE TREATMENT OF DISEASE BY THE ULTRA-VIOLET LIGHT.*

BY WILLIAM J. HAMMER.

(Continued from page 235.)

While various theories have been advanced to account for the phenomena of radium, there remain many things which have not been satisfactorily accounted for; and perhaps the subject which has been most widely discussed is the loss in weight of radioactive substances. At the British Association meeting last summer, Prof. J. J. Thomson is reported to have stated that if a square centimetre of surface were covered with pure radium, it would only lose in weight one-thousandth of a milligramme in a million years. This is in accordance with the previous statements made by Becquerel. Later in the year, A. Heydweiller, of the Royal University, Munster, Germany, stated that he had been testing a sample of De Haën's preparation of radium, and found that it lost in weight two one-hundredths of a milligramme per day for 50 days, and a whole milligramme in that period. (*Phys. Zeit.*, Oct. 15, 1902.) The great discrepancy in the statements on this important subject led the writer to enter into correspondence with Profs. J. J. Thomson, Henri Becquerel, Lord Kelvin, Sir William Crookes, P. Curie, and A. Heydweiller, which resulted in the following expression of views. Prof. Thomson was inclined to think that from the magnitude of loss found by Heydweiller, it must be due to some secondary effect, and he stated that he could not speak with certainty without a greater knowledge of the details of the experiments. As accounting for the results he, however, drew attention to the well-known coloration of glass by radium, by remarking, "One point, however, that ought to be attended to in these experiments is the effect of the radiation from radium on glass. Glass, as is well known, gets deeply coloured when in contact with radium. It seems to me possible that the glass might be charged right through. If this were the case, it is possible that reactions might occur between the glass and the air, producing volatile substances and a loss of weight. I only throw this out with hesitation, for as I said before, I am not familiar with the details of the experiments." Prof. Becquerel informed the writer that he knew nothing reliable regarding the experiments of Heydweiller, and called attention to his original paper on this subject which appeared in the *Comptes Rendus* of March 26, 1900, adding, "I believe I am the first to have published an estimate in this way which could only result from my own experiments. The loss of one milligramme per square centimetre require 1,000 million years. This statement refers only to the part of the deviable portion of the radiation to which measurements were applied; but this is only a part of the total loss.

*A lecture delivered at a meeting of the American Institute of Electrical Engineers and the American Electrochemical Society, New York, April 17, 1903.

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The deviable radiations comprise rays ranging from 10^9cm. and $3{\cdot}10^{10}$cm. Besides, there is also all the non-deviable portion, either penetrating or absorbing, which corresponds to a notable loss of energy; and in addition, if the emanation is of material importance, which seems quite probable, the loss on this account would be a thousand times greater. These estimates are but theoretical, for it is probable that at least a portion of the mass calculated or estimated as material is apparent and corresponds to the effects of induction."

In response to an expression of view from Sir William Crookes on a theory to satisfactorily account for the phenomena of radioactive substances, he wrote as follows:

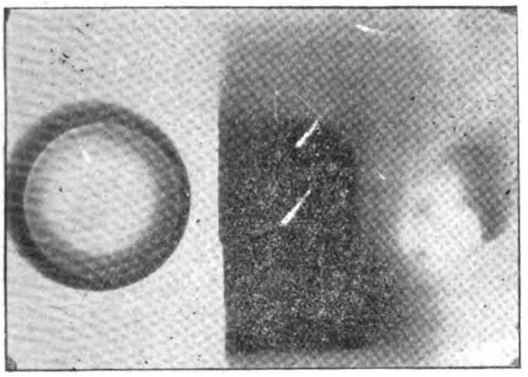

FIG. 6.—Radiograph made by Radium of a Disc for Testing Radioactivity, a Block of Rock-salt and a Lump of Pitch-blende.

"You will find them fully given in my address to the British Association at their Bristol meeting in 1898. I have not seen any special reason to alter the views there propounded"; and in writing on the subject of Heydweiller's experiments, Prof. Crookes says, "I do not think the experiments of Heydweiller have been corroborated by other observers; and there are many sources of error in his experiments which I should like to see discussed before giving credence to it. Personally, I find no loss of weight in a rich sample of radium compound during continuous weighings extending over many months. I should be inclined to agree with Becquerel and J. J. Thomson." Lord Kelvin wrote that he was sorry not to have been

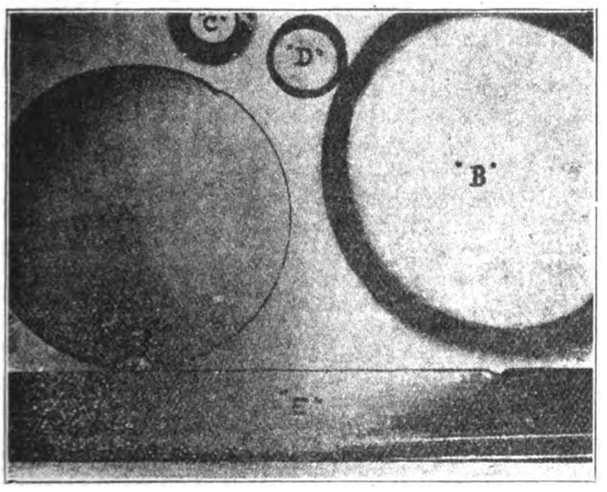

FIG. 7.—Radiographs of Various Types of Lenses made by Radium

able to make any experiments on radioactive substances which could allow him to offer any opinion that would be helpful on the subject, and added, "What you tell me regarding radium, and your correspondence with Prof J. J. Thomson, is very interesting." On this point Prof. Curie recently wrote me as follows: "I never did believe in the exactness of Mr. Heydweiller's experiments, and I always thought he did not take care enough to avoid some source of errors. In fact, with a substance considerably stronger than his own, I only obtained a reduction in weight of one-tenth of a milligramme in four months for several decigrammes of substance, and as the tubes were used at the same time in several experiments, that loss of weight does not allow me to affirm that radium is losing weight spontaneously. I believe, meanwhile, as does Mr. Heydweiller, that the question cannot be answered in any other than an experimental way, and that all speculative theories are of small interest. I have published my recent researches in the *Comptes Rendus d l'Academie des Sciences de Paris.*" As regards the published statements of Prof. Heydweiller's experiments, the writer can state that he is most reliably informed that a mishap

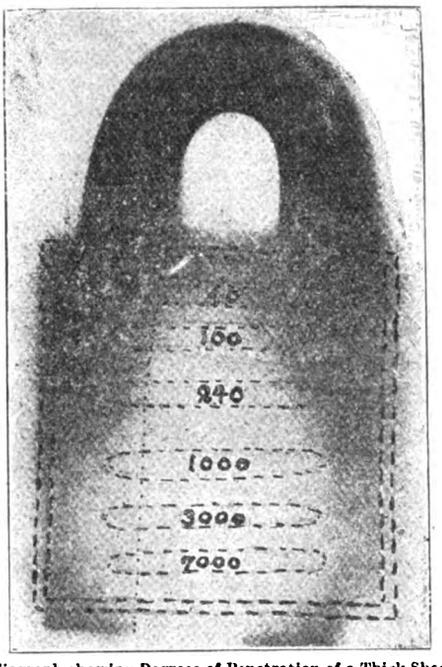

FIG. 8.—Radiograph showing Degrees of Penetration of a Thick Sheet of Lead and a Steel Magnet by Tubes of Radium of Different Radioactivities.

occurred during his experiments which resulted in one of the tubes becoming cracked, which was not observed until later, and that this practically nullified the results published, and, in fact, they have not been confirmed by subsequent tests; but, on the other hand, they tend to corroborate the experiments of Becquerel, and the statements made by him, Sir William Crookes, J. J. Thomson, and others. The writer is also informed that Prof. Heydweiller is continuing further experiments, the results of which will doubtless be published when his investigations are complete.

As bearing upon the coloration of glass already referred to, I hold in my hand a flask which I secured at the laboratory in Paris, which has contained radium, and has

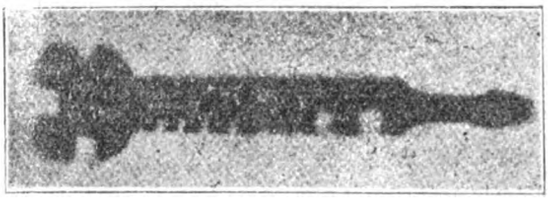

FIG. 9.—Radiograph of Steel Tool made by Radium acting through Two Thick X-Ray Plate Envelopes.

been most beautifully coloured a deep violet. I also have several tubes in which radium has been kept, which are similarly coloured, and in this connection I would call attention to the fact that X-ray tubes which have been in use for a considerable time become similarly coloured, forming another link between the Röntgen rays and radium rays. I also have here a tiny bulb of glass which is coloured a deep brown. I have seen only one other piece of glass coloured in this way, this being due to the difference in the chemical constituents of the glass (though in some cases the glass subsequently turns a violet colour). This is a duplicate of the tiny tube which Prof. Curie showed the writer, which contained between two and three one-hundredths of a gramme of chemically pure radium. It is interesting to note that the Becquerel rays induce activity which persists, whereas that excited by Röntgen rays ceases immediately on the removal of the rays. As illustrating the X-ray character of radium rays, I would call your attention to Fig. 6, in the centre of which is

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shown a block of rock salt. The original sample was about 1in. thick, and was so transparent that a person's features might be seen through it. The rock salt is not only transparent to ordinary light, but also to ultra-violet light, whereas it is very opaque to X-rays.

Mrs. Hammer, appreciating the serious physiological effects of radium, has made the interesting suggestion that radium be kept in boxes made of rock salt; and the author is now having such a receptacle made. This might be even more satisfactory than a lead box. It would be interesting to note the change in the temperature of such a box or vial which so well intercepts the radium rays. The illustration referred to was made by placing the rock salt on a photograph plate with the radium some 5in. above it. To the right of the rock salt is shown a piece of

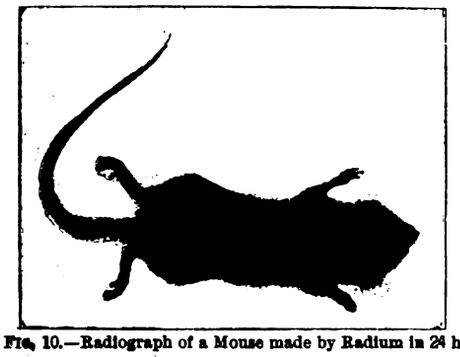

FIG. 10.—Radiograph of a Mouse made by Radium in 24 hours.

uraninite (pitchblende), from which radium is extracted; and you will note that not only has the mineral been photographed by the radium above it, but the radium has acted on the radioactive constituents of the pitchblende and caused this to affect the plate. The disc shown at the left of the cut is one made in Paris for the examination of radioactive substances. I have one of these here, and it consists of a rim of brass, enclosing a brass washer with a glass disc at the centre. The opposite face is covered with aluminium foil, and between the aluminium and the glass is placed some radium of 1,000 radioactivity. Substances which it is desired to examine are laid on this disc. It is, however, a rather crude piece of apparatus; but in the cut shown not only has the disc been photographed by the radium 5in. above it, but the radium inside of the disc has penetrated through the aluminium and fogged the plate.

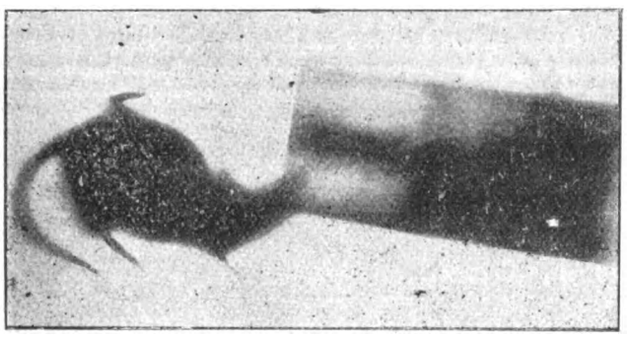

FIG. 11. Radiograph of Mouse caught in trap and exposed to Tube of Radium for three days. (Note transparency of wood, as with X-Rays.)

In Fig. 7 are shown some interesting effects of the radium rays in affecting a photograph negative after passing through lenses. The lenses, A and B, are plano-convex condensing lenses, one being placed with the flat surface down, and the other with the convex surface down. C is a double convex lens of crystal, D is a plano-convex lens of uranium glass, and E represents an ordinary glass prism. It is stated that radium rays cannot be reflected, refracted, or polarised. Those familiar with the phenomena of light will, I feel sure, be interested in the above photograph. In Fig. 8 is shown another illustration of the penetrative character of the rays, it being a thick lead box containing six tubes of radium, ranging from a radioactivity of 40 to 7,000; this box being laid upon a large steel magnet $\frac{3}{8}$in. thick. You will note the degree of penetration of both the lead and the steel varies according to the radioactivity of the radium in the various tubes. The exposure was made in 22 hours. Fig. 9 illustrates the penetration of the rays through black paper, the steel tool shown having been laid on the plate covered with two thicknesses of heavy black paper, such as used for wrapping X-ray plates, a single sheet of which is entirely impervious to light. The exposure was made in 24 hours. Fig. 10 shows a mouse which was radiographed in 24 hours by laying it directly on a plate, which was, as in the case of other experiments, placed in the bottom of a trunk, the trays being replaced and the trunk wrapped in three thick rugs, and kept in a dark room for 24 hours.

The radiograph of the mouse shown in Fig. 11 represents a mouse caught on another occasion, in which I placed the mouse, trap and all, on the plate, leaving it there for three days. The trap was an ordinary six-cent trap, and it will be noted that the metal parts of the trap are shown opaque, whereas the portion of the wood nearest to the radium is shown absolutely transparent, as if it had been exposed to X-rays. In the original photograph the mouse is also shown somewhat transparent, indicating slightly the bones. I also show you in Fig. 12 and upon the screen a slide which I have made of a radiograph of a human hand. This was exposed for eight days, and bears resemblance to an X-ray picture which has been over-exposed. In making a faint print of this, a slight trace of the bones is shown, and the embalming material employed is brought out strongly.

FIG. 12.—Radiograph of a Human Hand made by Radium in eight days' time.

This is, perhaps, the first picture made of the human hand by means of radium, and it would not have been possible, of course, to have exposed a living person to these rays for even a small percentage of this length of time. Perhaps subsequent experiments will bring out much more strongly the bone structure (the irregularity in the fingers is due to their being somewhat cramped). As X-rays will excite phosphorescence in many substances, one would naturally wonder whether there were any X-ray characteristics in phosphorescent substances.

(To be continued.)

THE SEPARATION OF THE FRICTION LOSSES IN ELECTRICAL MACHINES.*

It is usual to separate the combined bearing and air-friction losses from the brush-friction loss, but no further subdivision is carried out, as it is assumed that the air friction forms only a small percentage of the total friction. This is not generally sufficiently accurate.

In modern machines, one of the chief objects of the designer is to obtain a good cooling effect, and for this reason the air velocity and the volume of air moved are made as great as possible, and the cooling surface is increased by the insertion of gaps and passages, towards which the air is properly led by means of baffle plates, etc. Even without special cooling devices, the rotating poles of high-speed alternators and the end con-

* Translation of an article by Dr. Leo Finzi in the *Elektrotechnische Zeitschrift* for July 9.

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nections of rotating armatures act as fan vanes. In this way, though the rating of the machine is considerably increased, the ventilating losses also rise considerably, and may become the major part of the total friction losses. Brush friction is easily determined by running the machines under the same conditions, first with the brushes down and then with them up, so that the term "total friction" used below will be understood to include only bearing and air friction.

One way of separating air friction from bearing friction depends on the fact that between temperatures of 15deg. C. and 80deg. C. bearing friction is inversely proportional to the bearing temperature,* whilst the air friction is, of course, independent of this temperature.

One may, therefore, state the total friction, R, in terms of an equation of the form

$$R_{(t)} = a + \frac{b}{t} \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

where the first term represents the air friction and the second the bearing friction, t being the bearing temperature.

It is only necessary to determine the total friction at two different temperatures in order to obtain the values of the constants a and b.

For greater accuracy the readings at the two temperatures should be repeated at various speeds.

Considering the matter graphically, it will be seen that the equation

$$R_{(t)} = a + b\,T \quad . \quad . \quad . \quad . \quad . \quad (2)$$

$\left(\text{where } T = \frac{1}{t}\right)$ represents a straight line, whose angle ϕ (Fig. 1) has a tangent equal to b, and which cuts the ordinate axis at a (Fig. 1). Given the total friction watts at constant speed and at different temperatures, within the above-mentioned range, and plotting the total watts against the reciprocals of the temperatures, such a straight line will be obtained.

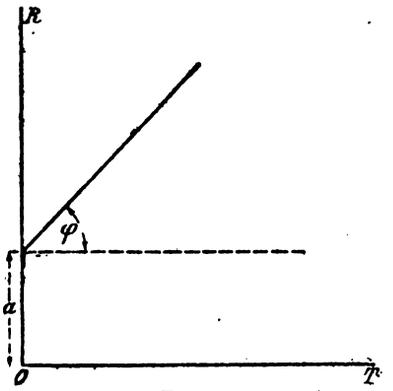

FIG. 1.

A simpler method of separating the friction losses is based on the fact that air resistance is proportional to the square of the speed, whilst the bearing friction coefficient is proportional to the square root of the speed. On this assumption the total friction watts may be expressed as

$$R_{(n)} = c\,n^3 + C\,n^{1.5} \quad . \quad . \quad . \quad . \quad . \quad (3)$$

where n is the number of revolutions of the machine and c and C are two constants, the first quantity representing the air friction and the second the bearing friction.†

If the total friction watts, R_1 and R_2, are known for two speeds, n_1 and n_2, the values of c and C may be found from the equations

$$R_1 = c\,n_1^3 + C\,n_1^{1.5} \qquad R_2 = c\,n_2^3 + C\,n_2^{1.5}$$

$$\text{for} \quad c = \frac{n_2^{1.5} R_1 - n_1^{1.5} R_2}{n_1^3\, n_2^{1.5} - n_2^3\, n_1^{1.5}} \text{ and } C = \frac{n_1^3 R_2 - n_2^3 R_1}{n_1^3\, n_2^{1.5} - n_2^3\, n_1^{1.5}}.$$

The following figures relating to a 100-h.p. three-phase motor will serve as an example of the application of the method. The rotor had a winding of which the end connections were radial and at right angles to the spindle. The speed was 600 revolutions per minute, giving a peripheral speed of 28m. per second, and a peripheral speed of the spindle in the bearings of 2·5m. per second.

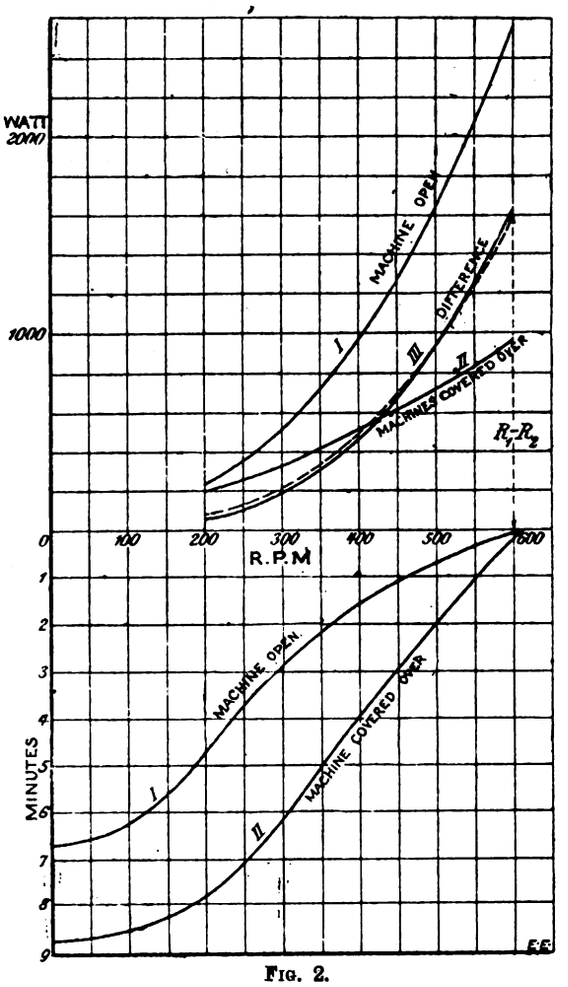

FIG. 2.

The lower curves in Fig. 2 are the run-down curves (drop of speed with time as the machine slows down from full speed) of the machine. For Curve I. the rotor was in its ordinary uncovered condition, whilst Curve II. is for the same machine with bearings in the same condition, but with a light cover arranged to rotate with the rotor, so as to reduce the air friction to a minimum.

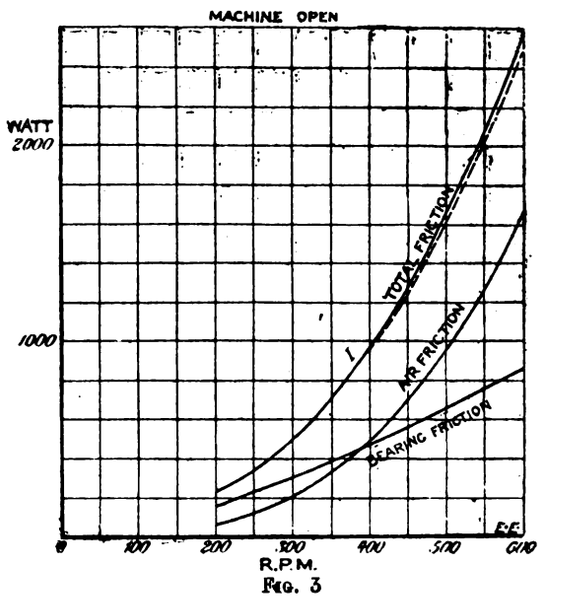

FIG. 3

The upper Curves I. and II. are the corresponding loss curves, whilst Curve III. shows the difference between the two. This represents, if not the whole, at least the greater part of the air friction. The value of the ordinate, $R_1 - R_2$, and consequently the ordinate scale, was determined by two independent direct measurements of the open-circuit loss.

* According to the investigations of Tower, Thurston, Woodburg, Deltmar, Stribeck, and Lasche.

† The proportionality of the friction coefficient to the square root of the spindle velocity holds good for peripheral speeds of spindle between 2·5 and ·8 metres per second—*i.e.*, in most ordinary cases. With ball bearings and ordinary bearings having high speeds (over 10m. per second) the friction coefficient is almost independent of the speed, and in such cases the equation $R(n) = c\,n^3 + C\,n$ should be used.

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The dotted Curve III. is drawn to the equation

$$R = \frac{74}{10^7} n^3,$$

and the close agreement with the test curve confirms the assumption of the air-friction watts being proportional to the third power of the speed.

Further pairs of points were taken from that part of Curve I. within the range for which the formula, bearing friction $= C\ n^{1.5}$, holds, and the values of c and C were determined. The various values of each constant so obtained differed only by a small percentage from one another, the average values being: $c = \cdot0000077$, $C = \cdot0585$.

The total loss (dotted) and the individual losses are shown in Fig. 3. It will be seen that even at moderate speeds the bearing friction is considerably exceeded by the air friction. At 600 revolutions the latter is 1,660 watts (over 2 per cent. of the output of the machine), whilst that part of the air-friction loss which can be directly measured by covering the rotor in was 1,600 watts.

When Curve II. is used to determine the value of C, an average value of ·06 is obtained, and this close agreement with the value obtained from Curve I. is satisfactory and forms an indirect check on the accuracy of the method.

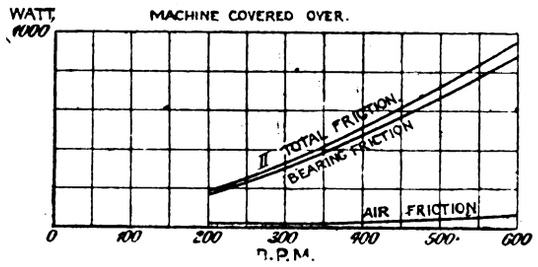

FIG. 4.

On Fig. 4 (for the covered rotor) the value of air friction, which in this case is very small, has been taken as simply the difference between total loss and bearing loss.

These methods do not possess any great theoretical value, but they are self-checking, and so may be usefully employed to obtain an idea as to the relative values of the two losses.

THE FINANCIAL IMPROVEMENT OF ELECTRICITY SUPPLY WORKS.*

BY JOSEPH A. JECKELL.

The following is a condensation of the above paper, in which, however, all the most important calculations and figures are given in full. The author commenced his paper by stating that it was written chiefly for discussion by chairmen of committees, as on them lay the policy of the commercial side of electric supply business. Electricity works were mostly designed for supplying lighting loads at a time when the technical questions were most prominent. Now the question was rather how to make those stations commercially successful, and to supply from them the demand for cheap power.

It was small manufacturers which most needed this service, as large works could put down their own plant. Also, the local authorities wished to encourage small manufacturers to do business within their areas. Power Bills were introduced to supply cheap power. As is well known, many of the Power Bills were thrown out when it was clearly proved that the local authority in the area the company proposed to supply in was actually supplying power at a rate lower than the company promised or was then doing. For instance, before the committee of which Sir James Kitson was chairman, the South Shields Corporation, when a power company proposed to come in and supply power in their area, were able to prove that they were manufacturing current at 28 per cent. less and selling it at 19 per cent. less than the company was. Again, in the case of the Leicestershire and Warwickshire Power Bill, the company proposed to come in and supply energy in Coventry. The price at which the company proposed to sell energy was 3d. per unit for the first 400 hours per quarter and 2d. afterwards. The price at which the Coventry Corporation were then selling current was 6d. for the first 91 hours in the quarter, 3d. for the second, and 1d. for all the remainder. Energy for power, heating, and cooking was being supplied at 1¾d. per unit all round—*i.e.*, a consumer using energy for eight hours a day under the company would pay 2½d. per unit; under the local authority, 1¾d. per unit; or if on the lighting tariff, 1·87d. per unit.

The author then proceeded to deal with the case of the Coventry electricity supply since it came under his charge, and he pointed out that a committee will often allow a new engineer to spend money which they refuse to the previous holder of the position. On the question of cost of energy, the author refers to the argument that for a low load factor capital should be economised by putting in an inexpensive and less efficient plant. Of course, the worse the load factor the more weight this argument would have, but the longer the plant was at work the less it would pay to save capital and use steam, because the capital could only be saved once, whilst the longer the plant was run the greater the loss due to the increased coal consumption over that of the more efficient plant becomes. It is in stations where this principle has been acted upon that the greatest difficulty will be experienced in dealing with the supply of electricity for power purposes. As an example of influence of the price of coal and efficiency of plant on the supply of power, the author gives the instance of two towns, A and B, where coal is the same price and same quality, A having an output of 1,000,000 units and B an output of 2,500,000 units, both stations working condensing.

The load factor at B is better than at A. Coal costs 1-3d. per unit more at B than at A. Had the coal costs been the same at B as at A, B station would have made £3,437 more profit, or, capitalised at 6 per cent., £57,000. *Or taking a hypothetical case*, assuming 1,000-kw. plant running 12 hours a day for 300 days in a year.

A set takes 25lb. of steam per unit.
B set takes 35lb. of steam per unit.

Say coal costs 7s. 6d. per ton and evaporates 5lb. of water per pound of coal, therefore

$$\frac{\text{Kw.} \times \text{Hours.} \times \text{Days.} \times \text{Lb.} \times \text{Shillings.}}{2{,}240 \times 20} = \frac{1{,}000 \times 12 \times 300 \times 2 \times 7{\cdot}5}{2{,}240 \times 20} = £1{,}200.$$

Therefore B plant costs £1,200 per annum more to run than A, or, capitalised at 6 per cent., £20,000—*i.e.*, this amount extra could have been paid for A plant, and still it would have cost no more than B to run. Or, where coal is dearer, take best Welsh costing 30s. a ton, and this evaporates 10lb. of water per pound of coal.

$$\frac{\text{Kw.} \times \text{Hours.} \times \text{Days.} \times \text{Price.}}{2{,}240} = \frac{1{,}000 \times 12 \times 300 \times £1{\cdot}5}{2{,}240} = £2{,}410.$$

Therefore B plant costs £2,410 per annum more to run than A, or, capitalised at 6 per cent., £40,000. This shows that however much it pays to use the most efficient plant where coal is cheap, it pays much more where coal is expensive; and it also shows what an immense saving can be made by using the most efficient plant for generating current for power purposes. As regards the type of engine to be chosen, the chief point was the economy and a range of load from half-load upwards, and the question of speed in larger sizes was not very important. It was not good policy to try to save too much in attendance and stores, and it might entail much higher maintenance charges.

Coming to the cost of supplying power, the author showed that the extra, rather than the average cost, should be considered. Thus, taking the example of a station with the following accounts: capital, £75,000; total plant capacity, 600 kw.; earning capacity, 400 kw.; sells 400,000 units per annum.

Station costs at 2d. per unit		£3,333
Capital charges at 5½ per cent.		4,125
		7,458
Revenue, 400,000 units at 4d.		6,666
Loss		£792

A demand occurs for power at 1½d. per unit, probable amount 1,000,000 units. The question is, Can this amount be supplied at this price and a profit made? One manager will say, "No, because my costs are 2d. a unit now without capital charges." Another manager works it out like this:

Extra capital required, £30,000		
Extra capital charges at 5½ per cent.		£1,650
Extra station charges		2,000
Total extra cost		3,650
Extra revenue at 1½d. on 1,000,000 units		6,250
Less cost		3,650
Profit on transaction		2,600
Less loss on lighting		792
Profit on station		£1,808

The second manager naturally closes with the offer at once and turns the loss on his station into a profit. It will be seen at once from this how very profitable it is to supply power from

* Paper read at the recent meeting of the Municipal Electrical Association at Sunderland.

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TABLE A.

Year.	Capital expended.	Station costs. Total.	Station costs. per unit.	Capital charges. Total.	Capital charges. per unit.	Amount of current sold.	Total revenue.	Average price obtained.	Cost.	Loss per unit.	Deficit made good by rates.
	£	£	d.	£	d.	units.	£	d.	d.	d.	£
1896	23,556	1,287	6·04	1,665	7·81	51,114	1,246	5·85	13·85	8·00	1,706
1897	31,388	1,853	5·58	1,741	5·25	79,583	1 959	5·90	10·83	4·93	1,635
1899	45,600	3,253	5·22	1,963	3·15	149,547	3,586	5·48	8·37	2·89	1,630
1900	63,555	3,282	3·43	2,532	2·64	229,607	4,069	4·27	6·07	1·80	1,745
1901	75,813	4,358	3·05	3,789	2·66	341,810	5,897	4·14	5·71	1·57	2,250
1902	78,442	4,115	2·43	4,160	2·46	404,968	6,467	3·83	4·89	1·06	1,808
1903	102,712	3,573	1·51	4,574	1·94	566,731	7,959	3·37	3·45	·08	189

an existing station. Table A is a summary of the Board of Trade returns for the years that the undertaking at Coventry has been running.

When the author took up his position at Coventry the maximum-demand system was in use, the charges being 6d. per unit for the first hour and 3d. per unit afterwards. He could not raise the first charge, as he would like to have done, but reduced the second to 1d. per unit. The system of supply was single-phase high-tension at 87 frequency. With regard to the financial position of the undertaking, the accounts for 1901 show the position of the works when it became the author's duty to try and improve the position financially. At that time the capital expenditure was £75,813. The plant capacity at the station was 550 kw., but, as is well known, it is necessary to keep one plant in reserve in case of a mishap occurring to any of the others; therefore, the earning capacity of the station was 350 kw. One can reckon on selling 1,000 units per kilowatt of earning capacity when supplying an ordinary town lighting load. Of course, if motors, tramways, etc., are supplied, where current is used for more hours a day than it is in an ordinary lighting load, more than 1,000 units per kilowatt can be sold. In that case the price obtained would probably be less than would be obtained from a lighting load, because in fixing the price due consideration is taken of the length of time that the current will be used, and therefore the number of units sold per kilowatt of earning capacity. In the station costs are reckoned all the costs of manufacture—that is, oil, stores, wages, rent, rates and taxes, etc., management, everything, in fact, except capital charges, which consist of interest and sinking fund or redemption. The station costs amounted to 3d. a unit for the year ending 1901, and the capital charges amounted to over 2·66d., making a total cost of 5¾d. The average price obtained was 4·14d.; the loss was, therefore, 1½d. on every unit sold.

In order to make the undertaking pay it was necessary to reduce the cost of manufacture or else to raise the price. The author chose the first alternative, as the capital charges were so high. It was necessary, in order to make the undertaking a financial success, to bring down the cost of manufacture under the headings of both station costs and capital charges. Had it been possible to have pulled the undertaking round by merely reducing the station costs, it would have been an extremely simple matter. It should further be pointed out that the revenue for 1901 was £5,897, and the deficit made was £2,250. It is therefore apparent that this *large* deficit was made on a *very small* revenue. Had the revenue been considerably larger, say £20,000 or £30,000, it would have been probably quite easy to have made this up by merely bringing about economies at the works, but the undertaking was suffering from an extremely limited revenue. This was chiefly due to the policy which had been pursued in the past—viz., laying mains in a very restricted area in the centre of the city. The Council had always been very averse to allowing money to be spent on mains, and as the factories are more generally on the outskirts of the town, it will be readily seen why the revenue was so restricted. After going carefully into the figures, it appeared that the only thing to do was to increase the earning capacity of the plant. This could certainly be trebled if the capital of the undertaking was doubled. It was, of course, necessary to popularise the light in order that the new plant might be fully loaded, and with this object the price was lowered as before mentioned.

The motor question had to be very energetically taken in hand. The price for heating and power and photographic printing by electric light (of which there is a considerable amount done in Coventry) was reduced to 1¾d. It was also decided to hire out motors, so that consumers might be able to try them and convince themselves of the superior advantages of electric driving over any other means of motive power. It was also decided to adopt a broad policy with regard to main-laying, so as to reach districts which had not yet been tapped. It is interesting to note that on April 1 last year £27,893 had been spent on mains, and to these were connected 27,226 lamps. During the past year £5,185 was spent on new mains, and to these mains have been connected 10,266 lamps. It ought to be mentioned that in the £27,893 there was no money included for spare ducts, and in the amount of £5,185 a considerable amount has been spent in providing spare ducts. It will therefore be noticed that though many of the old mains had been laid a large number of years, and though the new mains had only been down a few months, the cost of mains per lamp connection on the extension was considerably less than half that in the case of the old mains. This shows how very advantageous it is to extend mains widely.

Doubtless it seemed rather a drastic measure to advise a committee, when the undertaking had made so large a deficit, to double the capital and lower the price, and it would have been quite impossible to have induced the committee to take this course unless the chairman had been thoroughly convinced that it was advisable and really the only course to adopt. With the addition to the plant a change was made in the system of supply. The new machines were of the two-phase type with 50 frequency. It was found that a 600-kw. two-phase alternator could be obtained for the same price as a 400-kw. single-phase alternator. Therefore, by adopting two-phase the capital cost of the machinery was reduced, which it was extremely advisable to do in view of the already high capital cost per kilowatt. It was decided at present to keep the single-phase plant for supplying the centre of the town. The outlying sub-stations are supplied some with two-phase 50 ~ and some with single-phase only. No difficulty whatever was experienced in changing over, which was effected at the rate of one sub-station each Sunday.

The author mentioned that in the last six months they had connected up 350 h.p. of motors, and that two-phase motors are extremely satisfactory. Several of them have run quite comfortably at 60 per cent. overload for days without getting unduly warm. It is interesting to note how soon people take to motor driving when they can obtain the current cheaply, and when the Corporation is prepared to hire out motors, carrying at the same time a good stock of them so that consumers may be able to have any size they like at once, and if, as is very frequently the case, they have miscalculated the size of motor required it can be readily exchanged. By bringing about certain economies at the works the actual cost for station charges has been brought down to the same figure as for 1901. It will be seen from these figures how very little it costs to manufacture extra energy when once a station is running. In fact, it will be seen that even including the capital charges the actual cost of manufacturing current this year was the same as in the year 1901, though we sold this year 566,000 units, as compared with 341,000 units in 1901. No appreciable revenue has been obtained from the motors, except for the last quarter of 1902. The increase due to this cause will be felt very much more in the current year, or, to put the accounts in the form given in the previous hypothetical case:

Before extensions were carried out, 1901.		*After extensions have been partly carried out, 1903.*	
Capital spent, £78,513.		Capital spent, £102,712.	
Station costs	£4,358	Station costs	3,573
Capital charges	3,789	Capital charges	4,574
Total costs	8,147	Total costs	8,147
Total revenue	5,897	Total revenue	7,958
Loss	£2,250	Loss	£189

N.B.—It should be remembered in comparing these figures that, as before mentioned, the coal cost some £500 more in 1901 than it would have done in normal years owing to the greatly enhanced prices.

From the foregoing it may be considered as fairly proved (1) that the large manufacturer is desirous of obtaining a supply of electric energy; (2) that, however much the large manufacturer desires to obtain a supply of cheap energy, the small manufacturer is still more anxious to do so; (3) that it is to the advantage of the district that a cheap supply of energy is available; (4) if a power company can supply energy at a low rate, there is no reason why a local authority should not be able to supply it as cheaply; (5) that energy can be supplied from an existing lighting station at a rate low enough to induce manufacturers, and also an enhanced profit made for the undertaking.

The supplying of energy cheaply would, therefore, be an advantage to the manufacturer, to the owners of the electricity works, and to the electrical industry generally.

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THE FINANCE OF ELECTRIC SUPPLY.

The most interesting paper on "The Financial Improvement of Electricity Supply Works" by Mr. Joseph A. Jeckell, which we are reproducing elsewhere in this issue, calls attention to an all-important question. An engineer in charge of an electricity supply undertaking may be up to date in every development of the science, and may fill his station with every known device for economy and labour saving, but unless the balance-sheets of his undertaking are satisfactory financially his downfall is only a question of time. We have in mind a case in point in connection with an undertaking not a hundred miles from our office. In this instance the engineer had no less than three different systems of supply, each with particular advantages for different loads which occurred within the area. He had converting links between these systems, he had a large battery of accumulators with automatic regulating gear to keep the voltage of supply absolutely constant (which was never used), he had every labour-saving appliance and convenience which his staff could devise and money could buy, but he had not a paying load. In consequence, his capital charges were enormous, and his directors were firmly impressed with the idea that an all-day power load at 2½d. per unit would not pay. We need hardly add that in due time the engineer's services were dispensed with in favour of a gentleman who had grasped the simple idea that the real object of an electricity supply station was to supply electricity. The same moral underlies the paper referred to above. Mr. Jeckell found at Coventry an undertaking heavily capitalised and yet quite incapable of meeting the commercial requirements of the town. He recognised that any economies introduced would be absolutely unavailing unless a much larger load could be attracted. The mains already laid did not extend through more than a small proportion of the town, so that the extension of these was an absolute necessity if any large number of new consumers were to be connected. The laying of these mains and the remodelling of the station was an engineering matter with which no especial difficulties had to be faced, but they were, of course, made with a view of giving the utmost economy and the largest possible output for a given capital expenditure. The most difficult point Mr. Jeckell had to face was that of finance and of persuading not only his committee, but through that committee the Corporation of Coventry, that the old story of the orange woman was true after all. It will be remembered that this interesting and historic old lady explained to a passer-by that while she sold her oranges at two for 1½d. they actually cost her when delivered into her basket 1d. each, and that it was the quantity she sold which paid. Thus, when the average cost per unit supplied from the Coventry station amounted to 5¾d., which was 1½d. above the average price obtained in 1901, Mr. Jeckell had the onerous task of persuading his Corporation to largely increase the capital expenditure and also to decrease the price charged per unit. Up to the present there has hardly been time to gauge the full effects of the alteration, but the move in the right direction is so decided as to completely warrant the steps which have been taken. Thus, in 1900, when the average price obtained per unit was 4·14d., the average loss was 1·57d. per unit, and the rates were called upon to make good a deficiency of £2,250. In the next year, 1901, the average price obtained fell to 3·83d., and the rates were called upon to the extent only of £1,808. Last year, when Mr. Jeckell's alterations really began to have an effect on the balance-sheet, the average price obtained per unit had gone down to 3·37d., and the deficit was quite a nominal one, being

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under £200. In the two years the consumption of electricity had gone up from 341,810 units to 566,731. These improvements were made in spite of reorganisation troubles and the fact that capital expenditure always becomes a burden on the undertaking before it is remunerative. The above results are due to a large extent to the engineering improvements in the plant, but these are quite subservient to the commercial reorganisation which has taken place. The undertaking is now supplying motor loads at 1¾d. per unit, or at under a third of the price which it cost the Corporation to produce the unit at in 1901. The above results justify the conclusion that the good engineer who has sound commercial ideas, and can make others act on them, is the one to succeed in any supply undertaking.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

WIRELESS TELEGRAPH ALARM.

SIR,—I have noticed the publication of my letter on the above subject and your notes on the same in your issue of the 21st inst., for which I thank you. I note with pleasure that you have not objected to what I have said in my letter. I respect your opinion as I respect those of everyone, but it is remarkable that I, in order to defend my proposition, have given proofs and arguments, while you state yours without opinions or without combating my reasoning. You say that "the proof of the pudding is in the eating," but I have eaten the pudding, and have found it very good. From my experiments with apparatus I am assured that the wireless fire-alarm is the only solution possible and practicable to give directly automatic warning to fire stations. On the other hand, from regulating in the right way the receiving apparatus, I am convinced that it will not respond to signals of the ordinary wireless telegraphy—that is to say, transmitted at ordinary speeds—while it will respond to elongated signals given by the fire-alarms. By this means, then, I avoid interference with the stations of wireless telegraphy in towns. I gather that you doubt the success of wireless telegraphy on land. I hope that further trials and practical applications of my system will remove your doubts, and that then you will give me your support in the same way that you now dispute the possibilities of my system.—Yours, etc., E. GUARINI.

[We are afraid that if we had to give proofs for all the beliefs that are within us in connection with wireless telegraphy, we should allow our notes on correspondence to occupy the major part of our columns. We think that further comments or correspondence on the wireless fire-alarm system of Mr. Guarini should be deferred until the trial of the system on a practical scale.—ED. *E. E.*]

WIRELESS FIRE-ALARM.

SIR,—I shall be glad if you will allow me space to deal with one or two statements in Mr. Guarini's letter in your issue of 14th inst. I do not require to travel over the whole of the ground he covers, because your footnote points out one objection which must occur to every practical man. There are, however, others, and they are of a kind not easily overcome. I take it that Mr. Guarini is aware that the monopoly of the right to transmit telegraphic signals, automatic or otherwise, is vested in Great Britain in H.M. Postmaster-General, and that before his system can come into use it will require to be examined by the technical experts of the General Post Office, and a special license granted to practice. As a matter of opinion, I take it that no automatic system of wireless telegraphy will be licensed until such time as the authorities have convinced themselves that the transmission of any wireless signal will not interfere with, or be interfered with, by any other class of wireless message, commercial or otherwise. This difficulty, of course, does not arise in the case of brigade connections by metallic pairs such as the modern fire-alarm engineer confines himself to.

Another point to be considered, too, is that on account of service arrangements the connection between automatic systems and the brigade station seldom exceeds a mile and a-half, and averages about three-quarters of a mile, and that in consequence the cost is scarcely of much importance. One of the first duties of the practising fire-alarm engineer is to ascertain that the brigade with which he proposes to connect is well found and able to turn out with adequate appliances within a reasonable time, and to cover the ground at a fair rate of speed. Without mentioning names, a case which came within my own experience illustrates this point. I was sent for to design an installation for the protection of a large cotton mill, which was situated about 1¾ miles from the brigade station. The building itself presented no difficulty, but the road to be travelled was not an easy one, nor one on which a good pace could be made. After taking particulars, my next call was at the fire station, and there I found that the average time for getting into the street was little short of 30 minutes. The horses did not belong to the department, but were retained at an annual charge from a contractor who had the right to use them for sanitary and general haulage. Upon receipt of an alarm, the horses required to be called in from wherever they happened to be, and thus the time was lost. Looking at the matter fairly, in the first place, there would be a loss of 30 minutes, plus another 20, to cover the distance to the mill. I felt obliged to advise my clients that there was nothing in an automatic alarm system which would give them, under the circumstances named, the protection they sought. This is, I admit, a remote instance, but on the whole a conscientious engineer will not couple up indiscriminately, and prefers to protect buildings which are not too remote from a well-found brigade. I find, as a matter of experience, that the average cost to our clients of separate aerial pairs, or of metallic circuits forming the component parts of aerial or underground cables, does not exceed £3 a year, and this covers upkeep and occasional testing. I do not see, therefore, that, glad as I shall be to welcome wireless telegraphy when its reliability has been proved, there is anything commercially important in its adoption for automatic fire-alarm purposes.

Another objection—and this one is more difficult than any other to overcome—is the repugnance of the average brigade officer to rely upon telegraphic signals purely and simply. In our practice we find that primary reliance is placed upon the lowering of a legibly engraved shutter, and the coded message is treated as confirmatory only. Every fire chief fears that in the rush of a turn-out his dutyman will interpret a dash for a dot or *vice versâ*, and that the detachments will be sent scurrying away in a direction opposite from that in which they are needed. Even in the finest stations in the kingdom—and we have installations connected with many of them—the shutter is absolutely demanded, and our practice would be very much restricted by brigade authorities if we asked them to take a coded message apart from the shutter referred to. Few brigades have competent electricians on their staff who are capable of looking after the receiving set, and where these exist they make no secret of their appreciation of the shutter. Watch-room duty is continuous in the fire service, but the electrician cannot always be on deck. The responsibility for deciphering a code signal falls, perhaps, upon a junior officer or a senior fireman, and he, particularly toward the end of the week before the watch changes, tires in the small hours, and is not at all unlikely to err—especially in messages which consist entirely of combinations of one character, whether of dots or of dashes. It is not entirely his fault. As manufacturers, be as careful as you will, the slightest loss of speed in any transmitter forming one of a number coupled up to the same fire-station receiver has the tendency to lengthen the dot, until it is difficult to draw the line between the dot of the slow and the dash of the normally speeded instrument. Speed fluctuation in transmitters sending mixed dot-and-dash combinations cause no trouble, because the length of each character is relatively affected. These difficulties only reveal themselves in the course of an extended practice

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when one has a considerable number of installations coupled up with the central fire station, and under the constant supervision of interested and watchful critics. Can Mr. Guarini so attune his transmitters that each, whilst printing upon a common receiver at a uniform rate of speed, can pick out and drop its own particular shutter in a case, say, of a hundred? The brigades do not like the shutter by itself, because a line contact of any description will bring it down, but they are willing to accept, and they encourage the use of, the combination. If it is possible—and this is proven—to interpolate "rats" in a wireless message, what guarantee is there that the presence of an extra dash or dot from some other system, or a jumble of complete messages, may not confuse the brigade, and subject them to the chagrin of knowing that there is a fire in progress without being able to ascertain where. I am not writing as a scientist, but as an engineer, with a growing knowledge of the difficulties which exist.—Yours, etc.,

Glasgow, Aug. 20, 1903. GEO. H. OATWAY.

P.S.—Since writing the above I have seen Mr. Guarini's letter in yours of the 21st, and need only say, as the author of the specification he refers to as "the conditions printed by the Fire Prevention Congress of London," that he not only does not "furnish the best and perhaps the only solution," but that he fails to comply with the primary essential, "to detect the fire at a uniformly early period under all atmospheric or industrial conditions." This he can never do with the detector he employs, and there will be time enough to consider his compliance with the other condition when he has secured the license and overcome the other practical difficulties enumerated above, and when he can refer his critics to industrial installations under brigade supervision instead of diagrams or elementary demonstrations.—G. H. O.

QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any questions should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

613. I have two motors, 2¼ h.p., 85 volts, and my voltage on the mains is 110. Please tell me the best economical method of using above motors.—J. W.

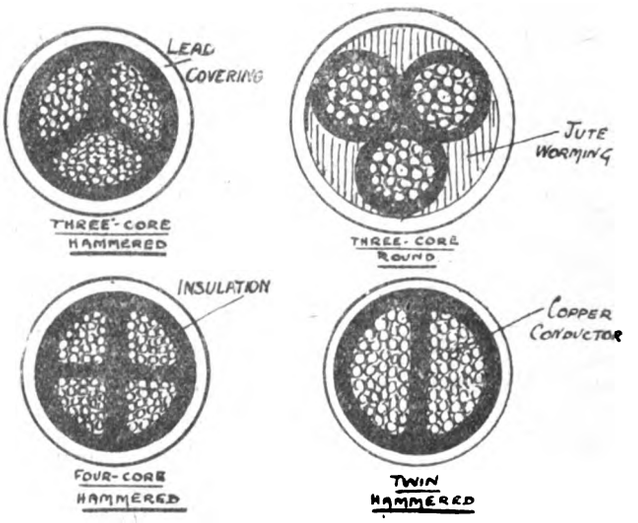
614. In motor starters, graded in G.P. and having wires with a rating proportional to dia.$^{\frac{3}{2}}$, how should the constant K (or the diameter of the wire) vary from the first to the last contact for the same temperature of wire, and for the greatest economy in resistance material, allowing the same space of time on each contact (say three seconds). Consider a 5-h.p. starter with 16 contacts, and a similar one with 24 contacts.—J. A.

ANSWERS.

Question No. 605.—What are the advantages and disadvantages of hammering electrical cables out of the ordinary round shape?

Best Answer to No. 605 (*awarded* 10*s.*). — Taking the question quite literally, there appears to be *no* advantage in hammering electrical cables out of shape, either to the cable or the hammerer. The scrap heap might increase its load. The exact amount of disadvantage attending the process depends on circumstances. For instance, if the cable happened to be a street main carrying a heavy load at, say, 8 p.m. on a winter's Saturday evening, probably a large portion of the town would be thrown into darkness, the engineer would be forced into the use of very strong and searching words, and the hammerer thrown into the nearest jail for a month's sojurn without the option of a fine, and serve him jolly well right. I presume, however, that the question is intended to read, "What are the disadvantages and advantages of hammering *the conductors* of electrical cables out of the ordinary round shape?"

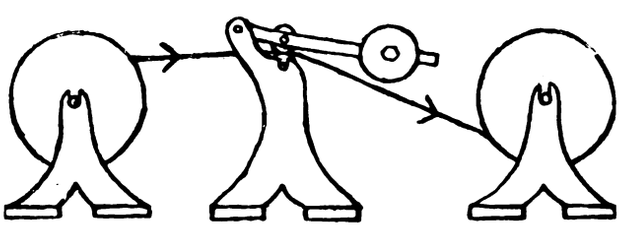
It is sometimes usual to hammer or roll the usual circular stranded conductors of twin, three-core, or four-core cables into segmental shape before insulating. As can be seen by comparing cables made up of hammered conductors with those of ordinary round strand (see drawing), the chief



advantage is that a smaller and mechanically better cable can be made, no space being wasted, the insulated conductors lying compactly and geometrically together. No jute worming is necessary to fill up the spaces which are left when round conductors are stranded together. Then the cable with hammered conductors is also cheaper by reason of its compactness and smaller diameter, less lead being used to cover it.

It is much cheaper and easier to joint or tap off services from a three-core cable than from a triple-concentric, and this is a consideration in a distributing system. In jointing the conductors the jointer can easily hammer the strand sufficiently circular again to make a good joint in a sleeve or fitting, so that the shape is no real disadvantage in making joints. I know of no practical disadvantages with this type of cable as compared with round conductor cable. DUPLICATOR.

Answer to No. 605 (*awarded* 5*s.*).—Although stranded conductors are often formed into sections other than circular, it would be very unusual and unsatisfactory to alter the shape by hammering. Suppose a stranded conductor is required to have an elliptical section; after having been laid up as a circular strand, the desired shape might be obtained by some such method as depicted in sketch. The strand is drawn over a grooved roller having



a weighted jockey roller above By altering position of the weight the pressure is adjusted to suit the work in hand. Of course, by increasing the pressure and drawing through several times, the strand may be made to approximate in shape to a ribbon. Some makers force the strand into rectangular and other sections by means of hydraulic pressure. There are several advantages due to this alteration in section, among the principal being the utilisation to greater advantage of the winding space on the armature cores of dynamos, reduction in size of electrical conductors, as seen in the well-known "clover-leaf" pattern, by flattening out the strand employed for lightning conductors greater flexibility is secured in manipulation, also for ornamental braids, etc.

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Two other advantages also might be instanced, but they are scarcely worth mentioning—viz., that by increasing the periphery with a given sectional area greater radiating power for heat is obtained, and in the case of alternating current the loss due to skin effect would be less. Disadvantages are that unless the rolling or pressing is carefully done the conductor may be hardened, and so have its electrical resistance increased, and there is more difficulty in covering, with cotton or other material, a conductor having a ribbon or an elliptical than one having a circular section.—M. M.

Question No. 606.—It is required to obtain current at 200 volts from two shunt-wound dynamos, each giving 100 volts, and it is found that if the two machines be simply connected in series, with the shunt of each machine across its own brushes, the field of one dynamo dies away and is then reversed in direction, whilst if the field windings are connected in series and not connected at the intermediate point between the two armatures, the machines run all right. Explain this.

Answer to No. 606 (*awarded* 7*s.* 6*d.*).—The effect noticed with the first arrangement is due to an ordinary loss of field, aggravated by the fact that with two machines in series a drop in the voltage of one machine of a given percentage only corresponds to a drop of half that percentage in the current through the two armatures, assuming that the volts of the second machine keep constant. Suppose that the two machines are running at 100 volts each, with a certain amount of current passing, and that then a slight drop in speed (and in volts) occurs on one dynamo. If this dynamo were working alone on the circuit, this drop in volts would produce a corresponding drop in armature current of equal percentage, and this would immediately lead to a rise in volts again, but as two dynamos are in series, the armature current will fall only half this amount, so that this self-righting tendency will be much reduced. Now, the stability of any shunt dynamo, especially of one working with only slightly saturated magnet iron, depends largely on this self-righting tendency, due to a reduction in the armature reaction following any drop in voltage, however set up. Naturally, therefore, the instability of a given machine is increased when used in series with a second machine.

Once the loss of field commences there is nothing to stop it, and the volts of the unstable machine will continue to fall. When they have fallen to zero, the current through the armature will have half its original value (assuming that the voltage of the second machine keeps constant, and that the external resistance is also constant). This amount of armature current will be sufficient to set up a small magnetic field in the reverse direction, and this will enable the shunt to start building up a field in the reverse direction, as described in the question. The volts of this dynamo will now be opposing those of the other machine, producing a still further reduction in external current, and these opposing volts will increase until they equal the volts of the other machine, and the external current falls to zero.

If, now, instead of connecting each shunt across the brushes of its own machine the two shunts are simply connected in series across the mains, a drop in voltage of a given percentage on either machine only affects the shunt current of each machine by an amount equal to half this percentage, and at the same time the total external current also falls by a percentage equal to half that of the voltage change in the one machine. In this way the relative changes of shunt current and armature current are as favourable as regards stability as in the case of a single shunt machine running alone, and much more favourable than when two machines are in series with each shunt connected to its own brushes.—Q

Answer to No. 606 (*awarded* 7*s.* 6*d.*).—It does not state in the question whether these two shunt machines each give the same output or run at the same speed. If one of them is a smaller machine than the other, the conductors in the armature of the smaller machine will tend to heat up under load and cause a larger volt drop in the armature, thus diminishing the voltage at the terminals of this machine. The shunt of the smaller machine would receive less current, and thus the field would be diminished. Through the field being weaker the armature conductors would not cut so many lines of force, and thus the voltage would be still more lowered at the terminals. The shunt current would be still further reduced, and this diminishing action would go on until it would die away altogether.

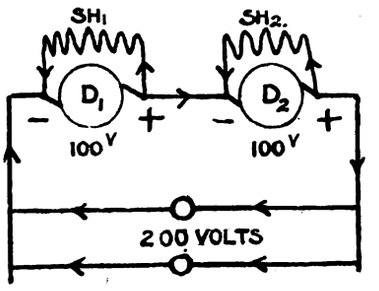

FIG. 1.

In Fig. 1 the dynamos, D_1 and D_2, are shown connected in series with their shunts, Sh_1 and Sh_2, connected across their respective terminals. The path taken by the current is indicated. Now, it has been shown previously that if D_2 is a smaller machine than D_1 the voltage of D_2 may die away. Let us suppose it has died away; what happens? The dynamo D_2 is simply conveying the current generated by D_1 through its armature, and as its shunt forms an

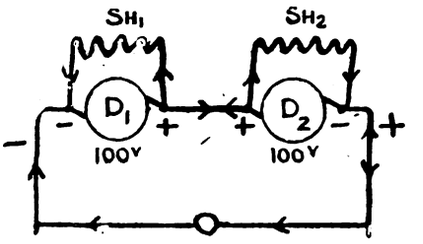

FIG. 2.

alternative path for the current, a portion of the current flows through it *in the opposite direction* to that when D_2 was itself supplying its own shunt current.

In Fig. 2 the new state of things is shown. The shunt current in Sh_2 now being reversed, D_2 will start generating in the opposite direction, and oppose the current generated by D_1. As D_2 is now generating it will be able to supply its own shunt current or part of it, and the two machines

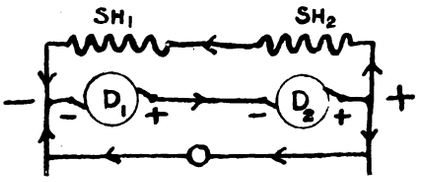

FIG. 3.

are working one against the other. Even if the machines are exactly similar, the above result may happen if the speeds and resistances of shunts are not so adjusted as to make the E.M.F.'s of the machines rise and fall in the same ratio. If the shunt of one of the machines—say D_2—heats up more than the other, then the same cycle of events will be gone through as previously described.

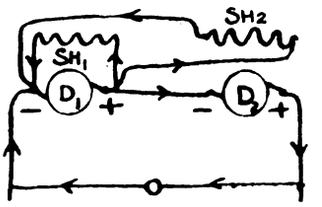

FIG 4.

The writer has had a great deal of trouble running two shunt machines in parallel through the E M.F.'s of the machines not rising and falling in the same ratio. So many things may cause reversal if the machines are connected as shown in Fig. 1, that it is preferable to connect the two shunts in series as shown in Fig. 3. In this case the

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current through the shunts, Sh_1 and Sh_2, will always be flowing in the same direction. There is, however, this disadvantage about this arrangement, that it is most likely that the machines will take a long time to generate current. In all probability one machine will start generating first, but as the two shunts are in series they will offer a high resistance, and as this first machine can only generate 100 volts, only a small current will flow through the shunt circuit. It might be advisable to ascertain which machine builds up its voltage the quickest, and connect the shunts of both the machines in parallel to the terminals of this machine. There would be no reversal, and the machines would quickly start generating.—W. A. T.

Answer to No. 606 (*awarded* 5*s.*).—No mention is made in the question as to whether the dynamos are exactly similar. Let us first suppose, for the sake of convenience, that one machine (No. 2) is intended for a greater output than the other. As the current through the armatures increases so will the demagnetising effect increase, and this will be of relatively much greater importance in the case of the machine having the smaller output. Suppose the machines connected up as in Fig. 1. Then, owing to the

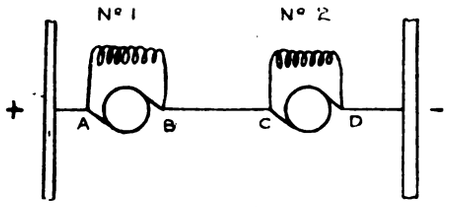

Fig. 1

field of No. 1 being weakened by the demagnetising effect of the armature current, the potential difference between A and B will fall. This will cause a diminution in the shunt current of No. 1, thus further weakening the field. The total E.M.F. of the two machines, and consequently the current, will fall, and this will reduce the demagnetising effect slightly, but it is obvious that as machine No. 2 is, comparatively speaking, unaffected, the percentage fall of potential difference between A and B will be much greater than that between A and D. Hence the demagnetising effect of the current in armature No. 1 will be greater with respect to the field of No. 1 than it was at first.

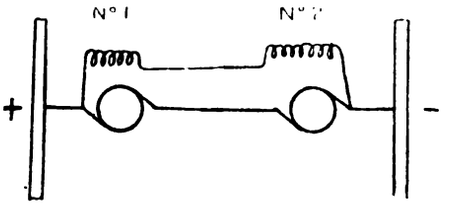

Fig. 2.

The above process will be continuous, and the field of No. 1 will eventually disappear, and since current will still be urged through the armature of No. 1 by machine No. 2, the field will finally be reversed. The same explanation will suffice if the two machines are apparently similar, because some trifling difference in the construction will cause the demagnetising effect of the armature current in one machine to be slightly greater than in the other, and the former machine will eventually have its field reversed. If the machines are connected up as in Fig. 2, when the armature reaction weakens the field, the main current and shunt current will drop proportionately, and thus the field due to the shunt of No. 1 will not be overpowered.—W. H. N. J.

Answer to No. 606 (*awarded* 5*s.*).—When two shunt machines are run in series, the shunt of each machine being connected across its own brushes, as shown in Fig. 1, they have a tendency to reverse one another. This is owing to the fact that when the current is reduced in the shunt of one machine its voltage drops. This drop in volts causes a further reduction in the shunt, the field gradually dies away, and finally a complete reversal of polarity takes place. If the shunts are also connected in series, as shown in Fig. 2, reversal of polarity in either of the machines cannot take place, as the same current flows through both shunt windings. The successful series working of two shunt machines may be ensured by cross-connecting the fields, as shown in Fig. 3. It will be seen that the field of machine A receives current from B's armature, the current from A's armature exciting B's field. Should

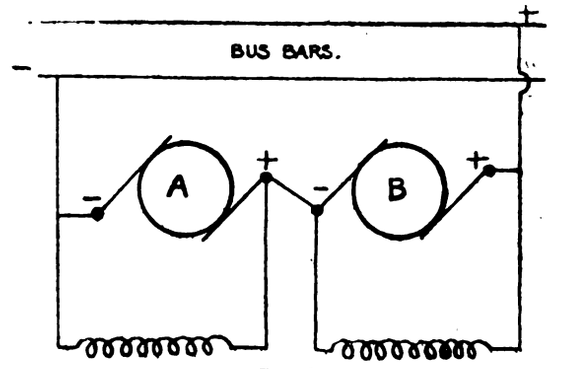

Fig. 1.

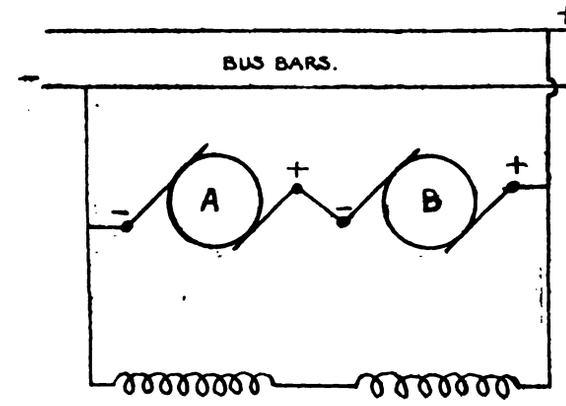

Fig. 2.

the current in the shunt of machine A be reduced, the voltage of machine B, which has caused this reduction, will also be reduced. It will, therefore, be seen that it is

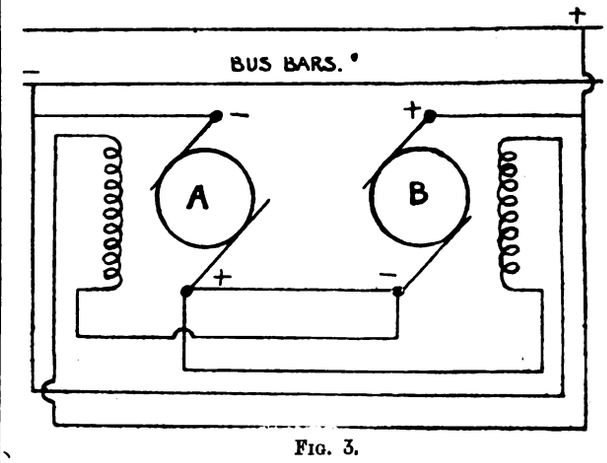

Fig. 3.

impossible for either machine to have the polarity of its shunt reversed, as any increase or decrease in the exciting current must affect the fields of both machines.—J. W. R.

FORTHCOMING EVENTS.

Iron and Steel Institute.—Summer meeting, Barrow-in-Furness, September 1-4.

Municipal and County Engineers.—Meeting at Hastings on September 11 and 12.

British Association.—Seventy-third annual meeting, September 9, Southport.

Sanitary Institute.—Sept. 16, lecture by Dr. E. J. Steegmann, "Natural Forces: Light, Heat, Electricity; Chemistry."

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THE BRITISH ASSOCIATION.

The following is the provisional list of papers to be read before Section A (physics and mathematics) of the British Association at the forthcoming Southport meeting: "On the Treatment of the Thermo-Dynamics of Irreversible Processes," by Mr. J. Swinburne; "Granular Structure in Solids," by Mr. G. Beilby; "Explosive Pressure and Rate of Combustion of Cordite," by Mr. J. E. Petavel; "Simultaneous Solar and Terrestrial Phenomena," by Sir N. Lockyer; discussion on "The Nature of the Emanations from Radioactive Substances," opened by Prof. Rutherford—Profs. J. J. Thomson, Dewar, Soddy, and Armstrong will take part; "Report of Electrical Standards Committee," by Dr. R. T. Glazebrook; "On the Use of Vectorial Methods," by Prof. Henrici, with discussion; "On the Use of Condensers as Multipliers to Extend the Range of a Multicellular Voltmeter," by Prof. Marchant; "On Design and Working of Ballistic Galvanometers," by Mr. P. H. Powell. Meteorology will be strongly represented, owing to the meeting of the International Meteorological Committee taking place at Southport at same time.

Following are the provisional arrangements for Section F (economic science and statistics): Thursday, Sept. 10—presidential address of Mr. E. W. Brabrook, chief registrar of Friendly Societies; Friday, Sept. 11—discussion on "The Wealth of the Country and what should be done with it," opened by Sir Robert Giffen. Monday, Sept. 14—papers and discussion on the economic aspects of the fiscal controversy, as follows: "Modern Economics and Free Trade," by Dr. E. Cannan; "Failures to Attain the Ideals of Free Traders," by Prof. W. Cunningham; "Statistical Methods and the Fiscal Controversy," by Mr. A. L. Bowley; "Comparative Statistics of our Trade with our Colonies, U.S.A., and the Protected Countries of Europe," by Mr. B. Etlinger; and probably papers on "History of Retaliation," "History of Commercial Relations with Canada," and "Statistics on Production." Thursday—final report of committee on "The Economic Effect of Legislation Regulating Women's Labour"; "Physical Deterioration and the Poverty Line," by Mrs. Bosanquet. The following other papers will probably also be read before this section: "Depreciation and Sinking Funds in Municipal Undertakings," by Mr. S. H. Turner; "The Growth of Rates," by Dr. Ginsburg; also a paper on "Garden Cities."

The preliminary programme of papers in Section G (engineering) is as follows: "The Problem of Modern Street Traffic," and "An Account of the Manchester Municipal School of Technology," by Lieut.-Colonel Crompton, R.E., C.B.; "Protective Devices for High-Tension Circuits," by Mr. W. B. Woodhouse; "Permanent Set in Cast Iron, due to Small Stresses, and its Bearing on the Design of Piston Rings Springs," by Mr. C. H. Wingfield; "Refuse Destructors and Power Production," by Mr. W. F. Goodrich; "The Rebuilding of Kew Bridge," by Mr. C. A. Brereton; "Parallel Running of Alternators," by Mr. B. Hopkinson; "Balancing of Large Engines," by Prof. J. Perry; "Pendulum Apparatus for Testing Steel as Regards Brittleness," by Captain H. Riall Sankey, R.A.; "A New Form of Mirror Extensometer," by Mr. J. Morrow; "Clutches," by Prof. H. S. Hele Shaw; "Ventilation of Tube Railways," by Mr. J. W. Thomas; "Liquid Fuel,' by Mr. A. M. Bell; "The Potable Waters of S.W. Lancashire," by Mr. J. Campbell Brown; "A History of the Discovery of Natural Gas in Sussex," by Mr. R. Pearson; "The Manchester and Liverpool Express Railway," by Mr. F. B. Behr; "Aluminium as an Electrical Conductor," by Mr. J. B. C. Kershaw; "The Water Supply of South-West Lancashire," by Mr. J. Parry; "The Tidal Régime in the Mersey" and "Electric Traction," by Mr. J. N. Shoolbred; "A Further Note on Gas-Engine Explosions," by Mr. H. E. Wimperis; "The Single-Phase Repulsion Motor," by Mr. W. Cramp; "Steam Traffic on Common Roads," by Mr. T. Clarkson; "The Rate of Fall of Rain at Seathwaite," by Mr. H. R. Mill; "Smoke Abatement," by Mr. W. G. Popplewell; "Illustrations of Graphical Analysis," by Mr. J. Harrison; also reports of the Small Screw Gauge Committee and the Road Traction Committee. In connection with Section G, visits have been arranged to the following, among other, places of engineering interest: the Manchester Municipal School of Technology; the works of the British Westinghouse Electric and Manufacturing Company, Trafford Park; ss. "Lucania," Liverpool; the British Insulated Wire Company's works, Prescot; the L. and Y. Railway Company's works, Horwich; the Wigan Deep Coal Pit.

In Section L, devoted to educational science, it is proposed to devote two days (Sept. 10 and 11) to a discussion on "School Curricula," based on a series of short papers. Introductory papers have been promised by Miss Burstall and Messrs. M. E. Sadler, J. L. Paton, W. L. Fletcher (Liverpool Institute), John Adams, T. E. Page, and others. A joint meeting with the Geographical Section will be held to discuss the "Teaching of Geography." In addition to the above subjects there will also be discussions on the reports of committees on the conditions of health essential to the carrying on of the work of instruction in schools; the teaching of natural science in elementary schools; the influence exercised by universities, and examining bodies, on secondary school curricula, and also of the schools on university requirements; the teaching of botany in schools.

THE SHIFT ENGINEER.

There was a curious foreigner,
Who always wished to know
The meaning true of every term
And why we called it so.
He came across a term one day
That puzzled him no end,
And "Vat is Ingénieur-du-Shift?"
He asked of every friend.

The first he asked, a councillor
Whose town had got the juice,
Was not so very certain, but
He made up in abuse.
"They come and work a fortnight, when,
"To get a wages lift,
"They leave us for another job.
"They're always on the shift!"

The next he asked a Boniface,
At whose hotel he stopped,
Was noted for his bottled beer
And knew the men who mopped.
He gave it his opinion that:
"The term Shift Engineer
"Applies to those Electric chaps
"Who come and shift my beer."

But when he asked a lady friend
She blushed a crimson hue
And tried to change the subject, but
That did not suit m'sieu.
At last she bravely blurted out:
"The finest one on earth
"Is a gentleman in Paris, and
"His name is Mr. Worth."

B. C. H. J.

APPOINTMENTS VACANT.

Assistant Electrical Engineer, Londonderry, £130 per annum. See advertisement in last issue.

Mains Superintendent, Bury, £120, rising to £150 per annum. See advertisement in previous issue.

Pupil or Junior Draughtsman. See advertisement in former issue.

Assistant in the Distribution Department, Croydon. Salary to commence 20s. to 25s. per week, according to qualifications. See advertisement.

Switchboard Attendant. Salary, 10s. per week. See advertisement.

Electrical Engineer for mine work abroad. See advertisement.

Manager with knowledge of the trade in electrical accessories. See advertisement.

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GRIMSBY ELECTRICITY ACCOUNTS.

From the accounts of the Grimsby Corporation electricity department for the year ended March 31, 1903, it appears that the total expenditure on capital account amounted to £71,253. We give herewith abstracts of the revenue account, general balance-sheet, and statement of electricity generated, sold, etc.

REVENUE ACCOUNT.

Dr. Expenditure.	£	s.	d.
Coal or other fuel	1,553	15	11
Oil, waste, water, and stores	112	1	5
Wages at generating station	722	19	10
Repairs to buildings and plant	223	15	6
Distribution of electricity	131	17	5
Attending and repairs to public lamps	275	0	7
Rents, rates, and taxes	312	11	0
Management expenses, salaries, etc.	736	16	7
Special charges, insurances, etc.	62	18	2
	4,131	16	5
Amount set aside for bad debts	30	0	0
Balance carried to profit and loss account	3,277	1	7
	£7,438	18	0

Cr. Receipts.	£	s.	d.
Balance from last account	10	0	0
Sale of current per meter	3,310	13	9
Sale of current under contract (traction)	2,369	12	1
Public lighting	1,528	15	8
Rental of meters	110	6	10
Sale of incandescent lamps, etc.	49	6	10
Fees for tests, etc., and discounts received	60	2	10
	£7,438	18	0

GENERAL BALANCE-SHEET.

Dr. Liabilities.	£	s.	d.
Capital account—amount received	71,837	0	0
Sundry creditors	2,382	2	5
Sinking fund account	1,390	17	10
Amount for sinking fund account	1,825	19	9
Provision for bad debts	30	0	0
	£77,466	0	0

Cr. Assets.	£	s.	d.
Capital account—amount expended for works	71,253	14	10
Stores on hand	1,053	19	6
Sundry debtors for current supplied	2,188	10	7
Other debtors	142	8	0
By securities held (cost price)	1,390	17	10
Balance at debit of net revenue account	1,421	5	11
Cash in hand	15	3	4
	£77,466	0	0

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T. units			720,803
Units sold: Traction	372,114		
Public lighting	95,702		
Private consumers by meter	180,823		653,438
Sundry purposes	4,799		
Quantity used on works			25,527
Quantity unaccounted for			41,838

SOUTHAMPTON ELECTRICITY ACCOUNTS.

The accounts of the Southampton Corporation electricity department for the year ended March 31, 1903, show a total expenditure on capital account to that date of £138,259. Abstracts of the revenue account, general balance-sheet, and statement of electricity generated, sold, etc., are given herewith.

REVENUE ACCOUNT.

Dr. Expenditure.	£	s.	d.
Generation of electricity—wages	1,723	9	1
Coal or other fuel	5,044	10	8
Oil, waste, water, and stores	481	13	6
Maintenance of buildings and plant	1,310	7	4
Distribution of electricity—wages	121	2	2
Repairs and renewals of mains and meters	481	14	11
Sale of meters—loss on realisation	70	0	0
Repairs and maintenance of public lamps	315	1	9
Salaries of staff	943	8	7
Rents, rates, and taxes	966	12	7
Insurances	124	15	9
General establishment charges	308	4	5
	11,891	0	9
Balance, being gross profit for the year	11,938	4	7
	£23,829	5	4

Cr. Receipts.	£	s.	d.
Sale of current to private consumers	13,494	4	5
Corporation tramways	8,145	0	8
Public lighting	1,739	14	11
Meter rents	300	15	0
Miscellaneous receipts	149	10	4
	£23,829	5	4

BALANCE-SHEET.

Dr. Liabilities.	£	s.	d.
Southampton Corporation stock	120,164	15	2
Sundry creditors	5,907	19	8
Amount owing to bank	6,825	14	2
Surplus account	19,407	14	3
	£152,306	3	3

Cr. Assets.	£	s.	d.
Amount expended on works	138,259	6	5
Sundry debtors for current supplied, etc.	5,684	0	1
Stores on hand	690	0	7
Sinking fund investments	7,672	16	2
	£152,306	3	3

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T. units			2,227,015
Quantity sold: Private consumers by meter	623,368		
Private consumers by contract	444		
Public lighting	130,279		1,732,013
Corporation tramways	977,404		
Quantity used on works			51,787
Total quantity accounted for			1,783,800
Loss in distribution and batteries			443,215
Number of public lamps			166
Total maximum supply demanded (kilowatts)			1,263

HAMMERSMITH ELECTRICITY UNDERTAKING.

The report of the borough electrical engineer upon the annual accounts for the year ended March 31 last states that the amount of the loans has increased by £24,845, but of this amount the committee still have £5,981 in hand as cash, and a stock of over £4,000 of goods held in readiness to execute work chargeable to capital account, from which they have not reaped any benefit for the year under review. The sinking fund for the year is slightly heavier on account of one of the loans having to be repaid in 10 years, instead of 42 years. Another loan has been taken up amounting to £8,800, on the same terms, making a total of £10,700 borrowed for this short period. This money is required for meters, service lines, etc. In comparing this year's surplus with previous years, it must not be forgotten that all the recent loans bear interest at the rate of 3½ per cent., whereas at the commencement the committee paid only 2¾ per cent. to 3 per cent. It is interesting to note that the surplus would have been about £850 greater if all the capital had been obtained at an average of 3 per cent. This shows that the committee should restrict their borrowings, if possible, until money is cheaper. The revenue account shows a substantial increase, but, unfortunately, the receipts are not so great as estimated. The engineer goes through the accounts *seriatim*, and shows that the gross profit is £10,930. 2s. 7d., which leaves a net profit or surplus of £1,063, as set out in the net revenue account. The total surplus since the commencement now amounts to £3,814 after paying all sinking fund charges, but without any further allowance for the depreciation of the assets After six years' working the sinking fund represents only 7·4 per cent. of the total capital borrowed, and he does not consider this sufficient provision for the physical deterioration of the plant, and will not maintain the assets at their reduced book value, even if the only object is to make the plant last during the period for which the loans have been obtained, and then obtain new machinery by again borrowing. This will not achieve the gradual purchase of the undertaking, which will thus always be saddled with heavy loans In order to provide for the full depreciation (and the value of this physical deterioration of the plant has disappeared just as surely as the coal which has been consumed), it will be necessary every year to set aside out of current revenue a definite percentage of the capital borrowed, so as to maintain the assets at their full book value. This fund should be liberally drawn upon for new machinery each year, and should not be allowed to accumulate. During the past year there has not been any depreciation or renewal fund, so that all items which could not properly be placed to capital account have been charged direct to current revenue as "betterment," but as sufficient provision has not been made in previous years for depreciation, the whole of our accumulated surplus should be placed to the credit of a depreciation fund. The "betterment" charges can then be debited to this account, and removed from the revenue account, a sum being written off from the profits to allow for this year's depreciation. The question then arises whether the money so set apart may properly be employed in the business itself, or whether it should be invested outside the business. If the object of this fund is to provide ready money for some sudden call, the latter plan may be expedient, but in a manufacturing business the reserve funds may generally be best employed in it, and such a use of the reserve will go to diminish the need for borrowing. The committee have to pay 3½ per cent. on their borrowed money, whilst the return on the capital employed is nearly 6 per cent., and as any safe investment outside the business will only return about 3 per cent., there is every inducement to employ their reserves, set aside, either for depreciation or otherwise,

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in the development of their own business. A return of the progress made by the department in comparison with last year is appended, which shows that the committee will very soon have to consider the question of extending the plant.

Below we give an abstract of the accounts for the year. The total expenditure on capital account has been £196,311.

REVENUE ACCOUNT.

Expenditure.	£	s.	d.
Coal, including cartage	4,947	9	11
Oil fuel	134	8	0
Oil and engine-room stores	723	6	4
Wages at generating station	2,096	0	7
Repairs, etc., of buildings and plant	2,268	18	2
Wages of linesmen, fitters, and labourers	623	14	11
Repairs, etc., of mains	99	3	0
Repairs of meters, etc.	252	18	2
Repairs, etc., of apparatus	602	1	8
Carbons for public arc lamps	135	8	10
Lamp renewals, globes, etc.	314	1	8
Wages of trimmers, etc.	665	11	9
Miscellaneous expenses	3	5	0
Salaries of engineering staff	814	9	6
Salaries of clerical staff	394	15	2
Stationery and printing	133	8	2
Advertisements	14	2	3
Cost of mortgage deeds	45	16	6
General establishment charges	284	5	3
Rates and taxes	1,385	0	1
Law and parliamentary expenses	25	0	6
Insurance of boilers, engines, etc.	291	12	0
	16,254	17	5
Balance carried to net revenue account	10,930	2	7
	£27,185	0	0

Income.	£	s.	d.
Private lighting—sale of current	21,677	17	4
Less interest and discounts on consumers' payments	74	4	1
	21 603	13	3
Public lighting	3 986	16	11
	25,590	10	2
Meter rents	20	5	10
Miscellaneous receipts	870	12	10
Inland revenue—refund in respect to over-payment of tax	324	12	2
Allowance for rates over-paid	378	19	0
	£27,185	0	0

BALANCE-SHEET.

Liabilities.	£	s.	d.
Capital account	181,771	0	0
Revenue account	2,780	19	10
Net revenue account	3,814	2	8
	£188,366	2	6

Assets.	£	s.	d.
Capital account	175,789	8	11
Revenue account	6,315	0	10
Stores on hand	1,177	6	10
Treasurer's balances	5,084	5	11
	£188 366	2	6

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T. units		2,149,548
Quantity sold { Public lamps by contract ..... 324,542 / Private consumers by meter.. 1,412,297 }		1,736,839
Quantity used on works		377,556
Accounted for		2,114,395
Not accounted for		35,153
Total maximum supply demanded (kilowatts)		1,320

Number of public lamps: 165 arcs, 74 Lotus.

GLASGOW ELECTRICITY UNDERTAKING.

We have received a copy of the report of the Electricity Committee to the Corporation of Glasgow, together with the accounts for the year ended May 31 last. It shows that the gross revenue for the year amounts to £127,004. 6s. 6d., and the working expenditure to £51,138. 19s. 7d., leaving a balance of £75,865. 6s. 11d., out of which the committee had to meet the following statutory requirements: (1) interest on loans, £33,275. 8s. 2d.; (2) sinking fund, £11,770. 15s. 7d.—total, £45,046. 3s. 9d., leaving a balance on the year's ordinary working of £30,819. 3s. 2d., from which deduct proportion of cost of lamps and fittings supplied to consumers consequent on change of voltage, charged to this year's revenue account (£6.536. 7s. 1d.), and the legal and parliamentary costs of the Glasgow (Kinning Park) Electric Lighting Order, 1902 (£992. 11s. 8d.), leaving a net balance of revenue over expenditure of £23,290. 4s. 5d. The committee, on consideration, have come to the conclusion that, in addition to the reduction of debt by sinking fund and writing off the loss on realisation of plant which is being dispensed with in consequence of change of voltage rendering the plant unsuitable for the purposes of the Corporation, amounting in Waterloo-street station to £6,455. 7s. 2d., and in Kelvinside station to £1,370. 13s. (total, £7,826. 0s. 2d.), there should be written off the several items comprising the capital account in name of depreciation for the year now closed, a sum of £29,359. 10s. 4d. The total amount thus proposed to be written off for depreciation and loss on realisation of plant, against revenue account, is £37,185. 10s. 6d., making a debit balance on the year's operations of £13,895. 6s. 1d., which in terms of the Glasgow Corporation Electric Lighting Order, 1890, is, in the meantime, transferred to the debit of the gas account. The committee note with pleasure the increasing revenue of the department. There is, as compared with the previous year, an increase in the sums received from all sources of £23,000, without any corresponding increase in the working expenditure. The cost of generation and distribution is less, particularly in the item of fuel, this being due not only to a fall in the price of coal, but also to a still further economy on the moderate working of the previous year. The increase in revenue, combined with the economy in working costs, has resulted in leaving a balance on the year's ordinary working of £30,819. 3s. 2d., as compared with £14,514. 6s. 3d. last year. This increased surplus on the year's ordinary working has, however, been neutralised to some extent by the increased amount paid for changing consumers' installations to the higher pressure which is now almost completed throughout the city. This increase has been caused by the special effort which has been made to bring this work to a close as soon as possible. It is probable that next year this item of charge will be small, and that by the year after next it will have entirely disappeared as an item of account. In addition to these extra expenses there have been, as before stated, special sums written off revenue account in connection with the forced realisation of the Waterloo-street plant With these facts before them the committee look confidently forward to a prosperous year, and to such a balance on the year's working as will not only provide for a sufficient depreciation of the undertaking for the year now entered upon, but also wipe out the debit balance on the operations of the year now closed. Subject to the modification of the power rates to long-hour consumers, which was approved by the Corporation on March 19 last, and possibly an alteration of the public street-lighting rates, a subject which is presently under consideration of a special sub committee, the committee recommend that the charges during the year 1903-4 for the various supplies of current should remain the same as last year. The quantity of electricity sold to private consumers during the past year was 10,419,488 units, as compared with 8,384,696 units during the previous year, being an increase of 24·27 per cent. The number of consumers at May 31 was 7,013, as compared with 5,374 the previous year, being an increase of 1,639, or 30·49 per cent. during the year. There were 237 consumers who consumed the equivalent of five hours or more per day of their maximum demand throughout the year, the consumpt under this head amounting to 1,696,103 units in all. The number of motors in use and supplied off the Corporation mains as at May 31 was 1,059, with a total horse-power of 4,597, as compared with 682, with a total horse-power of 3,086, the previous year. The number of units consumed for power purposes was 1,560,509 units. The total number of arc lamps erected and in regular use in the streets as at May 31 was 719, as compared with 500 the last year, and the quantity of electricity consumed for street and stair lighting was 1,081,836 units, as compared with 897,347 units during the preceding year. The number of 8-c.p. lamps, or the equivalent in other devices applied for, connected to the mains at May 31 was 630,708, as compared with 491,306 at the corresponding date the previous year, being an increase of 139,402. The number of units consumed by private consumers, per lamp fixed, averaged out month by month, according to the date of connecting up, was 19·13, as compared with 20·04 the previous year. The maximum load during the year occurred on Dec. 22 last, when it was 9,371 kw., as compared with 7,950 kw. the previous year, being an increase of 18 per cent. Contracts have been entered into for the erection of permanent brick stores and workshops at Port Dundas station, together with a complete boundary wall on three sides of the site, to take the place of the temporary wooden erections, which are now insufficient to meet the requirements of the department. These several works are now being proceeded with, and it is expected that the new buildings will be ready for occupancy in the spring of next year. The steam plant in Port Dundas station has not been increased during the year and consequently the total indicated horse-power in this station remains at 12,100, but a new set of condensing plant for the two large engines has been added and set to work. Automatic coal-weighing machines have also been installed during the year, and have been found of great service. Some of the economy in the fuel account, which has been already referred to, is attributable to their use. The other plant which was installed towards the close of last year is the induced-draught plant, which is of great assistance in meeting sudden heavy demands in foggy weather, and in providing steam economically for the peak load of the winter afternoons. The economisers, which were added before the close of last year, have also proved of great assistance in giving economical results. At Pollokshaws-road station no addition was made to the 4,400 h.p. noted in last year's report, but there is at present being installed, under a satisfactory arrangement with the contractors, a 750-h.p. engine with two dynamos in place of two 200-h.p. engines and dynamos In Waterloo-street station the steam plant has now been permanently shut down, but six of the largest dynamos there will be used in connection with the supply to be taken from the tramways department during the coming winter. The total available horse-power of the steam plant in the stations as at the close of this financial year was, therefore, 17,580, but before the winter demand comes on, the 750-h.p. engine now being erected at Pollokshaws-road and the further supply from the tramways department will be available, and will bring up the horse-power of the whole undertaking to 22,330. Under the arrangement entered into with the Corporation tramways department on April 10, 1902, by which a supply during the heavy demand experienced in the winter afternoons can be given from some

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of the spare plant of that department, 150,096 units were taken at Pollokshaws-road works at a total cost of £1,007. 10s. 4d. A further arrangement has this year been entered into with the tramways department by which an additional supply will be given from Pinkston-station into Waterloo-street station at a pressure of 6,500 volts, and be there transformed by induction motors, in connection with the six existing dynamos before mentioned, to a pressure of 500 volts. The subject of hiring out of motors, powers for which have been conferred by Parliament on the electricity department, as noticed in last year's report, is now under the consideration of a special sub-committee, who hope to be able to furnish a report thereon at an early date.

Below we give abstracts for the accounts for the year ended May 31 last, the capital expenditure on which date totalled to £1,041,745.

Dr. Revenue Account.	£	s.	d.
Coal or other fuel	11,363	9	6
Oil and engine-room stores	2,143	6	3
Salaries of superintendents at works	266	8	9
Wages at generating stations	6,475	17	3
Carting account	481	16	3
Repairs and maintenance	5,622	2	10
Corporation tramways department	1,007	10	4
Repairs of mains, cables, etc.	6,003	11	3
Repairs of meters, etc.	972	2	0
Salaries of surveyors	1,303	11	3
Attending and repairing public lamps	2,559	1	6
Rents and feu duties	1,309	8	1
Rates, taxes, and assessments	5,005	1	5
Salaries—Engineer's department	2,778	12	2
Treasurer's department	1,267	10	0
General establishment charges	1,604	4	0
Stationery, printing, advertising, etc.	975	6	9
Special charges	7,528	18	9
	58,667	18	4
Depreciation on works, machinery, mains, etc.	37,185	10	6
	95,853	8	10
Balance carried to profit and loss account	31,150	17	8
	£127,004	6	6

Cr.	£	s.	d.
Sale of current per meter	118,844	13	0
Public lighting	8,159	13	6
	£127,004	6	6

Dr. General Balance-Sheet.	£	s.	d.
Capital account	1,087,000	0	0
Deposits in security of electricity rents	409	0	0
Balance due to bank	11,927	3	5
Accounts due to sundry tradesmen and others	12,632	11	1
Sinking fund	49,693	0	7
	£1,161,661	15	1

Cr.	£	s.	d.
Capital account	1,041,745	14	2
Outstanding revenue assets	18,756	5	1
Stocks on hand	33,697	11	3
Sinking fund, invested	49,693	0	7
Suspense account	4,868	17	11
Gas department—balance due on current account	12,900	6	1
	£1,161,661	15	1

Statement of Electricity Generated, Sold, etc.

Quantity generated in B.T. units		13,197,612
Quantity sold: Private consumers	10,419,488	
Quantity sold: Public lamps	1,064,404	
Quantity sold: By contract	17,432	11,501,324
Quantity used on works		745,801
Total quantity accounted for		12,247,125
Quantity not accounted for		950,487
Number of public lamps		719
Total maximum supply demanded (kilowatts)		20,183

MEXBOROUGH ELECTRICITY ACCOUNTS.

From the accounts of the Mexborough urban district electricity works for the first 10 months' working up to March 31, 1903, it appears that the total expenditure on capital account amounted to £16,164. Herewith are given abstracts of the revenue account, general balance-sheet, and statement of electricity generated, sold, etc.

Revenue Account.

Dr. Expenditure.	£	s.	d.
Generation of electricity	583	10	10
Distribution of electricity	9	9	9
Attending and repairs to public lamps	68	4	7
Management expenses and establishment charges	170	8	4
Total expenditure	831	13	6
Balance carried to net revenue account	380	4	0
	£1,211	17	6

Cr. Receipts.	£	s.	d.
Sale of current per meter, less allowances	565	5	0
Public lighting	645	19	0
Stores sold	0	13	6
	£1,211	17	6

General Balance-Sheet.

Dr. Liabilities.	£	s.	d.
Capital account—amount received	15,529	17	0
Sundry creditors (including contractors)	786	2	9
Provision for interest accrued	181	12	10
Wages unpaid and clerk and surveyor's balances	5	10	10
Instalments of principal paid to date	514	13	0
	£17,017	16	5

Cr. Assets.	£	s.	d.
Capital account—amount expended for works	16,164	6	0
Stores on hand	58	12	6
Sundry debtors for current supplied	193	10	11
Cash with treasurer	398	10	8
General account—current for public lighting etc.	32	19	10
Net revenue account—balance (deficit)	169	16	6
	£17,017	16	5

Statement of Electricity Generated, Sold, etc.

Quantity generated in B.T. units		116,323
Quantity sold: Public lamps	73,100	
Quantity sold: Private consumers by meter	29,339	102,439
Quantity used on works		1,800
Total quantity accounted for		104,239
Quantity not accounted for		12,084
Total maximum supply demanded (kilowatts)		115·5

Number of public lamps: 15 arcs, 226 incandescents.

TRADE NOTICES AND NOVELTIES.

Rectifiers.

We have received from Messrs. Siemens Bros. and Co., Limited, 12, Queen Anne's-gate, Westminster, S.W., a pamphlet dealing with a type of rectifier (Koch's system) supplied by them for transforming alternating into direct current. The principle of the apparatus is described as follows: In rectifying an alternating current of any ordinary periodicity by means of a commutator rotating synchronously

Fig. 1.

with it, a pulsating direct current is produced of the form shown in Fig. 1. If this current is used for charging accumulators, the "makes" and "breaks," occurring twice in each alternating period, must be so timed as to close the circuit and keep it closed only when the impressed voltage exceeds that of the battery, in which case the charging current will assume the form shown by the full-

Fig. 2.

full-lined curve in Fig. 2, the line *a b* indicating the voltage of the battery. In actual work, however, it is practically impossible to effect the "makes" and "breaks" with a rotating commutator at the instant when the impressed voltage equals that of the battery, and for that reason the rectification of heavy currents by such means causes excessive sparking at the contacts, requiring constant supervision and entailing great loss of

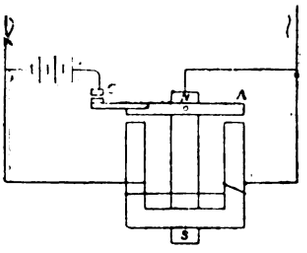

Fig. 3.

efficiency and quick destruction of the commutator. Koch's rectifier consists of a vibratory synchronous interrupter resembling in external appearance a polarised relay constructed for heavy currents and quick action. The arrangement is shown diagrammatically and in principle in Fig. 3. If the polarised interrupter is excited by an alternating current of any ordinary periodicity, its armature, A, if of suitable design, will vibrate

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synchronously with the phase of the current, and the current entering by contact C, which is of like phase, will be interrupted and restored once in each period. Owing to the self-induction of the coils of the interrupter, the hysteresis of the iron and the inertia of the armature, the phase of the armature lags behind the phase of the current as shown in Fig. 4. The con-

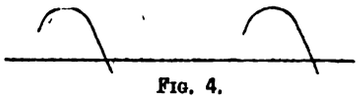

FIG. 4.

tacts may, however, be rendered sparkless by putting in series with the coils of the interrupter a condenser, G (Fig. 7), of such a capacity as not only to neutralise the self-induction of the coils, but to bring the phase of the exciting current in advance of that of the main current. This counteracts the hysteresis of the iron and the inertia of the armature and gives the curve of current the form shown in Fig. 5—viz., that of a pulsating intermittent current in which the "makes" and "breaks" occur exactly at the zero points. To make the rectified current serviceable for charging accumulators, the magnets of the interrupter must be provided with a second winding, so connected up to the battery that the

FIG. 5.

voltage of the latter opposes the current induced by the charging impulses. If this secondary winding is properly proportioned, only the excess voltage closes the contact against the potential of the battery, and an entirely automatic adjustment of the interrupter for all battery voltages is obtained. To avoid the troublesome "tuning" of the condenser, it is better to use one of relatively small capacity and to correct the excessive lead resulting therefrom by placing in the circuit a phase regulator, H, consisting of a coil of variable self-induction. The interrupter can be easily made sparkless by adjusting the position of the core of this bobbin, and it maintains its sparklessness when the fluctuations of potential

FIG. 6

in the alternating circuit are very considerable. If the potential of the battery approximates to the mean potential of the alternating current, the "closed" period is very short compared with the "open" period, and the armature, therefore, has a very jerky motion, liable to cause interruptions. To remedy this, a choking coil, D, of a moderate inductance, may be inserted between the alternator and the apparatus, which, having practically no effect upon the very weak current flowing in the exciting circuit during the "open" period, causes during the "closed" period—*i.e.*, during the period of load—a displacement of phase in the whole apparatus, and, therefore, a distortion (lengthening) of the charging impulse with respect

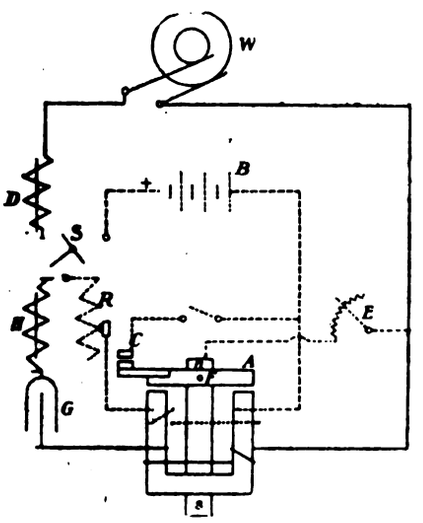

FIG. 7.

to time. Fig. 6 shows the shape of the curve of current with and without the use of the choking coil, the application of which, as will be seen, produces "open" and "closed" periods of the same length of time. Since the choking coil is placed in series with the apparatus, it affects during the "closed" periods the main and exciting currents in exactly the same way. The efficiency of the apparatus is the greater the nearer the potential of the battery equals the mean of the potential of the alternating current. Fig. 7 is a diagrammatic illustration of the apparatus, in which the dotted lines show the direct-current circuit; W is an alternator, D a choking coil, S a three-pole switch which closes simultaneously the circuit to the positive pole of the battery, B, and to the magnet coils of the interrupter. It also puts the secondary coils of the magnet in circuit with the battery. E is a starter, F the pivot of the armature A, and C the contact of the interrupter. R is an adjustable resistance, G the condenser, and H a phase regulator with variable self-induction. Following the above description are illustrations and particulars of some of the rectifiers which have been constructed on this system for charging batteries, working induction coils, and other purposes. With these we hope to deal in a subsequent issue.

Simplex Conduit.

From the Simplex Steel Conduit Company, Limited, Westinghouse Building, Norfolk-street, Strand, W.C., we have received a copy of their abridged price-list, just issued, with which is bound up a reprint of the new Institution of Electrical Engineers' wiring rules. This list is issued in conjunction with the firm's 200-page 1903 catalogue. It contains all prices in a con-

IG. 1.

FIG. 2.

densed form, with reduced illustrations. We note that two additional types of conduit are now listed to meet special requirements—viz., Simplex "Wireduct" and Simplex "Solid-Drawn" conduits, pp. 4 and 5. The first of the illustrations herewith shows one of the firm's lampholder fittings, with rosette attached; and the second their hand lamp for car-sheds, inspection pits, etc.

LEGAL INTELLIGENCE.

STEWART ELECTRICAL SYNDICATE.

Sitting as vacation judge on Wednesday, Mr. Justice Walton heard the case of Wells *v.* the Stewart Electrical Syndicate, Limited. It was a motion which was before his Lordship at the last sitting in a debenture-holder's action for the appointment of a receiver and manager. The syndicate was registered in 1896, and under their powers they, in October, 1898, issued a debenture bond for £2,200, which is held by the plaintiff. On May 18 a resolution was passed for winding up, and Mr. G. S. Pitt was appointed as liquidator. As creditors were pressing, plaintiff asked that a receiver and manager be appointed, and the syndicate consenting his Lordship made the order, subject to the usual security.

Mr. Galbraith, for the plaintiff, said they were now in a position to treat the motion as trial of the action. He asked that his Lordship should make an order in the terms of the agreed minutes, and make a declaration to the effect that the plaintiff and other debenture holders were entitled to certain debenture charges. The company was in liquidation, and the gentleman who was appointed last week as receiver and manager, acting as liquidator, consented to the order asked for.

His Lordship granted the motion.

SPEED OF TRAMCARS.

On Saturday four drivers in the employment of the London United Electric Tramways Company appeared at West London Police Court to answer adjourned summonses taken out by Mr. Moffat Ford, managing director of the Motorcar Company, for driving their cars at a speed exceeding the 10 miles an hour limit laid down in the Board of Trade regulations.

At the first hearing of the case it was contended that the Board of Trade were not empowered to make regulations as regards speed, but Mr. Muir, for the tramways company, now stated that the defence raised no point of law.

Mr. Ford stated that he timed the cars with a stop-watch over a measured distance of a furlong, and found they were going from 15½ to 17 miles an hour. He had previously gone to the police, but they refused to co-operate with him, telling him that they had had experience of the electric cars for two years, and considered that they were being run with perfect safety.

In cross-examination by Mr. Muir, the witness admitted that he himself had been convicted of driving his motorcar at an excessive

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speed. He had on occasion considered that he was convicted unjustly, but he had never gone into the witness box to refute the police evidence. His object in taking out the present summonses was to make the cars go at the speed laid down in the Board of Trade regulations, and then the man in the street would be able to appreciate what a snail's pace 10 miles an hour really was.

Mr. Muir: Then your real ultimate object is to increase the speed of the cars?

Mr. Ford: My object is to make the company go at the regulation speed.

Mr. Muir, in defence, said the tramway company could conclusively prove that none of the cars timed by the prosecutor could go at a greater speed than 13 miles an hour, and he suggested that an independent test might be made by an official of the Board of Trade for the benefit of the Court.

The **Magistrate** said the matter was an important one, and he thought the learned counsel's suggestion a good one. He adjourned the summonses in order that an official test might be made.

POWERS OF A TELEPHONE COMPANY.

Judge Lumley Smith, K.C., has delivered a considered judgment in the City of London Court in an action brought by Mr. Henry Lazarus, of The Hermitage, Bushey Heath, against the National Telephone Company for damages for wrongfully cutting off his telephone service. According to the plaintiff's case, he became a subscriber three years ago to the defendants' service for one year, and he paid a fixed rent charge of £3. 10s. a year. The company wanted to introduce a new method of payment, and as the plaintiff would not agree the service was cut off.

His Honour said in his opinion the approval of the Telephone Company was requisite at the commencement of each year to enable the hiring to continue. The defendants did not approve of a continuance after the third year, and were not bound to continue. No notice was stipulated for, but as the Telephone Company had decided to make a change in their terms a considerable time before the expiration of the third year, they might reasonably have given the plaintiff more than the few days' notice which they did give him. The action failed, but he would give leave to appeal. As the legal aspect was doubtful, he should order each party to pay their own costs.

COMPANIES' MEETINGS AND REPORTS.

GEORGE M. CALLENDER.

The statutory meeting of the shareholders in this Company was held at the Westminster Palace Hotel, Victoria-street, S.W., on the 20th inst., Mr. George M. Callender presiding.

The **Chairman,** addressing the shareholders, said the Company's prospectus was publicly advertised on April 6 and 8 inviting applications for an issue of 25,000 6 per cent. cumulative preference shares. The total amount received on account of the shares to the date of our report—namely, July 25—was £18,941, leaving £6,059 still to be paid at that date. Since then a substantial sum had been received, and it was expected that by the end of the present month there would be nothing outstanding. Owing to the receipt of some special cablegrams from South Africa with reference to important business to be done by them in that part of the world, it was decided that he should proceed there immediately after the allotment, which he did, and he only arrived home on Saturday last. During his absence it was thought advisable that another London director should be added to the Board, and after careful consideration and mature deliberation, Mr. Allan Greenwell, A.M.I.C.E., a well-known engineer, was appointed to that position, and his services during the last three months had been of great benefit to the Company. The prospects of business in South Africa were very encouraging, but at the moment the financial condition of that country did not warrant any extensive outlay. Apart from this, he thought that as soon as the controllers of the large mining groups on the Rand saw their way to start work on the large number of mines which had been closed down, there would be a great deal of work for them to do there. All the gold mines on the Rand were forced to have reservoirs and cooling ponds for conserving the water required for the cyanide. The sales of their pure bitumen damp-course had been moving along in a perfectly satisfactory manner. The new works at Bow had been delayed in their completion. However, the principal building would be ready for occupation this week, and they were now making arrangements for transferring the necessary plant from Callender's Cable and Construction Company's works at Belvedere, Kent, to their works at Bow. Concluding, the chairman said they were now in a position, not only to line reservoirs, but also to take over the whole work of constructing and maintaining same, and several works of this nature had been carried out, and had resulted in increased profit to the Company.

The proceedings terminated.

TYNESIDE TRAMWAYS AND TRAMROADS.

The half-yearly meeting of the shareholders in this Company was held at the offices, Newcastle, on Monday. Lord Armstrong presided.

The directors' report stated that the surplus of receipts over expenses amounted to £1,198. 7s. 6d., which, together with the balance carried forward from last year—viz., £233. 5s. 9d.—made a total to the credit of the profit and loss account of £1,431. 13s. 3d. Out of this the directors proposed the payment of a dividend at the rate of 2 per cent. per annum, less income tax, which would leave £326. 18s. to be carried forward. The extension between St. Nicholas Church and the High-street, Gosforth, was opened for traffic on April 10. As the extension of the Newcastle-upon-Tyne Corporation tramways along Shields-road from Heaton to the Wallsend boundary had only been completed for a few weeks, it was too soon to come to any conclusion as to the effect it might have upon the Company's lines. The traffic receipts showed a steady and satisfactory increase. The directors had authorised the construction of the line along the North-road to Gosforth Park, and for this work plans and specifications were now being prepared.

The **Chairman** moved the adoption of the reports. He thought they would agree with him that the balance-sheet of this, their first complete half-year of operation, was a satisfactory one, and indicated material progress. Regarding the question of interchange of traffic, he was glad to say that the Tynemouth Tramways Company had now obtained a Bill to enable them to lay a third rail from Borough-road to the Company's terminus, thus facilitating the transference of passengers from this system to theirs and *vice versâ*. With regard to Newcastle, on the other hand, it was common property that the Corporation of Wallsend had called upon their Company, in pursuance of an arrangement made with them when they were making application for the first Bill, to enter into active negotiations with the Corporation of Newcastle for mutual running power, and if these could be otherwise obtained to endeavour to get parliamentary powers for them in the ensuing session. This Company had informed the Corporation of Wallsend that they had been for some time past in active negotiations on the subject with the Corporation of Newcastle, and they had every hope that the matter might be concluded to the advantage of both the Newcastle Corporation and this Company, without the necessity of any parliamentary interference. For the future, without venturing to prophesy, he might say that there was every reason to hope that they would continue to make steady and material progress.

Dr. Merz seconded, and the resolution was carried unanimously.

The **Chairman** moved that a dividend of 2 per cent., free from income tax, be declared.

Mr. J. H. Armstrong seconded, and the resolution was also carried *nem. con.*

DUBLIN AND LUCAN ELECTRIC RAILWAY.

The ordinary half-yearly meeting of the shareholders in this Company was held at the Company's offices, Mr. James Wm. Hill, J.P., presiding.

The **Chairman,** in moving the adoption of the report, said that, as compared with the corresponding period of last year, there was an increase in the receipts of £60 from passenger and £80 from goods traffic. There was a decrease in parcels and sundries of £17. The net increase was about £61. The expenditure showed an increase in the maintenance of way of £39, of motive power of £71 and the other items of carriage and wagon repairs brought the total increase to £217. If the summer had been favourable there would have been a very considerable increase of receipts, but as it was, they ought to be satisfied that they had fully held their own, and were able to show an increase—even slight.

Captain Charles Colthurst-Vesey seconded the adoption of the report, which was unanimously carried.

The **Chairman** proposed and **Mr. William F. Clarke, C.E.,** seconded a resolution declaring that a dividend of 5 per cent. per annum be paid on the preference shares.

The resolution was adopted.

BLACKPOOL AND FLEETWOOD TRAMROAD.

The half-yearly meeting of the shareholders in this Company was held on Thursday afternoon last week, Mr. Geo. Richardson presiding.

In moving the adoption of the report and balance-sheet, the **Chairman** said he thought the shareholders would agree with the Board that they were very satisfactory. They had carried for the half-year 789,020 passengers, an increase of 109,280. The receipts from all sources were £10,748. 3s. 1d., as against £9,940. 19s. 4d., being an increase of £807. 3s. 9d. On turning to the revenue account they found an increase in income of £789. 2s. 8d., but on the other side there was an increase in expenses of £473. That was accounted for by a compensation case in which £300 had been paid, and also by an increase in the amount of rates and taxes.

Mr. Barningham seconded, and the resolution was carried unanimously.

NEW COMPANIES REGISTERED.

International Sprinkler Company, Limited.—Capital, £100. Object: to carry on the business of mechanical and electrical engineers, etc.

Carlton Motor Company, Limited.—Capital, £800. Objects: to manufacture and deal in motors, cycles, automobiles, and locomotives or stationary engines of every description, and to carry on the business of electrical engineers, manufacturers of, dealers in and generators, storers and suppliers of electrical and other power, etc.

Sybry, Searls, and Co., Limited, Cannon Steelworks, Sheffield. This business, which was established more than half a century ago, has been converted into a private limited liability company. The managing directorship has been taken up by Mr. Victor F. J. Tlach, for many years intimately connected with Messrs. Bohler Bros. and Co., Styrian Steelworks, Sheffield, and he will be joined on the Board by Mr. Edward C. Ibbotson, F.C.S., who will undertake the management of the works.

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CONTRACTS FOR ELECTRICAL SUPPLIES.

Macao.—The Colonial Office at Lisbon invite tenders for the electric lighting of Macao. Tenders by Oct. 21.

Lisbon.—The Public Works Department require tenders for the public electric lighting of Macao. Tenders by Oct. 21.

Queensland.—The Deputy Postmaster-General at Brisbane invites tenders for the supply of material for the postal and telegraph service by Sept. 30.

Paris.—The Post and Telegraph Department, Rue de Grenelles 103, invite tenders for (1) 190,000 ko. bronze or copper wire and 94,000 joints, and (2) 12 kilometre submarine telegraph cable.

Beszterezehanya (Neusohl, Austria).—Tenders are required by the municipality for installation, buildings, etc., of a central station of a minimum capacity of 600 h.p. Tenders by Aug. 31.

Kirkealdy.—The Corporation invite tenders for supply of all fittings for installing the electric light into the memorial halls in Bennochy-road. Tenders by Sept. 12. See advertisement.

Madrid.—The Post and Telegraph Department require tenders for a telephone system in communication with the principal central station in San Lorenzo del Escorial and sub-central stations in Cercedilla. Tenders by Sept. 6.

Dublin.—The Port and Docks Board invite tenders for the supply of a 100-ton electric crane. Specification can be obtained at the office of the engineer to the Board, Mr. John P. Griffith, M.I.C.E., Eastwall, Dublin. Tenders by Oct. 5.

Hackney.—The Council invite tenders for arc lamps and pillars and distributing mains. Forms of tender, etc., may be inspected at the office of Mr. Robert Hammond, M.I.C.E., 64, Victoria-street, Westminster, S.W. Tenders by 4 p.m. on 31st inst.

Linlithgow.—The County Council invite tenders for lighting the Uphall special lighting district by electricity. A plan will be exhibited in the office of Mr. J. G. B. Henderson, district clerk, Linlithgow, from whom all particulars may be obtained.

Worthing.—The Corporation invite tenders for the reconstruction of their storage battery at the electricity works. Specification of the work can be obtained from Messrs. Burstall and Monkhouse, 14, Old Queen-street, Westminster. Tenders by Sept. 7. See advertisement.

Shanghai.—The French Colony propose to instal motor-propelled tramways. Tenders may be sent by Oct. 31, 1903, to Secrétariat de la Municipalité Française de Shanghai. Particulars may be obtained from l'Office National du Commerce Extérieur, Rue Feydeau, 3, Paris.

Russia.—The Russian Minister of the Interior has sanctioned a plan for the reconstruction of three lines of municipal tramways—namely, those in Newsky, Sadovaïa, and Wassiliostrow districts. Each car is to provide for two classes of travellers, and will accommodate 52 persons.

Utrecht.—The Town Council will receive tenders for supply and erection of a central electric establishment for lighting, power supply, and working tramways. Contract, conditions, etc., to be obtained at the "Gemeente Secretaire" of Utrecht, on payment of 5fl. (8s. 4d.). Tenders by Oct. 1.

Radcliffe.—The Urban District Council invite tenders for the supply and laying of tramway and lighting feeders, distributing and pilot cables, conduits and accessories. Specification, etc., may be obtained from Mr. S. Mills, clerk to the Council. Tenders by Sept. 5. See advertisement.

Southend-on-Sea.—The Corporation invite tenders for steam dynamo, boiler, and condenser. Specification, etc., may be obtained from Mr. W. E. J. Heenan, M.I.E.E., borough electrical engineer and general manager, Southend-on-Sea. Tenders by noon on Sept. 14. See advertisement.

Bermondsey.—The Borough Council invite tenders for the erection of buildings in connection with extensions to the dust destructor house, electric light station, boiler-house, etc., at the Council's works near of town hall. Specifications, etc., can be obtained at the Town Hall, Spa-road, S.E. Tenders by Sept. 8.

Launceston (Tasmania).—The Mayor and Aldermen invite tenders for the supply of 500 or more electric meters. Particulars may be obtained on application to Mr. William Corin, city electrical engineer, Launceston, Tasmania, or to Messrs. John Terry and Co., 7, Great Winchester-street, London, E.C. Tenders by Sept. 28.

Madrid.—Tenders are invited for a concession for a telephone system with a central station at Palamós and subsidiary stations at San Feliú de Guixols and Palafrugell. A deposit of 2,000 pesetas is required, and tenders must be presented within 30 days from Aug. 14 to the Registry of the Directorate of Posts and Telegraphs, 10, Calle de Carretas, Madrid.

Manchester.—For the supply of points and crossings, for the Tramways Committee. Specifications, etc., may be obtained from Mr. J. M. M'Elroy, general manager, Tramways Department, 55, Piccadilly, Manchester. Tenders, addressed to the Chairman of the Tramways Committee, 55, Piccadilly, Manchester, must be received by 1 p.m. on 29th inst.

Pietermaritzburg.—The Corporation invite tenders for the supply, delivery, and erection of the necessary poles and overhead equipment for about 5¼ miles of tramway route. Specifications may be seen at Messrs. Mordey and Dawbarn, 82, Victoria-street, S.W. Tenders to Messrs. Ford Bros., 12, Southampton-street, Fitzroy-square, W., by Sept. 7 (noon).

Edinburgh.—The Council invite tenders for the following works in connection with the proposed extension of Macdonald-road electric power station; (1) building works, including excavator, mason, brick, joiner, slater, plasterer, plumber, and glazier's work; and (2) smith and ironfounder's work. Tenders must be sent to Mr. R. Morham, city architect, by 10 a.m. on Sept. 14.

London, S.E.—The London County Council invite tenders for the supply, delivery, and erection in the electricity generating station to be established by the Council at Greenwich of four 5,000-h.p. vertical-horizontal steam-engines, each suitable for driving a three-phase generator. Particulars, etc., may be obtained at the County Hall, Spring-gardens, S.W. Tenders by 10 a.m. on Oct. 6.

Batley.—The Corporation invite tenders for the mason, joiner, plumber, plasterer, slater, painter, heating engineer, and electric lighting engineer's work respectively, in erection and completion of additions to the present town hall. Plans and specifications, etc., can be seen, and bills of quantities obtained at the offices of Messrs. Walter Hanstock and Son, architects, Branch-road, Batley. Tenders to be sent to Mr. J. H. Craik, town clerk, by noon on Sept. 4.

Birmingham.—The Tramways Committee require the names of contractors who are desirous of tendering for the supply and delivery of materials and fittings as follows: (Section A) manganese steel points and crossings; (B) tapered steel side poles and bracket arms; (C) suspension ears, pull-offs, section insulators, and other overhead materials; (D) hard-drawn copper trolley wire and stranded steel span wire. Mr. John Price, city engineer, Council House, Birmingham.

Stoke-upon-Trent.—The Corporation invite tenders for the supply and erection of the following plant in connection with the proposed electricity and destructor works: (Contract 10, Section A) pipework; (B) non-conducting covering; (C) water-softening plant. Persons are at liberty to tender for any single section. Specifications, etc., can be obtained from Mr. P. J. S. Tiddeman, Field-place, Stoke-upon-Trent. Tenders to Mr. Jno. B. Ashwell, town clerk, Town Hall, Stoke-upon-Trent, by 5 p.m. on Sept. 11.

RESULTS OF TENDERS.

Bray.—The Urban District Council have accepted the tender of Mr. Fraser for bridging culvert at electric light works, at £22. 5s.

Grimsby.—The tender of Messrs. Hewins and Goodhand for the building of the new sub-balancing stations in Riby square for £589 has been accepted.

London.—The British Thomson-Houston Company have received the contract for the entire electric control equipments of the Metropolitan District Railway.

Aberdeen.—The County Council have accepted the tender of Mr. J. F. Anderson, at £109, for the work of fitting up the County Buildings with electric light.

Cardiff.—The tender of Messrs Beames and Nephew, Violet-row, at £1,972. 10s., for new electrical department for lupus treatment, etc., at the infirmary, has been accepted.

Dewsbury.—The Town Council have accepted the tender of Messrs. Robb and Mitchell, Ossett, at £634. 17s. 4d., for electric mains and switchboard at the new infectious diseases hospital.

Brighton.—The Town Council have accepted the tender of the Reason Manufacturing Company, Lewes-road, for the supply of meters for one year from Sept. 1, at £2. 5s. per meter for siphon-tube type, and £1. 17s. for single-tube type.

Ipswich.—The Town Council have accepted the tenders of the British Westinghouse Electric and Manufacturing Company for the supply of a combined motor watering and track-cleansing car at £864. 6s., and for a telescopic car and breakdown wagon at £70.

Crete.—Several tenders have already been received for the electric lighting of Canea, including one from a German resident in the town, specifying not only the electric lighting of Canea, but also an electric train between Canea and Halepa, and a possible extension to Suda.

BUSINESS NOTES.

TRACTION.

Bournemouth.—The Corporation Tramways Bill has received the Royal assent.

Axminster and Lyme Regis Light Railway.—This line was opened on Monday.

Brighton.—It is proposed to lay tramways at an early date on the Dyke-road and North-road routes.

Tanat Valley Light Railway.—Monday, Oct. 1, has been provisionally fixed for the formal opening of this railway.

South London.—The electrification of the London County Council tramway through Southwark to Greenwich is now rapidly approaching completion.

Keighley.—The Tramways Committee suggest that double lines be laid the whole length of the route in the reconstruction and extension of the tramways to Stockbridge.

Rochdale.—The negotiations between the local authorities and the Bury, Rochdale, and Oldham Tramways Company are reported to have ended without an agreement having been come to.

Bradford.—Mr. Spencer, the manager, has submitted proposals, which have been approved by a sub-committee, with a view to meeting certain grievances which the men desire remedying.

Central Wilts.—The Light Railway Commissioners are expected to hold an enquiry at the end of September or the beginning of October into the application for a light railway order for this district.

London County Council Tramways Manager.—Over 100 applications have been received by the London County Council for the vacant post of manager for their tramway system in South London.

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Leeds.—The Tramways Committee are encouraging their motormen to drive carefully, having decided to give all drivers who avoid accidents a bonus of ½d. per hour in addition to their wages, payable quarterly.

Leith.—A large meeting of merchants was held on Thesday afternoon, when a resolution was passed by an overwhelming majority urging the Town Council to complete the purchase of the tramway system in the burgh.

Audenshaw.—The work of laying the track for the electric cars from Audenshaw to Ashton is proceeding satisfactorily, and in a very short time there will be a thorough system of electric trams from Ashton to Manchester.

Rowley Regis.—The Light Railway Commissioners have submitted to the Board of Trade for confirmation an order made by them for the construction of light railways in the urban districts of Quarry Bank, Brierley Hill, and Rowley Regis.

Wrekenton.—Considerable interest has been aroused in the district by the running of a trial tramcar. The lines are almost completed; only the sidings want finishing. It is expected that the trams will be in full swing early in September.

Ilford.—During the week the first of the roofed tramcars which are to be introduced to London by the District Council will be running. The covers are of wood, with glass ends and movable glass sides. Smoking is to be permitted within the structure.

Aberdeen.—The Town Council have by 22 votes to 8 adopted the Tramways Committee's report, recommending that ½d. fares should be introduced in Union-street in two blocks—from Castle-street to Crown-street and from Crown-street to Holburn-street.

Birkenshaw.—It was reported at the last meeting of the District Council that the British Electric Traction Company had placed the order for the construction of the lines in Birkenshaw, and that they had agreed to use granite setts for the paving in the district.

Motorcabs.—The London Express Motor Service, Limited, have decided to place 50 motor-driven hansom cabs on the streets of London in about three months' time. The new cab has a 12-h.p. petrol motor, and is geared to travel at a speed not exceeding 24 miles an hour.

Lowestoft.—Since the opening day (July 22) the trams have carried 396,859 passengers, and the receipts have been £1,909. 3s. 4d. Last week's receipts amounted to £363, and 79,708 passengers were carried, a slight falling off from the previous week's figures, due to the bad weather.

German Rails.—A councillor has given notice of a motion which he will move at the next meeting of the Birmingham City Council in October, regretting that the Tramway Committee have thought it necessary to purchase tramrails from abroad at a time when the British industries need support.

Southsea.—The abnormal downpour of rain at the beginning of the week was responsible for considerable dislocation of the electric tramway traffic, several of the main streets being flooded. On some routes the service had to be temporarily stopped, and on others a through service was only maintained with difficulty.

Italian Railways.—A Rome correspondent says that the railway between Milan and Varese has been adapted for electric working, and a few experimental runs have been made at a speed in places of 72 miles an hour. The Mediterranean Company is shortly to establish a regular service covering the distance in 45 minutes.

Kirkcaldy.—The new electric cars for the extended route have now been delivered, and are running at intervals on the initial route with satisfactory results. The cars, five in number, are slightly different in construction from those previously running. The new route is expected to be opened about the middle of October. The route will be lighted by arc lamps.

Inquest.—Mr. J. F. Price, county coroner, has held an enquiry into the circumstances attending the death of Robert Smith, a child three years of age, who was killed by an electric car in Failsworth on Sunday night. The jury returned a verdict of accidental death, suggesting that the Corporation should be recommended to have more effective guards on the cars.

Bury.—A special meeting of the Town Council has been held for the purpose of passing a resolution authorising notice to be given to the Bury, Rochdale, and Oldham Tramway Company requiring the company to sell those portions of their undertaking within the borough which were authorised under the extension order of 1882. The resolution was adopted.

West Cumberland.—At the last meeting of the Egremont Urban District Council the clerk said he had received a copy of the West Cumberland Tramways Act. They petitioned against the Bill, and he was pleased to say the clauses that they agreed upon had been inserted. They might look upon it as very satisfactory. They had reduced the charge for electricity from 7d. to 3d. per unit.

Paris Metropolitan.—A Paris telegram dated Aug. 21 states that a short-circuit occurred on the Metropolitan Railway the previous night on train No. 48, which was one of those concerned in last week's disaster. As soon as the defect was noticed the train was emptied, but most of the passengers, instead of waiting for the next train, left the station, preferring to continue their journey by omnibus.

Glasgow.—A mass meeting of Corporation tramway workers was held at midnight on Saturday to discuss the refusal of the Tramways Committee to recognise the union and the rejection by the committee of the application by the men regarding working hours and extra payment for Sunday labour. Resolutions were adopted in favour of again approaching the committee urging them to recognise the union.

Rio de Janeiro.—Dr. Carlos Cesar de Oliveira Sampaio and Antonio Julio de Oliveira Sampaio have obtained a concession for the construction and working of a metre-gauge underground electric railway from Rio de Janeiro to Nitheroy. Amongst the provisions of the concession is the exemption from import duties of the material for the construction of the railway and for the first three years of its working.

Eastbourne.—Already two motor 'buses of the Milnes-Daimler type are running on the streets of this fashionable seaside resort, and another vehicle was expected to be delivered this week. A fourth 'bus may be expected shortly, the Electric Lighting Committee having arranged with the company for its early delivery. The new 'buses will have twin tyres, the single tyres on the first vehicle not having proved altogether satisfactory.

Dewsbury.—The electric cars from Dewsbury to Cleckheaton market-place, *via* Heckmondwike and Liversedge, have commenced running. At a meeting of the General Purposes Committee it was stated that after conferences of representatives of the Dewsbury and Ossett Corporations and the Soothill Nether District Council, a proposal in favour of constructing an electric tramway between Ossett and Dewsbury had been agreed upon.

Heywood.—A special meeting of the Town Council has been called for Sept. 28 for the purpose of taking into consideration a resolution that so much of the undertaking of the Bury, Rochdale, and Oldham Tramway Company, Limited, authorised by the Manchester, Bury, and Rochdale Tramways (Extension) Order, 1882, as is within the borough of Heywood shall be purchased by the Corporation on the terms specified in Section 43 of the Act.

Bankfoot Light Railway.—The Light Railway Commissioners have submitted to the Board of Trade for confirmation an order made by them reviving the powers granted and extending the period limited by the Bankfoot Light Railway Order, 1898, for the compulsory purchase of lands, and extending the period limited by that order for the completion of the railway and works by that order authorised. Objections must be lodged with the Board of Trade by Sept. 14 next.

Competition.—Mr. T. H. Jackson, speaking as chairman at the half-yearly meeting of the Wirral Railway Company, attributed the decrease in the passenger traffic to the competition of the electric tramways, through which the company had lost at least 25 per cent. of their New Brighton traffic. So far the electrified Mersey Railway had not brought them any great advantage. Mr. Jackson also hinted at the early adoption of self-propelled motors on the Wirral Railway.

Southport Railway.—The building of the transforming station which is being erected at Birkdale in connection with the electrification of the Lancashire and Yorkshire Railway line between Liverpool and Southport is now completed, and is waiting for machinery, which, it is expected, will arrive in about a fortnight. At the Formby power station the boilers are being placed in position. Gangs are working on the line itself both towards and away from Southport, and in about a fortnight the work on the line between Southport and Freshfield may be completed.

Motorcars on Railways.—The Great Western Railway Company have inaugurated a motorcar service between Helston and the Lizard. The cars are each of 16 h.p., and are known as the Constatt-Daimler, and are provided with Sims Bosch magneto ignition, with automatic inlet valve governed on the throttle. There are four gears and reverse, while the speed is from 16 to 4 miles per hour. The engine is fed with petrol from a tank at the back, capable of holding 14 gallons, sufficient for a journey of 140 or 150 miles. Each car, which costs £800, is capable of seating 20 persons, and weighs about two tons.

Northampton.—The work of converting the tramways to electr traction is being expedited as quickly as possible. The time for sending in tenders for the work expired on Saturday, and about 100 tenders have been received. The tenders cover the cost of generating stations, overhead equipment, the permanent way, the cars, cables, etc. The estimate of the surveyor (Mr. W. Fidler) in his original report on the work was that it would cost £85,000, and there is not much likelihood that this estimate will be exceeded. The Tramways Committee are not likely to arrive at a definite decision for about a fortnight.

Safety of the Tube.—Apropos of the Paris Tube disaster, the general manager of the Central London Railway has been explaining to a correspondent the safety precautions adopted on the "Twopenny Tube." We gather that it is proposed to equip the trains with telephones as an additional precaution, so that in case of accident the driver can communicate with the nearest station. It may be mentioned that the electric lighting of the tube is independent of the working current, so that in case of the current being cut off the illumination would remain. In addition, oil and gas are provided should the lighting current fail.

Electric Locomotives. — It is reported that the steamship "Roseley," which left New York recently for various South African ports, took out what will probably be the first electric locomotive to enter the "Dark Continent." The locomotive, which was manufactured by the C. W. Hunt Company, of West New Brighton, N.Y., is shipped to the order of the De Beers Consolidated Mines, Limited, for use on one of their plants. The locomotive, says *South African Exports*, is of the latest storage battery type, standard throughout, with the exception of the gauge of the wheels, which is special, to suit the track now in use at the mines.

Additional Traffic Returns.—Anglo-Argentine, £1,644 increase; Barcelona Ensanche y Gracia, £205 increase; Barcelona, £122 decrease; Brisbane, £34 increase (month of July, £10,160, increase £4); British Columbia Electric (month of March), gross earnings £10,352, net income £2,658; Buenos Ayres and Belgrano Electric, £322 increase (month of July, £13,269, increase £1,142); Calcutta, £471 increase; Cape Town (month of April), receipts £16,003, expenditure £8,313; Isle of Thanet Electric, £153 decrease; Mexico Electric (month of June), receipts £46,270; Perth Electric, £122 increase; Port Elizabeth (month of April), receipts £4,292, expenditure £2,281.

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Marlborough.—Upwards of £2,000 has been guaranteed in Marlborough and district towards the cost of the proposed light railway from Calne to Marlborough. The scheme is so framed that the line from Marlborough to Hungerford may be dropped if necessary. The Light Railway Commissioners are expected to hold their enquiry at the end of next month. Mr. Cecil Brown, the engineer, has succeeded in making an amicable arrangement with the landowners. The estimated cost of the line per mile from Calne to Marlborough is £10,500. An assurance has been given that providing the order is obtained there will be no difficulty in finding the capital.

Greenwich.—Addressing the shareholders at the half-yearly ordinary meeting of the London, Deptford, and Greenwich Tramways Company on Tuesday, Mr. George Ennis, alluding to the sale of the undertaking to the London County Council, stated that Sir Frederick Bramwell had been appointed arbitrator by the Board of Trade to settle the price to be paid by the County Council under Section 43 of the Tramways Act, 1870. It was expected that Sir Frederick, in whom both parties had every confidence, would hold his court in October, but no definite date had as yet been fixed. The Board would convey to the shareholders the rough result of the hearing at the earliest possible date, and at the next meeting they would, it was anticipated, be able to announce what the proprietors might expect to receive in the way of the return of capital.

Upper Norwood.—After opposing the introduction of tramways when first mooted, the people of Upper Norwood have suddenly changed their view, and are now clamouring loudly for their introduction. A canvass of the district recently made resulted in a majority of more than three to one in favour of an extension of the existing lines from Thornton Heath to Upper Norwood, and from Herne Hill to the Crystal Palace. Such extensions would put the people of the neighbourhood in tramway communication with the centre of London on one side, and with Croydon on the other, and render them less dependent than at present on a none too satisfactory train service. It has been resolved, subject to the Deptford and Lewisham Councils paying half the cost of widening the roads in their areas to proceed with the deferred tramway through Brockley from Lewisham to Forest Hill, which will also link up the Crystal Palace district by means of the South London system with Greenwich, Woolwich, and the riverside towns.

Portsmouth.—At the quarterly meeting of the Town Council the Tramways Committee presented a lengthy statement by Mr. Rotter with regard to the various tramway contracts. From this it appeared that a sum of over £27,000 had been spent in excess of the amounts originally sanctioned, and the total of the contracts was £378,425, of which £12,643. 11s. 10d. was still outstanding. Mr. Rotter's concluding remarks were as follows: "I should like to point out that this total is considerably less than my original estimate, which was for £402,050. This included an amount of £6,170 for a car-shed at East Southsea, which has not been used, and also a sum to cover general and engineering charges, alterations to pipes and mains, and other incidental works which could not be carried out under any contract nor estimated with any great degree of accuracy. The amount expended under this heading to date has been £10,306, so that, even after giving credit for these amounts, I can claim to have effected a saving of £7,149 on my estimate."

Liverpool.—A new form of cover for electric cars is being worked out by Mr. Bellamy on the lines of the original covers adopted on several of the Liverpool cars. The new cover is constructed on a framework similar to the old one, but, instead of the blinds closing in the sides of the upper deck, a series of windows is arranged which can be lowered or raised as necessity requires in the same way as the window of a railway carriage. The roof is formed of sliding wooden partitions, which are so constructed that there is no possibility of raindrops making their way through, and in bright, warm weather the sections can be opened so as to leave two-thirds of the roof of the car open. The improvement, both from the view of convenience and comfort, cannot fail to be appreciated. From the point of view of economy the improvement is also most satisfactory, as it can be fitted up at about three-fifths of the cost of the blinds formerly in use. The committee are so convinced of the utility and success of the new arrangement that they have ordered 20 cars to be fitted with it at Lambeth-road works, and these will be placed on the various routes in the city in the course of a few days.

Glossop.—The formal opening of the electric tramways took place in showery weather on Thursday last week, at noon. The lines are laid down on the single track and loop plan, and are 3½ miles in length, connecting Glossop with Hadfield, through Dinting, with a generating station between the two places. There is also a branch line of about three-quarters of a mile, running from the main route to Whitfield. The service will be a 15-minute one from the Hadfield terminus, and half-hourly from Whitfield and Old Glossop. Seven cars of the double-deck type will run. On Thursday the whole seven cars, gaily decorated, traversed the entire route, the first, or No. 1 car being driven by the Hon. Mrs. Hill-Wood, of Moorfield, who formally opened the service. Notwithstanding the heavy downpour, thousands of people thronged the streets to witness the opening. It is regarded as quite possible that in the near future Glossop will be placed in tramway communication with Manchester, a proposal having been put forward for the construction of a line connecting with the Godley and Hyde system. The tramways were opened for public traffic on Friday.

London Traffic.—At the half-yearly meeting of the London General Omnibus Company, the chairman (Mr. Alderman Pound) referred to what he called the "ill-considered schemes of municipal trading." The main question to be considered, he said, was: under what circumstances is a municipality to be allowed to go outside the province of government and enter into the arena of trade The unsoundness of the financial position created by municipalities, which had piled up debts of about 300 millions sterling on the security of the local rates, and which were increasing their indebtedness to an almost unlimited extent, had been apprehended by the controllers of the great banks. As regarded London traffic, the Alderman referred to the Royal Commission sitting on the subject, and said that on the members' return from their investigation of American traffic the omnibus traders would submit their solution of the problem of London traffic. They trusted that the members of the commission would recognise what the omnibus service had done, and could do, to facilitate intercommunication. At present the company had one motor omnibus, the license for which was under the consideration of the authorities. He trusted that at the next meeting he would be able to give the shareholders some account of its working. The two main points to consider on the subject of motors were safety and economy of working.

Birmingham.—A special meeting of the Tramways Committee was held on Wednesday, when Mr. Allen Baker, the newly-appointed engineer and general manager of the tramway scheme, was present, and was warmly welcomed. Tenders for the construction of the new tram-sheds in Elkington-street were examined. The committee also had under consideration the type of car to be used on the Aston line, and after a long discussion a definite choice was made. With regard to this point, Mr. Joseph Ansell and the engineer to the Aston Tramway Committee attended on behalf of the Aston District Council to arrange, as far as possible, for the adoption of a uniform type of car and rail in connection with the whole of the Aston route. The committee approved of a car similar in construction to that now in use on the Bristol-road route, with the exception that is is built on bogie trucks instead of on the four-wheel principle. At the close of the discussion, which lasted over two hours, Alderman Beale asked if there was anything to be said in regard to the German tramrail controversy. Mr. Beale said he could only say that the rails were being obtained from the well-known British firm of tramway contractors, Messrs. Dick, Kerr, and Co. "There is no doubt," added Mr. Beale, "that English manufacturers cannot turn out a tramrail equal to that obtainable from abroad at the price." If the City Council did not desire them to buy in the cheapest market, they must say so.

District Railway Electrification.—As will be seen from our "Tenders Accepted" columns, an important decision has been made by the Underground Electric Railways Company of London, Limited, in awarding the contract for the entire control equipments for their new electric trains on the Metropolitan District Railway to the British Thomson-Houston Company, Limited, of Rugby. The system to be employed is the Sprague Thomson-Houston multiple-unit system, with which an experimental train has been equipped on their newly-opened line from Ealing to Harrow, and on which, for over four months past, continuous experiments and competitive tests under special and normal conditions of traffic have been going on, to ascertain which of the two systems of control competing will best meet the various requirements of this railway, having due regard to the safety of passengers, reliability of control, economy of power, low cost of maintenance, comfort to passengers, and simplicity. After thoroughly weighing all these matters the contract was, as above mentioned, awarded to the British Thomson-Houston Company, Limited. It will be remembered that a somewhat similar series of tests were made before the decision was arrived at as to what system of control should be adopted on the New York underground railways, and the same system of multiple-unit train control was decided upon. This system may be considered as the universal system in use for operating electric railways, it being in use or contracted for by over 32 railways throughout the entire world, over 2,000 equipments being at present in use. The Metropolitan District Railway, in taking this step, have placed themselves in line with other English electric railways who have also adopted this system.

Fares in Glasgow.—An interesting report on the question of halfpenny tramway fares has been issued to the Corporation Tramways Committee by Mr. John Young, the general manager. As the outcome of enquiries addressed to over 50 corporation tramway managers throughout the country, he arrives at the conclusion that the opinion of the various corporations is not at present generally favourable to the adoption of halfpenny fares, although seven of them—including Glasgow—have such fares in operation over their whole systems; nine, including Leeds, Halifax, and Ilkeston, have halfpenny fares on certain stages; and four or five others issue halfpenny tickets to workmen. In Glasgow the halfpenny stage, which is about half a mile, was originally one-half of the penny stage, but subsequently the penny stage was doubled, while the halfpenny stages remained practically as they were originally fixed. Mr. Young gives figures showing that one-third of the passengers travel at the halfpenny fare, while the receipts from them are 18 per cent. Sixty-one per cent. of the passengers travel at the penny fare, the receipts from them being 69 per cent.; and 7 per cent. of the passengers travel at over the penny, the receipts from these being 13 per cent. The average fare collected per passenger at present is ·88d. Last year's accounts show that the average cost per passenger was ·75d., exactly three farthings. The profit is, therefore, only about one-eighth of a penny, which Mr. Young considers a narrow enough margin in a business of this kind. Investigation further shows, he says, that almost one-half of the penny passengers travel little more than a mile, or about the distance of two halfpenny stages. The immediate result, therefore, of doubling the halfpenny stage, as is proposed, would be to transfer about 54,000,000 million passengers from the penny to the halfpenny fare, with the consequence—taking the past year's experience as a basis—that not only would the surplus of £100,000 be wiped out, but the tramways would actually be carried on at a loss. Mr. Young accordingly recommends no change in the present stages and fares.

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Huddersfield.—The Tramways Committee, it will be remembered, were recently let in for some £1,700 damages as a consequence of an accident which occurred on their electric system. They have now sought to protect themselves against liability for such large sums, and visitors to Huddersfield may observe that notices are affixed to the seats of the cars, and to various other prominent positions, attempting to put a limit to their responsibility in cases of accident on the cars, etc. The notice, which is printed on the backs of the tickets also, reads as follows: "Important notice to passengers.—Issued at reduced fares and subject to the by-laws, and on condition that in case of injury from whatever cause arising the total liability of the Corporation shall not exceed £25. Except as above passengers travel at their own risk." In order to ascertain an opinion which might be regarded as fairly interpreting the law, a local resident recently put the case before the *Justice of the Peace*. The reply given in Saturday's issue of that journal is as follows: "The local authority being the owners of the tramways, and working them, are 'promoters' within Section 55 of the Tramways Act, 1870, and are under that section 'answerable for all accidents, damages, and injuries happening through their act or default, or through the act or default of any person in their employment, by reason or in consequence of any of their works or carriages.' This being a statutory obligation, the tramway authority cannot limit their liability in the case of passengers in the manner proposed. Even apart from Section 55, the tramway authority cannot except or limit their liability for negligence." The committee have instructed the manager to make arrangements for carrying a limited number of cycles by tramcars at owners' risk. At last week's meeting of the Town Council, attention was drawn to the fact that the tramways were being subsidised from the rates year by year, the amount this year being equal to 7d. in the £ Up to last year £58,683 had been drawn from the rates in support of this department. It was also complained that in revenue-producing undertakings there was only a balance of £37,000 to the good on a capital expenditure of over two million pounds.

LIGHTING AND GENERAL.

Buxton.—Tenders are to be obtained for pumps for the electricity station.

Limerick.—The Council have obtained sanction to borrow £60,000 for electric light.

Warrenpoint.—The Urban District Council have decided not to apply for an electric lighting order.

Brighton.—Sanction has been obtained to the borrowing of £550 for the purposes of the electricity undertaking.

Huddersfield.—The Town Council intend to apply for sanction to borrow £7,500 for supplying the township of Linthwaite with electrical energy.

British Insulated and Helsby Cables.—The directors have declared an interim dividend at the rate of 8 per cent. per annum on the ordinary shares.

Lowestoft.—An enquiry has been held into the Town Council's application for sanction to borrow £2,000 for laying of mains for private electric lighting.

Ossett.—The Town Council are negotiating for the purchase of Deanhead reservoir. Other expensive schemes are in view—viz., refuse destructor, electric light, and tramways.

Hull.—An enquiry has been held into the application of the Town Council for sanction to borrow £47,000 for the establishment of a telephonic system for the city and neighbourhood.

Grimsby.—The Great Central Railway Company has decided to illuminate the Grimsby fish pontoon by electricity. The company have their own generating station near the graving dock.

Londonderry.—The Corporation have decided to forward to the Lord-Lieutenant a protest against the action of the Board of Works refusing the Corporation a loan in connection with the private lighting scheme.

Quarry Bank (Staffordshire).—The Midland Electric Corporation have entered into a contract for the purchase at the Thorns, Quarry Bank, of a site for a power station for the supply of electricity in the district.

Norfolk.—The County Council have decided to apply for sanction to a loan of £500 for fitting up in the old asylum a system of fire-alarm bells, call points, telephones, tell-tale stations, ward bells, and bell pushers.

Electro Institute, Limited.—This Company has been registered with a capital of £6,000, the object being to carry on the business of medical electric specialists. Registered office: 26, Charles-street, Haymarket, W

Malton.—The Northern Counties Electricity Supply Company have decided to erect a generating station at Norton. The Malton Urban District Council object to the establishment of a station at Norton, as the original order specified Malton as the site.

Newcastle.—The Newcastle Guardians have received a report in favour of the entire relighting and heating of the union workhouse at a cost of £15,000, the scheme to include electric lighting and the heating of the house by hot water instead of steam.

Scarborough.—The Streets and Buildings Committee of the Corporation last Friday adopted a recommendation of the Streets Sub-Committee to ask the electric supply company if they would be prepared to light the streets from Falsgrave to Sandside with electricity and at what price. The lights, if erected, will be placed on the tramway poles.

Hove.—The Telephones Committee have approved the engineer's revised estimate of the cost of telephoning Hove underground; also application is to be made for sanction to borrow a sum of £4,691, instead of the sum of £3,000 previously applied for, to defray the cost of laying ducts and constructing other works in Hove for extending the telephone undertaking to that borough.

Recent Publications.—"Continuous-Current Dynamos and Motors, and their control," by W. R. Kelsey, B.Sc., A.I.E.E., 440 pp.; price 5s. net, post free; see advertisement. "Journal of the Institution of Electrical Engineers," edited by W. G. McMillan, secretary, part No. 163, price, 5s.; published by E. and F. N. Spon, Limited, 125, Strand. For contents see advertisement.

Injectors.—Messrs. Holden and Brooke, Limited, Sirius Works, West Gorton, Manchester, have just issued two new illustrated catalogues—viz.: List 37 (Section 1), injectors for boiler feeding by means of live steam—dealing with the firm's pattern S one-movement self-acting injector and other standard patterns. List 39 (Section 3) non-lifting injector—dealing with pattern C non-lifting injectors for feeding low-pressure boilers.

Barnstaple.—At the last Town Council meeting a statement was made with regard to the cost of electric light production per unit from Jan. 30 to June 24, and from June 24 to July 24. For the first-named period the cost was 2·9d. per unit, and for the second period 2·8d. per unit. The Council charges consumers 6d. per unit to provide for interest and redemption of capital, so that it seems the undertaking will prove a success.

British Thomson-Houston Company.—We are informed that this company has recently organised a new department, termed the "Local Companies Department," to handle its extensive business in connection with traction, lighting, and power schemes in various parts of the country, and has appointed as manager of this department Mr. A. W. Jones, who has been on the British Thomson-Houston Company's staff since its formation, and for the past three years has acted as assistant manager.

South Shields.—The balance-sheet of the past year's working of the electric lighting undertaking shows a considerable improvement on previous years in actual profits. After meeting all current expenses and payments in respect of capital and interest, there is a balance to the good of over £1,100. At the last meeting of the Electrical Committee it was decided to place £800 of this sum to the credit of the rates, £200 to reserve funds, while £160 will be carried forward. The reserve fund will thus be increased from £2,300 to £2,500.

Caversham.—A special meeting of the Urban District Council was held last week to consider a recommendation of the whole Council that a public meeting of the ratepayers be called to ascertain their opinion as to the advisability of applying to the Board of Trade in the coming session for a provisional order under the Electric Lighting Acts for a supply of electricity for Caversham. A motion was passed to the effect that the Council do not apply for a provisional order in the coming session, and that the public meeting of ratepayers be not called at present.

Accidents.—At Cardiff last week the underground electric lighting cables became ignited, and the fire was only got under after a portion of the cables had been severed, and consequently the electric light in the offices in the centre of the town went out when the current was temporarily cut off. On Friday, after the workmen had completed their day's work and left the premises, a steam pipe exploded in connection with a boiler at the Kensington Central electric lighting station, which is situated close to the West Brompton Station of the District Railway. Fortunately, no one was injured, and the damage caused was only slight.

Catalogue.—The Liverpool Electric Cable Company, Limited, Vauxhall-road, Liverpool, have just issued a new price-list of their manufactures including manufactures of vulcanised-rubber electric light and power cables, pure rubber-insulated cables, aerial cables, flexible cords, and dynamo wires. We are informed that the rubber used is manufactured on the firm's premises, and that Mr. Robert Taylor, who is in charge of the works, has had more than 25 years' experience in the manufacture of rubber and electric light cables. Mr. Taylor was with Messrs. W. T. Glover and Co., of Salford, Manchester, and their successors, when they were converted into a limited liability company, for a period of 11 years, seven of which he was works manager. Mr. Samuel Hartford, who is in charge of the commercial part of the business, was also with Messrs. Glover and Co. for 15 years.

Stock Exchange.—The Stock Exchange Committee has appointed Sept. 2 special settling day for County of London and Brush Provincial Electric Lighting Company's provisional certificates (fully and partly paid) for £250,000 4½ per cent. second debenture stock, and Sept 10 for British Westinghouse Electric and Manufacturing Company's further issue of 100,000 6 per cent. preference shares of £5 each fully paid, Nos. 375,001 to 475,000, and have ordered the above-mentioned securities and also Edmundson's Electricity Corporation's further issue of 20,000 ordinary shares of £5 each, fully paid, Nos. 50,001 to 70,000, to be quoted in the official list. Applications have been made to the Exchange Committee to appoint a special settling day in Marconi's Wireless Telegraph Company's further issue of 39,028 shares of £1 each fully paid, Nos. 157,084 to 196,111; and to allow the following securities to be quoted in the official list: Eastern Extension, Australasia, and China Telegraph Company's further issue of £282,400 4 per cent. mortgage debenture stock, and Eastern Telegraph Company's further issue of £302,169 4 per cent. mortgage debenture stock.

Aberdeen.—The Lighting Sub-Committee of the Town Council recently visited various parts of the town with a view to considering whether any improvements were required in the matter of street-lighting. They were much pleased with the new lighting arrangements alongside Westburn-road. Lamps, in which are used four different sets of burners, have been erected in Westburn-road and Burnside-road by way of experiment with a view to deciding which

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type should be recommended for future use. The erection of a number of additional arc lamps has been authorised.

Clydebank.—The Town Council have agreed to issue a *plébiscite* paper to the electors on the question as to whether the burgh should or should not carry out its own electric light provisional order. Statistics are to be added showing what has been done by other burghs of similar size to Clydebank which has municipalised the electric light supply. According to Messrs. Kincaid, Waller, Manville, and Dawson's report, a capital expenditure of £34,310 for the whole or extended scheme will be required. The annual expenditure, including interest on sinking fund, would be £3,185, and the revenue from lights, refuse destroyed, and clinker sold at £3,433.

Huddersfield.—The borough electrical engineer's last report is as follows: Number of consumers: August, 1,806; July, 1,795; increase, 11. Lamps connected: August, 125,417; July, 124,462; increase, 955. Units metered: July, 1903, 100,754; corresponding period last year, 61,711; increase, 39,043, equals 63 per cent. The Bill confirming the Linthwaite electric lighting provisional order has received Royal assent, and the Council have approved the borough electrical engineer's plans and estimates for purposes of supplying electricity within the Linthwaite district, and will apply for sanction to borrow the sum of £7,500 for the purposes of carrying out the work.

Whitehaven.—A local paper says the Harbour Commissioners have power to levy 2d. a ton on vessels for lighting. The lighting of the harbour has lately cost from between £200 and £300 to somewhere about £400 for electricity. For the year ended Dec. 31, 1902, 74 vessels in the foreign trade, totalling 52,913 tons register, entered this port, and in the coastwise trade there were 1,341 vessels, totalling 155,210 tons register. The whole of this tonnage—208,123 tons—at 2d. a ton yields a revenue of £1,734. 7s. 2d. This statement suggests several ideas, but the only one that need be followed at present is that there is a very ample margin here between income and expenditure, and that at all events the harbour ought to be well lighted for the money.

Hornsey.—At the last meeting the Urban District Council considered a report from the special committee as to the supply of electricity dealting with a report of the consulting engineers, Messrs. R. Hammond and Son, on extensions necessary in the immediate future. They recommended "that the works covered by estimate No. 1 in the report be immediately proceeded with, that the mains and services included under estimate No. 3 be laid, and provided as circumstances may require, that the other works be undertaken when determined on by the Council, and that application be made to the Local Government Board for their sanction to the borrowing, as may be necessary, of the total sum of £61,050." In the end the recommendation reduced to £35,898 was agreed to.

Wigan.—In order to meet the increasing demand for electric current both for lighting and power purposes, the Corporation have erected at the Bradford-place station a new engine and generator of the latest type, which forms the largest set installed at the works up to the present time. The engine is one of 700 h.p., and was manufactured by Messrs. Willans and Robinson, of Rugby, whilst the generator was constructed at Messrs. Dick, Kerr, and Co.'s works at Preston. On Tuesday last week the new plant was set in motion by the Mayor (Councillor Richard Johnson, J.P.), who said that the selection of Mr. Slevin as borough electrical engineer had been entirely justified, and the appointment had in every way been a success. The condition of the works at the present time was in every sense eminently satisfactory, and was a credit to Mr. Slevin and the town.

London Gazette.—The partnership heretofore subsisting between Alfred Slatter and Richard George Goatcher, carrying on business as art metal workers and electrical engineers at No. 11, Buckingham-street, Strand, and No. 15A, Bellenden-road, Peckham, London, under the style or firm of Alfred Slatter and Goatcher, has been dissolved by mutual consent from Sept. 30, 1902. A petition for the winding up of the Electric Tramway Trusts, Limited, was presented to the High Court of Justice on Aug. 20, 1903, by William Bratby, of Alton Lodge, Hale, Bowden, Cheshire. The Electric Lighting and Fittings Corporation, Limited, Liverpool, is to be wound up voluntarily, and Mr. Simon Jude, chartered accountant, has been appointed liquidator. The first meeting in the estate of John Pierrepont Child, electrical engineer, of 150, Powis-street, Woolwich, and 109, Piedmont-road, Plumstead, Kent, will be held at 12 noon on Aug. 31, 1903.

Redditch.—The Urban District Council on Tuesday conferred with Mr. Monkhouse upon the electric light undertaking. The Council have decided that provision should be made in the proposed new loan for the new starting gear recommended and four sets of wattmeters. Upon the question of the provision of new gas-producing plant to enable the Council to use bituminous coal for gas production, instead of anthracite coal, Mr. Monkhouse strongly favoured the alteration of method. The cost of the alteration would not exceed £500. The cost of anthracite coal to the Council was 17s. 9d. per ton. The bituminous coal could be bought, delivered at Redditch, at 7s. 6d. per ton. Mr. Monkhouse repeated his belief that, under the new conditions, a considerable reduction in the cost of production would be secured. He repeated that it was not necessary to make any allowance for depreciation if the plant was maintained in good working order out of revenue. He also said there would be no need of any addition to the existing staff. He recommended that the sale of power for motor purposes at present prices (1d. to 2d. per unit) be continued, as in any case the plant had to be running continuously during the day under the alternating-current system.

Yarmouth.—The whole of the electrical lighting of the Hippodrome, inside and out, is carried out by plant on the premises, and to this end Mr. Gilbert has had laid down a 65-h.p. Crossley gas-engine, said to be the largest of its kind in the Eastern Counties, which will drive one of Crompton and Co.'s specially-constructed dynamos of 162 amperes at 220 volts with 210 revolutions per minute. This dynamo will supply current for the lighting of the whole of the arc lights in and outside the building, as well as the hundreds of small lamps distributed over the span of the roof. It is intended shortly to introduce four projector lights. Messrs. Crompton are also putting up one of their rotary transformers and a specially-arranged switchboard, which will enable the engineer at a moment's notice to disconnect the dynamo in case of temporary derangement or overheating, and receive the current from the borough tramway mains. The Crossley engine is fitted with a self-starter, and in this respect is unequalled in the district. In addition to working the dynamo, the engine will also be used to pump the water in and out of the sunk ring in the arena of the Hippodrome.

Wakefield Accounts.—The first annual report for the year ending March 31 last of the city electrical engineer (Mr. C. M. Shaw) contains the following figures: Expenditure—Generation of electricity, £1,626. 9s. 8d.; distribution, £27. 7s. 2d.; public lamps, £264. 12s. 3d.; management, £398. 1s. 9d.; special charges, £529. 17s. 5d.—total, £2,846. 8s. 3d. Income—Sale of current, £5,681. 7s. 3d.; rental of meters, £234. 7s. 2d.; public lighting, £719. 15s.; miscellaneous, £33. 19s. 6d.—total income, £6,669. 8s. 11d.; gross profit, £3,823. 0s. 8d.: interest and sinking fund, £2,874. 14s. 11d.; net profit (surplus), £948. 5s. 9d. Electricity sold, etc.—Units sold, private consumers, 393,315; public lighting, 96,140; used on works, 7,363; accounted for, 496,818; unaccounted for, transformer, mains, and leakages losses, 47,289; quantity generated, 544,107. Comparative output—Units sold year ending March, 1902, 331,183 (1903, 489,455); used on works, 7,549 (7,363); unaccounted for and used for testing, 37,159 (47,289); generated, 375,891 (544,107); maximum load demand in kilowatts, 310 (496). Load on station—March 31, 1903, 377 customers (312); 29,433 8-c.p. lamps (19,860)—total increase, 65 customers, 9,573 lamps. Number of motors connected, 17. Total horse-power, 190. Lamp connections—1901, 16,824; 1902, 19,860; 1903, 29,433. Total revenue, £6,669 (£5,195); total costs, £2,847 (£2,522); interest and sinking fund, £2,874 (£2,485); net profit, £948 (£187). If comparison be made it will be seen that the 1903 year shows an increased consumption of 158,272 Board of Trade units, being 47 per cent. increase over year 1902. Also that the total increase of lamp connections is 9,573, being 48 per cent. increase on 1902. The analysis of costs shows that all items of expenditure show a decrease. Works costs ·25d. per unit, total costs, ·40d. per unit on year 1902, which are most satisfactory. Works costs per unit sold—1903 ·80d. (1·05d.); total costs per unit sold, 1·25d. (1·65d.). The total length of high and low tension mains in the city at the end of March, 1903, was 14½ miles; March 31, 1902, 20,030 yards; extension during year ended March 31, 1903, 6,440 yards—total, 26,470 yards. In addition to new mains laid, 225 yards cable of various sizes has been overhauled and repaired and partly replaced.

Grimsby.—The annual report of the electrical engineer (Mr. W. A. Vignoles) shows that during the past year a considerable amount of work has been carried out in extending the plant and laying additional distributing mains. The department laid 1 mile 780 yards of distributing cable, and made 106 services to connect new consumers. Additional feeder cables, etc., and a sub-balancing station have become necessary, and the Council have recommended the expenditure of £7,000 for this purpose. With regard to public lighting, there are now 70 10-ampere and 10 6-ampere arc lamps in use. The consumption of current for power purposes has increased, and as a reduced charge is being made for this class of work, the demand will doubtless increase substantially in the near future. Considerable progress has been made with the undertaking during the 12 months. The number of lamps connected is not quite so large as anticipated, but Mr. Vignoles thinks that nothing has been lost by reducing the price, as the actual gross profit is larger than he estimated it would have been if the price had not been reduced. Lamp connections are still being made, and plenty of new enquiries are coming to hand, as shown by the fact that on March 31 there were 2,210 8-c.p. lamps applied for and not connected. The total number of lamps applied for and connected is 23,544. The total cost of production works out at 1·4d. per unit, which compares favourably with that obtaining in other towns. During the year the gross profit amounted to £3,277, or 5⅝ per cent. on the average capital expended during the year. Interest amounts to £2,873, the sinking fund is £1,826, so that the total capital charges amount to £4,699, equal to 7·29 per cent. on the average capital expended, and a net deficit of £1,422 is the result, as compared with £2,015 last year. The total cost of supplying the current to the tramways company amounted to 1d. per unit; the average price obtained being 1½d. per unit, the gross profit on the supply of current to the tramways company was £819. The cost of the plant installed for traction work, including a share of the buildings and spare plant, is about £9,650; the interest and sinking fund last year on this amount was £705, so that during this period a net profit of £114 was made. If interest and sinking fund had been obtained at 6 per cent. a profit of £219 would have been made. The engineer considers that these figures prove conclusively that the price at which the committee are selling current to the tramways company leaves a safe margin of profit. The estimate for next year's working is as follows: number of lamps connected, March 31, 1904, 29,500; gross profit, £4,514; interest and sinking fund, £4,940; net deficit, £426. The matter of automatic stokers has been referred back again to the committee, as the engineer desired some further information. The monthly report of the engineer shows an increase in the number of lamps connected of 1,034 over last year. There has been an increase of 7,000 units in the current consumed by the tramway company during the past month as compared with the corresponding month last year, and an increase of 3,500 units over the amount consumed during the previous month. The engineer expresses disappointment that the destructor had not supplied

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more steam, and there was practically no spare steam from the destructor after supplying the forced draught required and the steam required for the clinker crusher.

Dublin.—A special meeting of the Municipal Council was to be held last night for the purpose of considering a report of the Lighting Committee on the extra expenditure in connection with the new electric lighting system, to cover which the committee recommend that an application for a loan should be made to the Local Government Board. The report states, according to the *Dublin Evening Express*, that "the Lighting Committee have from time to time laid before the Council various reports on additions to the electricity scheme, and have now pleasure in submitting a report from Mr. Robert Hammond, setting out in detail the various items of the extra expenditure incurred in connection with the complete system. The total amount is £48,000 in respect of the city undertaking, in addition to a sum of £5,961 expended in the city on the Clontarf electric lighting scheme, regarding which your committee submit a separate report. In every case in which it was possible full particulars of the additions to the scheme were submitted to Council before the expenditure was entered upon, but, of course, many difficulties arose from time to time which had to be dealt with at once in connection with building work and the laying of street mains. In the case of the latter work especially, very serious difficulties were met with, owing to the extraordinary number of old cellars run out under many of the streets, and your committee had to carry out from day to day arrangements with owners of city property to enable the work to be proceeded with. They are pleased to be able to report, however, that although these difficulties added to the cost of laying the mains, in not a single case did the arrangements effected entail the payment of compensation, the owners and tenants of property everywhere showing a disposition to assist your committee in every way reasonable." An exhaustive report from Mr. Hammond is also to be submitted to the Corporation. It is dated July 28, and the following are extracts from the document: "The capital expenditure sanctioned by the Local Government Board was £254,500. The contracts given out in respect of the plant, etc., embraced in the original scheme, covered by the Local Government Board's sanction of £254,500, showed a saving of £4,529. In carrying out the work, however, its scope has been somewhat enlarged with the authority of the Council from time to time, with the result that liabilities beyond the £254,500 have been incurred up to about £302,500, leaving an amount of £48,000 not yet sanctioned by the Local Government Board. I may here point out that in addition to the above there is a sum of £5,961, which sum represents the value of certain works executed in order that the Council may be in a position to meet its obligations with regard to giving a supply of electricity to Clontarf next year." The items making up these total figures are then set out, and they include iron troughing for the mains, substituted for earthenware troughing included in the scheme, £6,000; extension of engine-house to provide space for additional plant and Lancashire boiler, £4,261; substitution of Lancashire boiler for water-tube (extra seatings), £500; coal store and provision for mechanical coaling and ash disposal, £5,920; less provision in original estimate, £1,600—£4,320; lowering gear for arc lamps, £1,400; culvert at Victoria Bridge, £2,700. No provision, Mr. Hammond states, was made for this, as the consulting engineer understood that cables would be taken through culvert to be constructed in connection with the main drainage. Storing plant in consequence of delay in starting work in Pigeon House, £781; expenditure at Pigeon House on extra well, pipes, foundations, etc., £1,250; extra cost of constructing Sackville-street sub-station underground, £446; extra sub-station at Trinity College, £575; Trinity College transformers, £514. 16s.; removal of Thomas-street sub-station, £352; additional mains in present area, £2,370; sundries, including new design of brackets for arc lamp-posts in present area, for which price is under discussion with the contractors, say £500; demand indicators, £2,000; small meters, £500; expenditure in Dublin on preliminary expenses, legal expenses, contract charges, stamps, printing, clerk of works, water supply, etc., £3,000. The amount of contracts entered into in connection with the undertaking is as follows: total of contracts entered into up to Feb. 7, 1903, £250,366. Until complete measurements are made and agree with the contractors it is not possible, says Mr. Hammond, "to deal with the exact figures, but subject to this proviso, I beg to submit the following statements: estimated cost of additions to building work at Pigeon House, including provision for Clontarf lighting already reported to Council, £5,106; additions to building work at Pigeon House, not yet reported to Council, £1,259. 0s. 3d.; additional sub-stations and of additional work in connection with those contracted for originally, £2,139. 14s.; additional mains and additional work, including provision for Clontarf, £10,602. 17s. 9d.; increasing the section of mains in certain streets, and alterations to cellars, etc., £10,331; sundry extras on contracts not included in the remaining lists, £3,534. 8s.; total contracts entered into and reported on on Feb. 7, 1903, £250,336. The extra expenditure to be allocated as follows: to city lighting, £48,000; to Clontarf lighting, £5,961." The Lighting Committee say they have very carefully considered the items of Mr. Hammond's statement, and recommend them for the approval of Council, and recommend, further, that application be made to the Local Government Board for its sanction to a supplemental loan of £48,000, to cover the extra expenditure on the electricity scheme as set out in the above statement. The following report of Mr. Hammond on the proposed electric lighting of Clontarf is appended. It is divided into two sections—viz., private lighting and public lighting—and is as follows: "Under the Dublin Corporation Act (1900) you have taken over the obligations of the Clontarf Electric Lighting Order (1889) with the exception that the date by which the supply of electricity has to be given in the compulsory area is extended to Aug. 6, 1904. Under the Clontarf order the compulsory area is made up of the following streets: Annesley Bridge-road and Strand-road, known as the High-road, skirting the seashore (from the township boundary at Annesley Bridge to a point in the said High-road, immediately opposite the centre of the carriage gateway leading from said High-road to the mansion of St. Anne's, which point is distant 168 yards or thereabouts, measured in an easterly direction from the intersection of Blackbush-lane with the High-road aforesaid); Fairview-strand and Fairview (from Phillipsburgh-avenue to the High-road as aforesaid); Phillipsburgh-avenue (from Fairview-strand to the intersection of Annadale-avenue with Phillipsburgh-avenue aforesaid); St. Lawrence-road, Castle-avenue (from the High-road aforesaid to the intersection of Church-road with Castle-avenue aforesaid); Strandville-avenue, St. Joseph's-terrace, Marino-avenue, Beechfield-avenue, and Mooney's-lane, and it is in these streets that the distributing mains must be laid by the date referred to above—viz., Aug. 6, 1904. Keeping these observations in view, we have already laid two 5,000-volt feeder mains and one telephone cable from Fleet-street to Newcomen Bridge, and the next step will be to extend these mains into Clontarf. In the ordinary course, I should propose to deal with the lighting of Clontarf in exactly the same system as Dublin—that is to say, by a number of transformer sub-stations distributed over the whole area. It does not, however, appear to me that the demand in Clontarf would, at any rate for the present, justify you in going to the expense of a number of sub-stations, and I therefore propose to limit the number to one, and to deal with the balance of the load by means of single transformers, fixed either in pits below ground or in pillars above ground—preferably the latter. These transformer pits or pillars could, of course, be replaced by regular sub-stations at a later date should the demand warrant it. It would be possible from an electrical point of view to supply all the transformer pits direct from the 5,000-volt mains, but I should hesitate to use such a high pressure as 5,000 volts for such a purpose, and I therefore recommend, in that case, that the pressure be reduced at the sub-station at Clontarf to not more than 2,000 volts—in other words, the distribution of energy in Clontarf would be on somewhat similar lines to the distribution in the old area, Dublin, except that three-phase mains would be laid where practicable in place of simple concentric mains. The work to carry out the above scheme would be as follows: (1) the extension of two extra high-tension feeder mains from Newcomen Bridge to a sub-station at Clontarf; (2) the extension of the telephone cable from Newcomen Bridge to the above sub-station; (3) the building and equipment of an extra high-tension sub station; (4) the high-tension main from the sub-station, with branches to transformer pits, as required; (5) seven transformer pits, or pillars; (6) the necessary low-tension distributing mains. The above would be sufficient to deal with the compulsory area as scheduled in the Clontarf order, and I estimate that the cost of carrying out the work would amount to £14,000. In addition to the streets comprised in the compulsory area, there are several streets in which new houses have recently been built, from which a profitable load might be expected. Amongst those streets I am inclined to include the following: Haddon-road, Vernon-avenue, Howth-road, Hollybrook-road, Hollybrook-park, Seafield-avenue. The estimating cost of distributing mains in these streets would be £1,250. I also add £1,550 to provide for house services, meters, etc. I have prepared an estimate of the cost of lighting the sea-front as far as Dollymount with arc lamps, including the extension along North Strand, necessary to meet the Dublin lighting, which at the present moment will stop at Newcomen Bridge. For this purpose about 56 lamps will be required, placed something like 100 yards apart. It would not be practical to give energy to these lamps from the motor-generators at Fleet-street, and I should, therefore, propose that these lamps be of the alternating-current pattern, controlled from the sub-station. I draw your attention to the fact that you have power under the Dublin United Tramways Electrical Power Act (1897) to utilise the poles of the tramway company for the purpose of public lighting. Clause 15 of this Act runs as follows: 'Provided, however, the road authority may for the purposes of their own street-lighting utilise any of the pillars or standards at their own cost, and all the pillars or standards, whether erected in the road or footpath, shall be so constructed that they can be utilised for the purpose of street-lighting, and by the road authority, whenever they require to do so, free of charge.' The objection to the use of the tramway posts is that they are not situated throughout the area in the positions most suitable, at street corners, etc., for public lighting, nor can lowering gear be applied to them. I, therefore, submit two estimates, the first for the utilisation of the tramway poles, and the second for the erection of similar posts to those in the city, the alternative estimates being as follows: (1) for the utilisation of the tramway poles, £4,750; (2) for separate posts, with lowering gear similar to those in the city, £5,239. The cost of carrying out the whole scheme outlined above would be as follows: compulsory area, £14,000; other prominent streets. £1,250; house connections and meters, £1,550; public lighting from Newcomen Bridge, Dollymount, say, £5,239; already expended, £5,961—total, £28,000." The Lighting Committee believe that the members of the Council will agree that as the Corporation is bound to carry out the private lighting scheme for the compulsory area, it is advisable that it should be made complete by including the extra roads specified in Mr. Hammond's report, and the public arc lighting of at least the sea road, as suggested by Mr. Hammond. In the case of these extra roads, however, the committee suggest that the laying of the distributing mains be made conditional upon a reasonable number of promises to use the current being secured from residents. The committee consider that the suggestion of separate posts for the public arc lighting should be adopted, as apart from the advantage of better positions, the annual saving effected by the lowering gear would more than compensate for the slight extra capital cost. The Lighting Committee accordingly recommend that application be made to the Local Government Board to authorise the raising of a loan of £28,000 for the carrying out of the work above specified.

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PROVISIONAL PATENTS, 1903.

AUGUST 17.

17734. An electrical magnetic automatic stop-action appliance to be used with fustian, cerduroy, velvet cutting and other machines. Robert Reynolds, 101, Oxford-road, Chorlton-on-Medlock, Manchester.

17744. Improvements in and relating to the shifting of points and plough guides on electric tramways. William James Stewart, 96, Buchanan-street, Glasgow.

17745. An improved automatic safety device for use in connection with overhead electric conductors. Arthur Morris, 6, Finkle-street, Stockton-on-Tees.

17767. Improvements connected with the electrical propulsion of vehicles on the overhead system. Charles Shields McIntire, 40, Chancery-lane, London.

17814. Improvements in safety collision devices for electric tramcars. Reginald Haddan, 18, Buckingham-street, Strand, London. (Ramon Rué y Montparlé, Spain.) (Complete specification.)

AUG. 18.

17851. Improvements in or relating to electric railways. George Westinghouse, Westinghouse Building, Norfolk-street, Strand, London.

17871. Improvements in or relating to electric arc lamps known as flame arc lamps. Charles Oliver, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

17886. Improvements in lifeguards for electric cars and other self-propelled vehicles. Arthur Royle, 6, Lord-street, Liverpool.

AUG. 19.

17940. An improved method of calibrating alternating-current instruments and means for use therein. Charles George Lamb, 77, Glerson-road, Cambridge.

17974. Improvements connected with electric lamp fittings. Robert Walter Braham, 173, Fleet-street, London.

AUG. 20.

17994. A device for clamping a broken trolley arm or pole on an electric tramcar. James Dawes, 26, Buxton-street, Manningham, Bradford.

18010. Improvements in galvanic batteries. Lothar Fiedler and Frederick Julius Gerard, 22, Southampton-buildings, Chancery-lane, London.

18036. Improvements in or connected with arc lamps. William James Davy, 40, Chancery-lane, London.

AUG. 21.

18077. Improvements in electric trolleys. Jean Lauvernier, 23, Mittelstr., Berlin, Germany.

18080. Improvements in or connected with means for preventing corrosion and injury to water-mains by electric currents received through the rails of tramlines. William Bradshaw Leachman, 33, Chancery-lane, London.

18120. Improvements connected with electric lamps. Robert Walter Braham, 173, Fleet-street, London.

18121. Improvements connected with enclosed or open electric arc lamps. Louis Carl Henry Mensing, 173, Fleet-street, London.

AUG. 22.

18142. Improvements in or relating to the receiver cradles of telephone instruments. Robert Frederick Hall and the Electric and Ordnance Accessories Company, Limited, 24, Temple-row, Birmingham.

18143. Improvements in or relating to telephone apparatus. Robert Frederick Hall and the Electric and Ordnance Accessories Company, Limited, 24, Temple-row, Birmingham.

18177. Improvements in electric arc lamps. William Winterborne Smith, 36, Chancery-lane, London.

18185. An improved electrically-controlled indicator. Siemens Bros. and Co., Limited, and George Sylvester Grimston, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

18186. Improvements relating to telphers. Siemens Bros. and Co., Limited, and Arthur Stebbins Clift, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

18197. Improvements relating to electric apparatus for motorcars. Arthur Trevor Dawson, 45, Southampton-buildings, Chancery-lane, London.

COMPLETE SPECIFICATIONS ACCEPTED.

To be published September 10, 1903.

1902.

18855. Electrically-operated switches or circuit breakers. Hewlett and Button. (Date applied for under International Convention, Jan. 7, 1902.)

18999. Electric current regulators. British Thomson-Houston Company, Limited. (Wood.)

18230. Devices for making and breaking electric circuits. Lake. (General Electric Company.)

18706. Alternating-current electricity meters. De Ferranti and Hamilton.

18924. Variable speed-driving mechanism for electric meters. Lake. (General Electric Company).

20438. Electric car pulleys. Knowles.

20871. Electric storage batteries and the like. Sutherland and Marcuson.

21213. Method of and means for lighting miners' and other lamps by electricity. Patterson and Darrah.

22760. Tramway and railway rails, and means of bonding such rails for the purpose of electrical connection. Bigwood.

23426. Electric accumulators. Garcin.

26999. Electromotors and similar electrical apparatus. Macfarlane.

1903.

5278. Hood for telephones. Mirow and Hepke.

12516. Electromagnetic machine for the ignition of the mixture in explosion motors. Pichard.

13707. Mechanism for mounting and driving dynamos on railway trucks. Kennedy.

15479. Regulating systems of electric distribution. Justice. (National Battery Company.)

15489. Regulating systems of electric distribution. Justice. (National Battery Company.)

15552. Apparatus or devices for transmitting and receiving messages by wireless telegraphy. Burke.

15569. Method of and apparatus for wireless signalling, chiefly designed for determining the nautical bearing of navigable vessels. Ladd.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.		Last price
Commercial and Industrial.—	£		£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1	..	¼-¾
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1	..	¼-¾
British Insulated and Helsby Cables, Ord., 1-100,000	5	..	6¾-7¼
—— 6 per cent. Cum. Pref., 1-100,000	5	..	5¼-5¾
—— 4½ per cent. Mortgage Debentures	100	..	102-106
British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red.	100	..	105-107
British Westinghouse Elec. and Manuf., 6 per cent. Pref., 275,001-375,000	5	..	5¾-6
—— 4 per cent. Mortgage Debenture Stock	100	..	100-102
Brush Electrical Engineering, Ordinary, Nos. 1-105,751	2	..	¾-1¼
—— Non. Cum., 6 per cent. Pref.	2	..	1-1¼
—— 4½ per cent. 1st Debenture Stock	100	..	99-102
—— 4½ per cent. 2nd Debenture Stock	100	..	85-90
Callender's Cable, Debentures	100	..	106-110
—— Ordinary	5	..	11¼-12¼
—— 5 per cent. Pref.	5	..	5¼-5¾
Crompton and Co.	3	..	2-2½
—— 5 per cent. Debentures	100	..	101-105
Edison and Swan United, "A" Shares, 1-99,251	3	..	¼
—— "A" Shares, 01-017,139	5	..	1¼-2¼
—— 5 per cent. Debentures	100	..	75-80
—— 4 per cent. Deb. Stock, Red.	100	..	71-75
Electric Construction, Limited, Nos. 1 to 112,100	2	..	1¼-1¾
—— 7 per cent. Cumulative Pref.	2	..	2¼-3
—— 4 per cent. Perp. 1st Mort. Deb.	100	..	99-102
Ferranti Limited, 5 per cent. 1st Mort. Deb. Stock, Red.	100	..	90-95 xd
General Electric Company (1900), 5 per cent. Cum. Pref.	10	..	9¼-10
—— 4 per cent. 1st Mort. Deb. Stock	100	..	99-102
W. T. Henley's Telegraph Works, Ordinary	5	..	14-15
—— 4½ per cent. Preference	5	..	5-5¼
—— 4½ per cent. Debentures	100	..	108-112
India Rubber, Gutta Percha, and Telegraph Works	10	..	18¼-19¼
—— 4 per cent. Debentures	100	..	100-103
Parker, Thos., Limited, Ordinary	10	..	14¼-15¼
Telegraph Construction and Maintenance	12	..	34-37
—— 5 per cent. Bonds	100	..	100-103
Electric Lighting and Supply.—			
Blackheath & Greenwich District Ordinary 1,201-101,200	1	..	⅝-¾
—— 4½ per cent. Deb. Stk. Certs., Red. and Conv.	100	..	118-121
Bournemouth and Poole, Ordinary	10	..	12¼-13¼
—— 4½ per cent. Cum. Pref., 7,501-15,000	10	..	10-11 xd
—— 6 per cent. Cum. Second Pref., 15,001-22,500	10	..	10¼-11¼
—— 4½ per cent. Debenture Stock, Red.	100	..	103-106
Bromley (Kent) Electric Light and Power Co., 4½ per cent. 1st Debenture Stock, Red.	100	..	102-105
Brompton and Kensington, Ordinary	5	..	10¼-11 xd
—— 7 per cent. Preference	5	..	10¼-10¾
Calcutta Electric Supply Corp., Ordinary, Nos. 1-40,000	5	..	6¼-7¼
—— Nos. 20,001-30,000	5	..	7-8
Cambridge Electric Supply Company, Ltd., £10 Ord.	8	..	14½
—— " " £10 Ord.	6	..	10¾
Central Electric Supply, Ld., 4 per cent. Guar Deb. Stock	100	..	105-109
Charing Cross and Strand, Nos. 1-70,000	5	..	9-9½ xd
—— 4½ per cent. Cum. Pref.	5	..	5¼-5
—— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000	5	..	4¾-5
—— 4 per cent. Debenture Stock, Red. (Prov. Certs.)	100	..	104-106
Chelsea Electricity Supply	5	..	5¾-6¼
—— 4½ per cent. Debentures	100	..	108-111
City of London, Ordinary	10	..	10¾-11¼
—— 6 per cent. Cumulative Pref.	10	..	13-14
—— 5 per cent. Debenture Stock	100	..	122-127
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100	..	102-105
County of London and Brush Provincial, Ordinary	10	..	8-9
—— 6 per cent. Cum. Pref.	10	..	11¼-12¼
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	100	..	109-112
Edmundsons' Electricity Corporation, Ordinary, 1-50,000	5	..	6¼-7
—— 6 per cent. Cum. Pref.	5	..	6-6¼
—— 4½ per cent. First Mort. Deb.	100	..	107-110
Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-30,000	5	..	5¼-4¾
—— 5 per cent. Debenture Stock, Red.	100	..	96-98
Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000	5	..	6-6¼
—— 4½ per cent. First Deb. Stock, Red.	100	..	100-103
Hove Electric Lighting, Limited, Ord., 1-13,000	5	..	7¼-8¼
Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000	5	..	10¼-11¼
—— 4 per cent. Debenture Stock Red.	100	..	103-106

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Name.	Amount paid.	Last price.
	£	£
Kensington and Knightsbridge and Notting Hill	100	103-106
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	9¾-10¼
London Electric, Ordinary	5	2-2¼
—— 6 per cent. Pref.	5	5¼-6
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	100-102
Metropolitan, Ordinary	10	17-18
—— 4½ per cent. First Mortgage Debenture Stock	100	108-112
—— 3½ per cent. Mortgage Debenture, Red.	100	97-100
Newcastle-upon-Tyne Electric Supply, Ordinary	5	98-101
—— Preference	4	100-103
Notting Hill Electric Lighting	10	13-14
—— 4 per cent. First Mort. Debs., Nos. 1-500 (Reg.)	100	99-102
Oxford Electric, Ordinary, 1-96 and 407-14,310	5	5-6
—— 4 per cent. Debenture Stock	100	98-101
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100	100-102
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5	3¼-3½
—— 4 per cent. Debenture Stock	100	98-90 xd
South London, Ordinary	5	3¾-4¼
St. James's and Pall Mall, Ordinary, 101-20,080	5	15¾-16¼
—— 7 per cent. Pref.	5	8-9
—— 3½ per cent. Deb.	100	98-101
Urban Electric Supply Co., Ordinary, 8-30,007	5	5-5¼
—— 5 per cent. Cumulative Preference, 50,001-80,000	5	5-5¼
Westminster, Ordinary	5	13-14
—— 5 per cent. Cum. Pref., 110,101-138,251	5	6-6½

Electric Railways.—

Central London, Ordinary	100	97-100
—— 4 per cent. Pref.	100	99-102
—— ,, deferred	100	101-104
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100	116-119
City and South London, Consolidated Ordinary	100	60-61
—— 4 per cent. Debenture Stock	100	116-119
—— 5 per cent. Pref. Stock '91	100	127-130
—— ,, ,, ,, '96	100	126-129
—— ,, ,, ,, '01	100	125-128
Liverpool Overhead, 5 per cent. Pref.	—	13-13¼
—— Ordinary, 1-50,000	—	7¼-8
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	100	102-104
Waterloo and City, Ordinary	100	95 98

Electric Tramways.—

Anglo-Argentine, 1-260,007	5	4¼-4¾
—— Permanent 6 per cent. Debenture Stock, 1888	100	125-130
Blackpool and Fleetwood Tramroad	10	13½-14½
Brisbane Tramway Invest., Lim., Ord., 1-75,000	5	2-3
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5	4-4¼
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100	101-104
British Columbia Electric Railway Co., Ord., Nos. 1-20,000	100	74-77
—— Non-Cum. 5 per cent. Pref., Nos. 25,001-38,600	100	91-94
—— 4½ per cent. 1st Mt. Debs., Nos. 1-6,250, of £40 each	40	104-106 p.c

Name.	Amount paid.	Last price
	£	£
British Electric Traction, Ord. 1-300,000 & 60,001-80,000	10	11¾-12¼
—— 6 per cent. Cm. Pf., 50,001-60,000	10	11¾-12¼
—— 5 per cent. Perpetual Debenture Stock	100	122-125
Buenos Ayres and Belgrano Tram., Ord., 1-100,000	5	2¾-2⅞
—— "A" 6 per cent. Cm. Pf., 1-40,000	5	5-5¼
—— "B" 6 per cent. Cm. Pf., 1-27,500	5	4¾-5¼
—— 5 per cent. Deb. Stock, Red.	100	106-109
—— Prov. Cert., all paid	100	99-102
Cape Electric Tramways, Nos. 1-480,000	1	2-2¼
City of Birmingham Tramways, 5 per cent. Cum. Pref.	10	5-5¼
—— 4 per cent. 1st Mortgage Deb., 1-3,000 (1917)	100	99-102
Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red.	100	102-105
Cork Electric Tramways and Lighting Co., Ordinary	10	13-14
—— 5 per cent. Cum. Pref.	10	11-12
—— Debentures	100	96-99
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10	12¼-13½
—— 6 per cent. Pref., Nos. within 1-60,000	10	15-16
—— 3½ per cent. Mort. Debs., 1-3,000, Red.	100	94-97
Imperial Tramways Ordinary	all	22-22¼
—— 6 per cent. Cum. Pref.	all	14¼-15¼
—— 4½ per cent. Deb Stock	100	112-114
Isle of Thanet Electric Tramways and Lighting, 5 per cent. Cum. Pref., Nos. 30,001-60,000	5	4-4½
—— 4 per cent. Debenture Stock	100	82-85
Kidderminster and District Lighting and Traction, Pref.	5	3¼-4
London United Trys. (1901), 5 per cent. Cum. Pref.	10	11¾-12¼
—— 4 per cent. 1st Mt. Db. Stock, Red.	100	106-107
Metropolitan Electric Trams., Deferred, 1 000 001-1,314,016	1	3/16-5/16
—— 5 per cent. Cum. Pref., 500,001-814,016	1	⅝-1⅛
New General Traction, Ordinary	5	1½-2
—— 6 per cent. Cum. Pref.	5	2-3
—— 5 per cent. Mortgage Debentures, 1-1,713 (Regd.).	100	88-93
Oldham, Aston, and Hyde Tramway, Ordinary	10	10¼-10¾
—— 5 per cent. Cum. Pref.	10	11¾-12¼
Perth Elec. Tramways (W.A.) 5 per cent. 1 Mort. Deb. Stk.	100	99-102
Potteries Electric Traction, Ordinary, 20,001-40,000	10	9-10
—— 5 per cent. Cum. Pref., 1-20,000	10	9¼-10¼
—— 4½ per cent. Debenture Stock	100	102-105
South Lancashire Electric Traction and Power Company—		
—— £250,000 Ordinary	1	1
—— £101,132 6 per cent. Preference	1	1
—— £528,093 4½ per cent. Debenture Stock	100 p.c.	00 p.c.

Telephones.—

National Telephone, Preferred	100	100-102
—— Deferred Stock	100	78-80
—— 6 per cent. Cum. First Pref.	10	13-14
—— 6 per cent. Cum. Second Pref.	10	13-14
—— 5 per cent. Non. Cum. Third Pref.	5	5-5¼
—— 3½ per cent. Deb. Stock, Red.	100	96-98
—— 4 per cent. Deb. Stock, Red.	100	101-103
Oriental Telephone and Electric Company	1	13/16 15/16

TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line	Traffic Returns for week			Increase or decrease.		Miles of single track open.		Accounts for past year.						Cost per car mile.
	Ending	1903.	1902.	Week.	Current year.	1903.	1902.	Ending	Total receipts	Passengers carried.	Car miles run.	Receipts per Pas-s'nger	Receipts per Car mile.	Receipts per Mile of track.	
		£	£	£	£				£			d.	d.	£	d.
Aberdeen Corporation	Aug. 13	1,372	1,154	+ 217	+ 1,713	19¼	17¼	May 31	37,931	9,099,715	794,641	0·98	13·02	1,970	6·14
Ayr Corporation	—	—	—	—	—	8	6	Sept. 25	12,503	2,979,276	290,099	1·00	10·34	1,560	4·7
Birmingham Tramways	,, 23	5,139	4,708	+ 431	+ 8,140	6¼	6¼	—	—	—	—	—	—	—	—
Blackburn Corporation	—	—	—	—	—	24	24	March 25*g*	40,964	7,234,106	826,558	1·36	11·87	1,705	7·44
Blackpool Corporation	—	—	—	—	—	17½	16½	,, 31	211,168	6,169,121	784,443	1·52	10·8	—	—
Blackpool-Fleetwood Tramways	,, 22	1,955	1,912	+ 43	—	16½	16½	Dec. 31	30,923	2,049,677	584,989	3·62	12·68	1,932	6·99
Bolton Corporation	,, 23	2,283	1,952	+ 331	+ 5,581	38	25	March 31	85,704	17,761,605	1,896,247	1·15	10·75	3,430	5·87
Bournemouth Corporation	,, 12	1,438	—	—	—	10½	—	—	—	—	—	—	—	—	—
Bradford Corporation	,, 23	4,267	3,688	+ 579	+10,056	41	—	—	—	—	—	—	—	—	—
Brighton Corporation	,, 23	1,131	1,065	+ 66	+ 5,939	6½	—	,, 31	—	10,432,508	1,031,928	1·00	10·10	—	—
Bristol Tramways Company	,, 21	4,951	4,995	— 144	—	51½	51½	Dec. 31	223,480	41,192,899	5,724,114	1·30	9·38	4,348	—
Burnley Corporation	,, 22	902	696	+ 206	—	—	—	—	—	—	—	—	—	—	—
Burton Corporation	,, 15	493	—	—	—	—	—	—	—	—	—	—	—	—	—
Cardiff Corporation	,, 1	2,133	1,535	+ 598	+12,345	—	—	—	—	—	—	—	—	—	—
Carlisle Tramways Company	—	—	—	—	—	—	—	,, 31	—	2,216,583	320,129*h*	—	—	—	—
Central London Railway	,, 22	5,445	5,491	— 36	— 1,645*h*	6	—	,, 31	367,225	45,305,110	1,276,971*a*	1·87	66·6 *a*	59,076	35·6 *a*
City and South London Railway	,, 23	2,252	2,645	— 393	— 2,685	6⅜	—	,, 31	165,003*a*	19,069,319*a*	—	—	—	—	—
Cork E. T. and L. Company	,, 13	646	885	— 239	— 677	—	—	—	—	—	—	—	—	—	—
Darwen Corporation	July 10	220	243	— 23	— 113	7·23	—	March 31*g*	12,341	2,360,735	254,279	1·25	11·65	1,707	9·36
Dover Corporation	Aug. 22	304	320	— 16	+ 85	3	—	—	—	—	—	—	—	—	—
Dublin & Lucan Electric Railway	,, 23	139	171	— 32	+ 59*h*	—	—	Dec. 31	5,796	364,796	102,087	3·81	13·62	859	7·68
Dublin U. T., electric cars	,, 21	4,106	3,909	+ 197	—	46	46	March 31	126,121	24,553,133	3,429,356	1·23	8·82	2,741	5·06*h*
Dublin S. District, Electric	,, 21	1,123	1,056	+ 92											
Dundee City Tramways	July 15	834	718	+ 116	—	22	22	May 15	35,874	9,084,522	752,814	0·93	11·276	1,630	—
East Ham Corporation	Aug. 22	769	491	+ 169	+ 4,676	10·75	7·52	March 31	25,341	9,971,337	650,224	0·61	9·35	2,357	—
Farnworth U.D.C.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Glasgow Corporation	,, 22	13,642	11,685	+1,957	+18,217	124	101	May 31*g*	656,572	177,179,549	14,008,750	0·88	11·25	5,489 *b*	7·40*d*
Halifax Corporation	—	—	—	—	—	30½	27¾	—	—	—	—	—	—	—	—
Huddersfield Corporation	—	—	—	—	—	34	35	March 31	56,631*h*	9,738,213	1,218,539	1·4	11·14	1,618	6·38
Hull Corporation, E. S.	,, 22	1,833	1,726	+ 106	+ 1,819	19	19	,, 31	87,707*h*	21,065,999	2,218,696	1·00	9·49	5,004	5·07
Ilkeston Corporation	,, 20	187	—	—	—	—	—	—	—	—	—	—	—	—	—
Kirkcaldy Corporation	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Leeds Corporation	,, 22	5,630	5,119	+ 511	+ 7,439	77	—	March 25	262,656	57,239,779	5,773,651	1·11	10·91	3,283	—
Liverpool Corporation	,, 15	10,183	10,091	+ 92	+11,538	101	95	Dec. 31	504,304	108,906,472	11,705,425	1·11	10·34	5,000	6·88
Liverpool Overhead Railway	,, 23	1,716	1,670	+ 46	+ 756	15½	15½	June 30	79,252	10,466,726	986,185*a*	1·82	19·30*a*	5,110	— *a*
Metropolitan District Railway	,, 23	6,171	6,089	+ 82	— 2,777	—	—	—	—	—	—	—	—	—	—
Nelson Corporation	,, 22	112	—	—	—	—	—	—	—	—	—	—	—	—	—
Newcastle-on-Tyne Corporation	,, 22	3,506	2,800	+ 706	—	38½	36	March 25*g*	150,334	33,474,122	3,379,119	1·08	10·93	4,175	6·17
Portsmouth Corporation	—	—	—	—	—	29	29	Sept. 30	47,651	9,168,137	868,157	1·24	13·17	1,643	—
Rochdale Corporation	July 20	157	164	— 7	—	4½	—	March 31	5,416	925,281	127,456	1·38	10·27	—	7·66
Salford Corporation	Aug. 24	3,856	2,721	+1,135	+24,705	—	—	—	—	—	—	—	—	—	—
Sheffield Corporation	,, 23	4,616	—	—	—	53½	46½	Mar. 25*g*	216,709	56,812,049	4,926,083	0·904	10·428	7,510	7·0
Southampton Corporation	,, 13	1,270	1,270	—	—	11	11	,, 31	35,874	9,084,522	752,814	0·946	11·436	3,760	—
Sunderland Corporation	,, 23	1,506	1,390	+ 116	+ 1,208	18·48	17·18	,, 31	59,930	13,987,121	1,270,957	1·03	11·3	3,243	6·43
Wallasey U.D.C.	,, 22	834	714	+ 120	+ 2,152	10·5	10·5	,, 31*g*	31,307	5,690,378	654,550	1·32	11·47	2,981	6·97

* Includes maintenance of permanent way and proportion of profits paid to the tramway companies for term of unexpired lease. *a* Train mile.
b Per mile of single track. *c* Include rail and tram. *d* including depreciation. *f* Including one section of horse traction *g* 1903. *h* Half-year's figures.

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NOTES.

Book Received.—"Practical Construction of Electric Tramways," by Mr. Wm. R. Bowker, C.E. The information given in this, the first edition, is limited to the laying out and construction of the permanent way and the overhead equipment of electric tramways. In future editions closer attention will be paid to the slotted conduit system, and also to electric street, underground, and elevated railway systems. The book is published by Messrs. E. and F. N. Spon, Limited, at 6s.

Institution of Civil Engineers.—The secretary of the above institution has issued another batch of papers, comprising vol. cliii. of the society's proceedings. Among those which interest us more particularly are "Electric Automobiles," by Mr. H. F. Joel, with an abstract of the discussion; "Cauvery Power Transmission Scheme," by Mr. H. T. Hincks; "Construction of the Permanent Way of Electric Tramways," by Mr. Robert Bruce; and "Municipal Work in Sydney, N.S.W.," by Mr. R. W. Richards.

Electric Traction Trials.—Advices from Berlin state that trials are being conducted on the Prussian State Railway at Spindlersfelde with a new system of electric traction, employing single-phase alternating currents. The motor used is a special contrivance of the Union Elektricitäts-Gesellschaft. The one great claim which is put forward in favour of this motor is that it is capable of giving every desirable degree of speed, and notwithstanding is exceedingly simple in construction. So far the trials are reported to have given the utmost satisfaction. They are now being continued, and no doubt some authoritative data of the results will be issued before long.

Literary Notice.—Messrs. Longmans, Green, and Co. announce that they will publish during the present month a new edition of "The Steam-Turbine," by Robert M. Neilson. The size of the volume has been nearly doubled. Large additions have been made to the chapters descriptive of the Parsons and De Laval turbines, the additions including dimensions drawings. Illustrated descriptions are now given of the Westinghouse-Parsons, Curtis, Stumpf, Seger, and Schulz steam-turbines. Indicator diagrams are shown taken from the latter turbine by Herr Schulz's ingenious device. The new Rateau governing device is also described. The chapter on "Marine Propulsion" has been greatly extended, and the recently completed turbine vessels are now included.

Electricity in Sicily.—The use of electrical machinery in the sulphur mines of Sicily is increasing. We learn from a British consular report that at the Trabonella mine, which is about the largest in the island, the proprietors have erected four 120-h.p. gas-engines of German manufacture with the relative Dowson gas plant, using anthracite coal, four dynamos of 110 h.p., which produce the necessary power for electric winding, electric haulage on surface, electric pumps of 10 h.p. each, electric lighting on surface and underground, and for a 25-h.p. flok and maccaroni mill, which supplies the workpeople with food, at lower prices than those current in the neighbouring towns. Developments are impending, and manufacturers will find an open field for their wares in the island of Sicily.

Wireless Telegraph Conference.—The result of the international conference held recently on the initiation of Germany to consider the subject of wireless telegraphy was announced in Berlin on Wednesday night. The chief recommendation arrived at by the conference, it is reported, is that there should be an international convention making it compulsory for all coast stations in all countries to accept and transmit wireless messages, whether by the Marconi or other systems. This was agreed to by a majority of six out of the eight countries represented, Great Britain and Italy being in the minority. It is stated that the above recommendation was directed against the Marconi Company's attempt to create a monopoly. The conference also recommended that tolls should be fixed, as for ordinary telegrams, by international arrangement.

Pupin's Long-Distance Telephony.—Dr. Jeutsch, who is attached to the German telegraph service, has been criticising Dr. Pupin's system of long-distance telephony. His objections are levelled, not at the electrical features of the system, but simply at certain mechanical difficulties that might be encountered. In his opinion external pressure of the water would increase with the depth to which a submarine cable was laid. At a depth of two or three miles it would not be impossible that a pressure of 3,000lb. to the square inch would be found. From this, according to the *Scientific American*, Dr. Jeutsch concludes that Pupin's inductance coils, unless constructed with extraordinary strength, would be crushed in. Dr. Jeutsch, however, as well as Prof. Pupin himself, agrees that the difficulty is by no means insurmountable.

Atlantic Wireless Telegraphy.—Mr. Marconi now promises to establish a commercial service of wireless telegraphy across the Atlantic within three months. We conclude from this that the new installation in Cornwall, which was stated to be essential for the dispatch of wireless messages to the other side, will be completed by that time. However, Mr. Marconi, who arrived in New York on Sunday, told a Dalziel correspondent that he would then be prepared to send messages of any length by wireless telegraphy from Canada to England. He is also reported to have said that the "Lucania" had been in touch with land during the whole of her voyage across the Atlantic. Mr. Marconi evidently recognises the impracticability of a commercial service so long as it can be interfered with by other wireless telegraph systems. He is going to take legal advice on the point.

Water Power in New Zealand.—In the last few years great attention has been paid by some of the principal municipalities in New Zealand to the possibilities of water power for electrical purposes. There are several swift-flowing rivers in the colony which offer good opportunities for this, not the least important of which is the Waitaki River. An early visit from an American electrical expert employed by the Government is expected to test the resources of this river, with a view to a scheme for supplying three boroughs with electricity and power. These are the cities of Timaru, Waimate, and Oamaru, and the proposal to work in conjunction in this matter gives better hope of the scheme being eventually carried out than if it were undertaken individually. The Waitaki River has already been subjected to a preliminary inspection by a Government local inspector, whose reports have decided the Government to seek the more practical advice of an American expert on the question.

Becquerel Rays and Water.—Some interesting facts about an action of radium rays on water were brought into prominence in a note by F. Kohlrausch, recently read before the German Physical Society, Berlin. A mixture of radium and barium bromides was placed in a flat capsule and covered with an aluminium sheet 0·1mm. in thickness, and the rays emanating from it allowed to traverse a water layer about 18mm. in thickness, when an acceleration in the increase of the conductivity of the water was noted during a prolonged action of the rays, though no immediate effects were stated. The author is unable to

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give a sure interpretation of this fact, as the radium rays may either have given rise to a development of ions within the water or else have accelerated the disaggregation of the walls of the glass tube. As regards a third hypothesis, according to which something like bromine would have penetrated into the tube, the author states that this is highly improbable, a special experiment having given negative results.

American Electrochemical Society.—We have received from Philadelphia an announcement of the fourth general meeting of the above society to be held at Niagara Falls on the 17th, 18th, and 19th of this month. In the choice of Niagara Falls as the place of meeting the society has, no doubt intentionally, lighted on the centre of electrochemical activity in the States, and a good part of the time will be devoted to visits to power-houses and certain of the electrochemical plants which are open to inspection. A large number of papers will be read and discussed at the three days' meeting, and some of the leading American electrochemists will participate. We are glad to note that an arrangement has practically been arrived at between this society and the recently formed Faraday Society for a free exchange of their respective *Transactions*. This is as it should be, and although involving extra expense on both sides, the advantage to the members of the societies of receiving these volumes regularly is ample compensation for any pecuniary loss.

Automobile Reliability Trials.—The Trials Organisation Committee of the Automobile Club have now made public the list of entries for their fifth annual reliability trials. An analysis shows a gratifying increase in the British competitors as compared with last year. There is a total of 76 British cars, compared with 41 in 1902; the increase for foreign cars being from 43 to only 59. Thus it will be seen that the British increase is 85 per cent., while that of the foreign entries is only 37 per cent. There is a net increase of 16 in the number of British firms in the list of competitors, which is in itself a strong argument against unduly strict administration of the law. The principal increase is in cars built to meet the requirements of people of moderate incomes, say cars costing under £400, the annual upkeep of which should certainly not exceed £50 per annum, and of this type upwards of 50 cars are entered for the trials. Out of a total of 140 entries, only 10 are steam cars, which shows the enormous preponderance of the internal-combustion engine in popular favour.

Electrical Exports from the States.—These show an increase for the fiscal year ended June 30 last, although the exports for the previous 12 months were less than those in 1901. The figures as given in the annual statement of the U.S. Treasury Department are interesting. Last year the value of the electrical machinery exported from the States was £1,155,891, of electrical appliances, including telegraph and telephone instruments, £841,324, making a total value of £1,997,214. In 1902 the exports were valued at £1,802,301, an increase last year of £194,913, or about 10¾ per cent. But, as before stated, there was a diminution in the exports for 1902 as compared with 1901. A further comparison of the figures shows that the gain last year was in both electrical machinery and appliances. As in previous years, Great Britain and the British Colonies were America's best customers for electrical machinery, the exports to Great Britain alone amounting to £451,212, or nearly double those to British North America, which comes next with a total of £248,180. Mexico is third on the list with a total of £117,652, and British Australasia fourth with £85,685.

Electric Lighting in Buenos Ayres.—A monopoly of electric lighting at Buenos Ayres is held by a German company, but originally the undertaking was in the hands of a syndicate of French capitalists. In 1901, however, the German Transmarine Electricity Company purchased the undertaking from the French company, and this was followed by the acquisition of the works of the River Plate Electricity Company in that city, and more recently by a decision to obtain possession of the electrical works of the Primitiva Gas and Electric Lighting Company of Buenos Ayres. The latter works have been leased to the German company for a period of 41 years on the payment of £30,000 per annum, but on completion of that period the works will pass into the possession of the German company without further payment. Thus we have a case of German private enterprise absorbing both English and French interests in a particular business in one town, and creating a monopoly which practically controls the whole of the electrical lighting works in Buenos Ayres, and also owns the metropolitan tramway in that city.

Aluminium Production.—At present Niagara Falls is the centre of the aluminium industry in the United States, and the Pittsburg Reduction Company is the sole producer of the metal in that country. However, this company is preparing a power plant at Massena, New York, which is expected to double the output of aluminium in the States. The new plant will consist of four units of 300 h.p. each, generating current at 1,500 volts. The approximate output of aluminium in the States during 1902 was 7,300,000lb., as compared with 7,150,000lb. in the previous year. Twenty years ago the annual output was 83lb., and three years later it had risen to 3,000lb. Each year for the next 10 years the industry made steady advances, until in 1896 the output was about 1,300,000lb., increasing year by year until now the output has reached over 7¼ million pounds, which looks like being doubled before very long. Aluminium has advanced in popularity for use on transmission lines very considerably in the last few years, but it has also attained a high standing for the manufacture of domestic and culinary articles. The price is believed to be regulated by an international agreement between the producers.

Guttapercha in the Philippines.—The belief that the Philippine Islands could furnish a very valuable supply of guttapercha if properly cultivated, is confirmed by a report which has recently been issued by Dr. Penoyer L. Sherman, jun., of the Philippine Forestry Bureau. The report has been made as the result of an expedition in search of guttapercha trees in the Philippines, during which several species of the trees were found in the island of Mindanao, and the islands of the Sula Archipelago; and it is stated that the Chinese have built up a large trade in this product. The total exports of guttapercha from the Philippines last year is put at 14,000lb., but the report states that particularly in the mountainous regions the guttapercha tree is to be found in abundance. Dr. Sherman extracted the gum from some of the trees during the expedition. One tree, 160ft. in height and 8ft. in circumference, yielded 9½lb. of dry guttapercha. Under cultivation it would probably have yielded 20lb., while, had the bark and leaves been secured, from 150lb. to 200lb. could have been obtained. In view of the present wasteful methods of harvesting now in use by guttapercha planters it is proposed that the United States Government shall take over the business of rubber cultivation in the Philippines, with the object of regulating the supply and preventing much of the cheating which is now done by the Chinese merchants.

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Electricity in the East.—It is not to Northern China that one would usually look for an example of electrical progress, but there is at least one place on the eastern shore of the Liaotung Peninsula which might well set an example to many of the Western towns. We refer to the city of Dalny, which lies near Port Arthur in that portion of the Chinese Empire which was leased to Russia in 1898. Electrically, Dalny is up-to-date. It has both telephones and the electric light. The central station, which is considered the finest electric plant in Asia east of Singapore, was finished over a year ago. It is equipped with three of Ganz and Co.'s generators, with a total of 1,000 h.p., and has a reserve space for additional machines to double its present capacity when required. Dalny, besides other things, is an important seaport, and has a dry dock 380ft. long, 50ft. wide, and 18ft. deep, which is equipped throughout with electric pumps. A larger dry dock is building, at which electricity will also be adopted. In connection with the dry dock are the harbour repair shops, with foundry, smithy, machine and fitting shop, boiler shop, etc. All these shops are electrically driven and lighted throughout. Dalny also boasts an excellent telephone service, and altogether it may fairly claim to be one of the most progressive cities in the East.

Large Electric Locomotives.—In the issue of the *Street Railway Journal* for Aug. 22 an interesting description is given of two large electric locomotives which have been constructed for the Baltimore and Ohio Railway for tunnel work. Each locomotive is made up of two 75-ton units, so that its total weight is 150 tons. It will be operated with type M control of the General Electric Company, the control being so arranged that each section may be operated independently, or any number of sections coupled together and operated from any one section. The locomotive is designed to draw a 1,600-ton train on the Baltimore and Ohio trunk line through the tunnel over an 0·8 of the 1 per cent. grade at a speed of 10 miles an hour, and over a 1½ per cent. grade at a speed of nine miles per hour on 625 volts. Under practical operating conditions the motors have sufficient capacity to maintain this service hourly, running loaded up the grade and returning light. In starting, the motors have more than sufficient capacity to handle as heavy a train as the weight on the drivers will permit. The motor equipment of each unit consists of four G.E. 65 motors of about 225 h.p. each, with special slow-speed winding, making a total for the eight motors of 1,800 h.p. The locomotives have recently been finished at the General Electric works, and will be put in service almost immediately.

Superheating Tests.—We have received for publication results of some experiments recently carried out at Messrs. Mechan and Sons' works at Glasgow by Prof. Watkinson to determine the percentage gain in power, with a given boiler, due to the application of a superheater, and the saving in steam and coal for a given output in horse-power. A Lancashire boiler, 8ft. diameter and 30ft. long, was used, and the superheater was one of Watkinson's shunt-circuit type. The test with saturated steam was of the same duration as that with superheated steam, about seven hours, and among the results obtained are the following: The average temperature of the steam leaving the superheater was 492·5deg. F., and at the engines 470deg. F. The electrical horse-power during test averaged 176·2 in the case of saturated steam, and 240·8 in the case of superheater; the gain in power due to superheating was thus 36·6 per cent. The consumption of steam per electrical horse-power hour comes out, however, at a very high figure, even with superheated steam. In the test with saturated steam it was 44·9lb., and with superheated steam 31·7lb. The consumption of coal per electrical horse-power hour was 7·51lb. and 5·45lb. respectively. The main result, however, is that by superheating a saving was effected in steam of 29·3 per cent., and in coal of 27·4 per cent. The actual amount of coal burned on each trial was practically the same.

Technical Instruction for Apprentices.—At the present time the large railway companies are particularly anxious to encourage the technical education of the most promising of the apprentices in their workshops. We know of one or two cases in which the apprentices have been granted several months' leave of absence in order to take up technical study—of course, under the surveillance of their employers. The Great Western Railway Company is now offering facilities, in conjunction with the Swindon Education Committee, for a limited number of selected students to attend day science classes at the technical school. Candidates must be registered apprentices between 17 and 18 years of age, and must have spent at least one year in the works. Another stipulation is that they must have regularly attended for at least one session in the preparatory group of evening classes at the technical school. The number of studentships will be limited to 30 at any one time in groups for a three years' course. The Great Western Railway Company deserves all praise for its generosity in this matter. Not only will the company pay the students their wages as if at work in the factory, but also their school fees. The students attending the day classes will be expected to give some time each evening to private study. Those who distinguish themselves will be allowed to spend part of their last year in the drawing office and chemical laboratory.

Institution of Electrical Engineers.—From the secretary of the above institution we have received three volumes—viz., Part 5, No. 163, of the *Journal*, index to vol. xxxii., and a new list of officers and members, corrected to June 30 this year. The first-named volume contains the following papers with the discussions thereon: "Applications of Electricity in Engineering and Shipbuilding Works," by Mr. A. D. Williamson; "Electric Driving in Machine Shops," by Mr. A. B. Chatwood; "Electricity Supply for Small Towns and Villages" (Leeds Section), by Mr. A. B. Mountain; "On the Preservation and Packing of Plant for and in Bengal" (Calcutta Section), by Prof. Bruhl; "The Carriage of Goods on Electric Tramways" (Manchester Section), by Mr. A. H. Gibbings; "Notes on Motor-Starting Switches," by Mr. A. H. Bate; together with a paper by Messrs. C. D. Taite and R. S. Downe, entitled "Comparison Between Steam and Electrically Driven Auxiliary Plant in Central Stations" (Manchester Section), and an original communication by Mr. F. W. Carter, M.A., entitled "Some Notes on Heat Runs.' This number also contains the annual report of the Council for the past session, and is the last of vol. xxxii. As usual, there will be no further issue until the end of the year. The membership of the Institution, including associate members, associates, students, and foreign members, as shown by the new list, now stands at the highly respectable figure of 4,818.

Steam and Electric Competition.—In America the railway companies operating their lines by steam have recognised by this time that they must adopt some radical changes if they are to stem the inroads on their revenue, resulting from the competition of the electric roads. They must prepare to meet this competition, and various proposals have been made for achieving this end. The heavy expense involved in completely changing over from steam to electric traction, has induced several of the large

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railways in this country to adopt motorcars which are self-contained and driven by petrol motors. In America they have another idea. It is to construct electric lines alongside the present tracks, so that they may operate an electric service in those districts mostly affected by the electric tramway, or street railway, competition, and at the same time maintain their steam trains for long-distance traffic. This, it is thought, would solve the question as to local traffic, which is what the steam railways are rapidly losing. The competition of the electric lines is, of course, far more active in America than in this country, but English railways may profit by the experience of their American cousins, and take up the question before it is too late. It will be apparent that the electric lines, if constructed on private ground, such, for instance, as is proposed by the American railways, would prove more advantageous than if laid in the form of tramways on the public roads, in which case they would not be able to reach the high speeds required owing to other traffic.

Tramways and Light Railways Association.—There are two or three announcements of much interest in the official circular issued by the above association for the present month. In the first place, we note that the council has decided to grant annually a prize of a bronze medal and books to the best essay on improved means of communication. Papers, which must be sent in to the secretary on or before Nov. 30, must not exceed 4,000 words in length. There will probably be plenty of competitors for the prize, and some interesting papers should be the result. Another announcement of importance is that the next tramway congress will be held early in September, 1904, in Vienna. The International Tramways and Light Railways Union has prepared a list of the questions to be submitted and discussed, to which replies are requested before Oct. 30 next at the latest. The subjects are briefly: depreciation, transfers, savings in current consumption, brakes, guard wires, trailers, electric traction on light railways, fall in potential thereon, permanent way therefor, comparative legislation, accounts and reports, general inspection, use of automotors on light railways. The first meeting of the winter session of the association will be held in London at the beginning of October, when Mr. R. H. Scotter will deliver an address on "Fiscal Policy as affecting Tramway and Light Railway Enterprise." Notice of time and place of meeting will be made soon. Another matter of interest is a proposal to form a tramway club in London if the scheme meet with sufficient support.

Experiments with "N" Rays.—Mr. Blondlot, the French scientist, has lately been making experiments with these rays, and has published some of his conclusions. It has been established that most of the artificial sources of light emit radiations capable of traversing metals and a number of other bodies opaque to light—that is to say, radiations affecting the eye as light. These rays, which are distinguished by the name of "N," enhance the phosphorescence of phosphorescent substances, and Mr. Blondlot has employed this fact in trying whether such rays are emitted by the sun. With this object he placed a tube of phosphorescent material—for example, sulphide of calcium—behind an oaken panel or shutter, closing a window exposed to the sun, and keeping the chamber dark. If, now, a plate of lead, or even the hand, be interposed between the shutter and the tube the phosphorescence diminishes, and when the plate is withdrawn it increases. The panel of oak had a thickness of 15mm. The phosphorescence is rather feeble at first, and a sheet of black paper may be held as a background to the tube. Plates of aluminium and cardboard between the shutter and the tube do not prevent the phenomenon. The "N" rays from the sun, it was found, can be concentrated by a lens of quartz. They are reflected by polished glass and diffused by ground glass. Like the "N" rays from a Crookes tube, or a flame, those of the sun act on a small spark and a tiny flame so as to increase their brightness, but the experimenter has not obtained any photographic effect from these rays.

The Victoria Falls.—Our readers are cognisant of the scheme for turning to account the immense natural forces of the Victoria Falls, in Rhodesia, for electrical purposes. We have on more than one occasion in these columns spoken of the almost inexhaustible energy which these falls—in comparison to which those at Niagara sink into something approaching insignificance—contain, and only await the latest devices at the disposal of man to be converted into a source of indigenous wealth and prosperity to the country. The initial survey of the falls has yet to be made, but a rough estimate has placed the energy that might be harnessed at several hundred thousand horse power, at present running to waste. This may easily be imagined when it is stated that the falls are over a mile in breadth, and considerably higher than Niagara Falls. An interesting statement was made regarding the possibilities of the scheme at the meeting of the African Concessions Syndicate, which owns the concession. Although the proposal has not yet taken definite form, the concessionaires have already defined a very wide market for the electric power. A great deal, of course, depends upon the distance the current can be conveyed; but in America they have accomplished great things, and it is thought, profiting by their experience, that it will be possible to transmit power within a radius of 300 miles from the falls. This would embrace all the principal mining grounds round about, including the Waukie coalfields, the Gwelo, Sebakwe, Selukwe, Lomagunda, and Hartley goldfields, the Northern copper discoveries, and some 800 or 900 miles of railways. It will be seen, therefore, that the field open to electric power in the neighbourhood of the Victoria Falls offers splendid prospects, and on the face of it fully warrants the scheme being energetically pushed forward. It must take some years, however, before the scheme is in operation, but when accomplished it should play an important part in the development of what is still a comparatively new country.

Engineering Standards Committee.—Mr. Leslie S. Robertson, the secretary of the Engineering Standards Committee, has issued an interesting review of the work of the committee since its appointment some three years ago. In that time no fewer than 27 committees have been at work with 170 members, including 25 representatives of Government departments, and the results of their labours are so far very satisfactory. For instance, in the matter of tramway rails the sub-committee have agreed upon a series of standards which have been approved by the Board of Trade and have been rolled abroad, and the report of the sub-committee on railway rails is nearing completion. The standardising of electrical plant is presided over by Sir Wm. Preece, and four sub-committees have been doing much useful work. The sub-committee on generators, motors, and transformers have been collecting evidence for the determination of standard voltages and frequencies, and also the standard sizes for dynamos and motors. The other electrical committees deal with such subjects as cables and conduits, telegraphs and telephones, and the temperatures of insulating materials. It may be mentioned that the French Government have sent over a commissioner to study the procedure and the lines upon which the Engineering Standards Committee is organised.

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Mr. Robertson concludes that "the epitome sufficiently indicates the enormous importance of the work in hand to the trade of the Empire. The Premier, Mr. Arnold-Forster, Sir John Wolfe Barry, and others have expressed opinions as to the immense value of its labours, the result of which it is difficult to over-rate if they are loyally supported by the trade and commerce of this country, as by the Government and its various departments." It may be added that the example of the Government in granting £3,000 towards the expenses of the committee has been followed by the leading manufacturers, who are also subscribing to the support of the movement.

Water Power in Switzerland.—There have been many proposals put forward for operating the whole of the railway system of Switzerland by electricity obtained from water power. Different engineers have their different ideas and prejudices, but however far removed from each other they may be on the question of the particular system of operation to be adopted, there is very general agreement as to the practicability of and necessity for changing from steam to electrical working. The chief cause for this is the recent rise in the price of coal, which leaves little margin on the right side between revenue and expenditure, besides which it is generally conceded that the almost illimitable water power, a great part of which is at present performing no specific function in the Swiss mountains, offers opportunities such as are to be found in very few countries. The latest exponent of a scheme having for its object the use of electric energy on the Swiss railways furnished by hydraulic plants is a Mr. Thormann. He estimates that the five main railways in the country would require over 30,000 h.p. daily, but that in order to organise a complete electric system it would be necessary to obtain about double that horse-power in the shape of alternating current of high tension, not counting the reserve plant, which is indispensable. Already there exist 21 large hydraulic plants capable of giving an aggregate of 86,000 h.p., and there are a large number of falls in the country which have not yet been taken advantage of. Mr. Thormann estimates the total cost of changing over to electric traction over the whole railway system at some 32 millions sterling, which includes eight millions for rolling-stock and ten millions for sub-stations. Coal has to be imported into Switzerland, there being no home supply, and it is to be noted that the adoption of electric traction, although involving a huge cost, would have the great advantage of dispensing with the present large importation of coal. The scheme is undoubtedly practical, and one which the Swiss Government very rightly cherishes as the future salvation of the State railways.

Telegraphs and Telephones in New Zealand.—Marked progress in the telegraph and telephone fields is shown by the annual report of the Post and Telegraph Department of New Zealand, and it also indicates a general increase in the electric power and lighting industries of the colony. The period considered is the 12 months ended March 31 last, and the total value of the telegraph and telephone business for the year amounted to £241,964, compared with £228,404 for the previous year—an increase of £13,560. During last year there were over 4½ millions of messages exchanged over the various lines, an increase of 391,323. Of the total number of telegrams, 4,271,218 represent the paid traffic, producing a revenue of £149,044. This amount, compared with the revenue from paid telegrams for the year ended March 31, 1902 — £137,616 — shows a gain of over 8 per cent. There were 22,672 miles of wire in operation at the close of the present fiscal year, as compared with 21,705 miles the previous year, an increase of nearly 1,000 miles. As regards the telephone business, the number of central exchanges increased during the year from 23 to 26, and the sub-exchanges from 35 to 44. With this expansion there was an increase of 1,373 new subscribers, bringing the total up to 10,633. The exchange subscriptions for the year amounted to £58,410, an increase of £6,424 over the previous year. On March 31 last 8,727 miles of telephone wire were in operation, an increase of 960 miles during the year. Reference is made in the report to the completion of the British Pacific Cable, and it is stated that since the cable has been in operation the colony's telegraphic business has increased about 50 per cent. The average number of messages transmitted to and from New Zealand since the opening of the Pacific Cable has increased from about 425 to 600 a day. The report also records much activity in electric railway building and in electric light and power work, the principal places affected being Auckland, Wellington, and Dunedin. The applications for licenses for electric lighting of boroughs are on the increase. Many of the above schemes contemplate the transmission of power at considerable distances and at high voltages.

Paris Metropolitan.—The deplorable disaster which recently occurred on the Metropolitan Underground Railway of Paris has had its lessons. Mr. F. Poussel, reporter to the special commission of enquiry appointed to investigate the causes of the disaster, has drawn up a number of recommendations which in themselves are a complete condemnation of the methods of working adopted by the Paris company. Briefly, these recommendations state that the present method of traction is proved to be a public danger, and should be modified as soon as possible. Any outbreak of fire caused by a motor should be followed by the immediate isolation of the motor, and consequently its release from further service. Communication by telephone or speaking-tube should be established throughout the whole railway system. A permanent surveillance should be maintained on every platform. The company should establish the means of verbal communication between the employés of every train. The exit at every station should be rendered visible by a light which cannot be affected by currents of air, and specially clear signs should indicate the way out of the station. All these signs ought to depend for their illumination on a source independent of the current which supplies the trains and lights the tunnels. An alarm should be used to indicate the necessity for evacuating the platforms, and the company's servants should call out to the public the side of the platform on which they will find the exit. The fact that the special commission has found it necessary to make these recommendations is sufficient evidence of the total lack of precautions against accident up to the present, and a deplorable want of good organisation on the part of the management of the Paris railway. The sooner the company set about improving these conditions, the sooner will public confidence be restored in their railway. One would not think that the present time was particularly auspicious for applying to the public for more capital. But so it is, the company having decided on an issue of £1,000,000 at the end of this month, thus raising the capital to three millions sterling. There seems to be little doubt entertained about getting the money, for the Paris correspondent of the *Financial Times* says that, notwithstanding the heavy fall in the traffic receipts which has taken place as a result of the accident and the onerous expenditure which the new municipal requirements will necessitate, the issue will probably be subscribed entirely by the present shareholders.

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THE DESIGN OF EXTRA HIGH TENSION SWITCHGEARS.

BY W. E. WARRILOW.

(Concluded from page 316.)

If it is required to make this change without breaking the circuit, a set of parallel contacts are provided which admit of the insertion of a plug, current passing through this while the fuse is being replaced. In Fig. 24 the arrangement of the fuse under the switch gallery is shown, as well as the main portion of the gear, and it will be noticed that a clear space is left above the top of the fuse pot, as explained previously. The switch used with this form of board is also of the oil-break type, and its external appearance will be gathered from Fig. 25, which represents

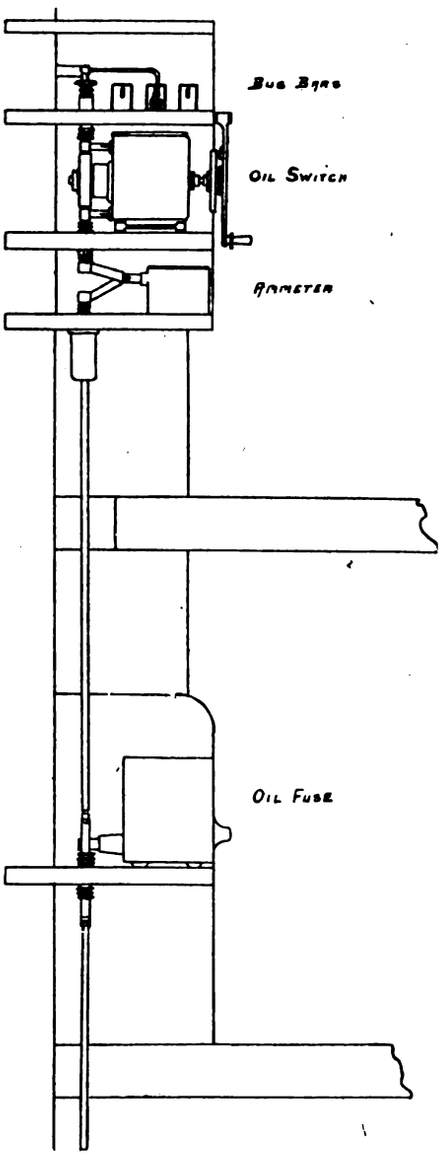

FIG. .—Cellular Gear, showing Mounting of Fuse.

the device with lid on and off, the latter photo being taken with the oil removed to show the contacts. A large porcelain box is used, in a similar manner to the fuse, to contain the oil, the moving and fixed contacts, and also to act as an insulating medium to all the parts of the switch. Two breaks have been provided for—the main break, carrying all the current during the time the switch is closed, and the shunt breaks, fitted inside the pot, and arranged to be left in circuit after the dry break has left its contacts. Referring to the section of the switch in Fig. 26 will make the arrangement quite clear. A steel spindle passes through the box at its centre, and one end of this shaft is fitted with the operating handwheel at the front, while the rear end has the main contact securely fixed to it. The central portion within the pot carries a loose drum, formed of a steel tube on which are clamped the shunt contacts, the rear portion of the drum having an enlargement provided for the spring and catch motions. These latter have been introduced to ensure a quick break under the oil, and comprise a laminated clock-spring fastened at one end to the spindle and at the other to the drum. A weighted catch, fixed to the oil-gland and having a projecting lug for tripping, drops into a notch on the enlarged part of the drum, which remains in the "on" position, with its contacts, until a pin on the spindle, engaging with the trip on the catch, throws this up and allows the energy stored in the spring to be expended in turning the drum round. The main contacts outside the pot will have in the meantime been turned almost at right angles (or horizontal) during the half revolution of the spindle which is necessary to open the circuit. The principal insulator used in the switch is ambroin, which is moulded round the main contacts to prevent flashing from one terminal of the switch to the other. The driving disc is of the same material, and also the plates carrying the fixed auxiliary contacts on the inside of the pot. The building-up of the revolving drum with its connecting blades has been effected by sliding ambroin washers and brass blades alternately over a sleeve of similar insulating material moulded in

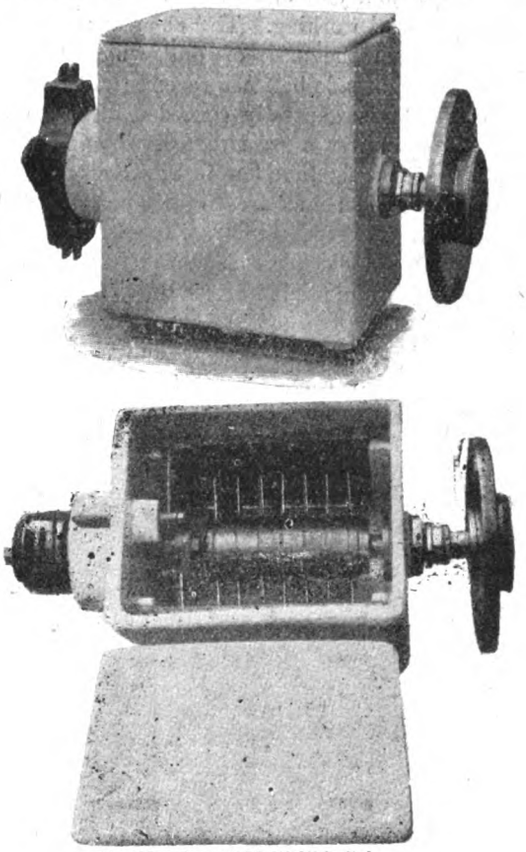

FIG. 25.—Ferranti Multi-Oil Switch.

hexagonal form on the steel spindle. There is no danger from shock in operating the switch, and no noticeable leakage takes place to the metal portions of the apparatus—in fact, every precaution has been taken to render all exposed parts absolutely safe. The oil-level is maintained above the contacts about 4in., and the body of liquid thus obtained effectually quenches the arc formed when the circuit is broken. The auxiliary breaks are arranged to split the arc between 14 points or gaps, these all being in series with one another, and by this means a reliable method of securing a long break is obtained. Suitable glands are fitted for the operating spindle to prevent oil leakage, and the complete switch is designed to draw out of its panel for examination or repair, and it can be replaced by another of similar make in a few minutes. The shunt connection is made at the top and bottom contacts of the switch panel by plugs which enter spring clips bolted to the contacts themselves, all parts being registered from the guide runners on which the switch slides. The operating handle is linked up to the driving disc, and is provided with stops on the lower slate which limit its travel to the correct distance necessary to the motion of the switch. When polyphase work is

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dealt with, the discs are coupled together and driven by one central handle.

The ammeter used with the board is similar in design to that employed with similar gears of lower voltage—that is, it is placed directly in the high-potential circuit, and is made to be withdrawn from its particular panel without removing any connections. The case is of ambroin, and the front is shaped to suit the sweep of the needle over the scale, this latter being presented vertically edgewise towards the front of the gear. A projection at the back of the case carries the main coil, and a central hole is made in the projection which admits of the movement of a soft-iron plunger towards the centre of the coil. This plunger is pivoted to a parallel motion carrying the pointer, an oil dash-pot being included to check the violent action of the needle. The scale is fixed on edge at the front of the meter and the zero is at the top of the scale, so that the needle sweeps in a downward direction when reading.

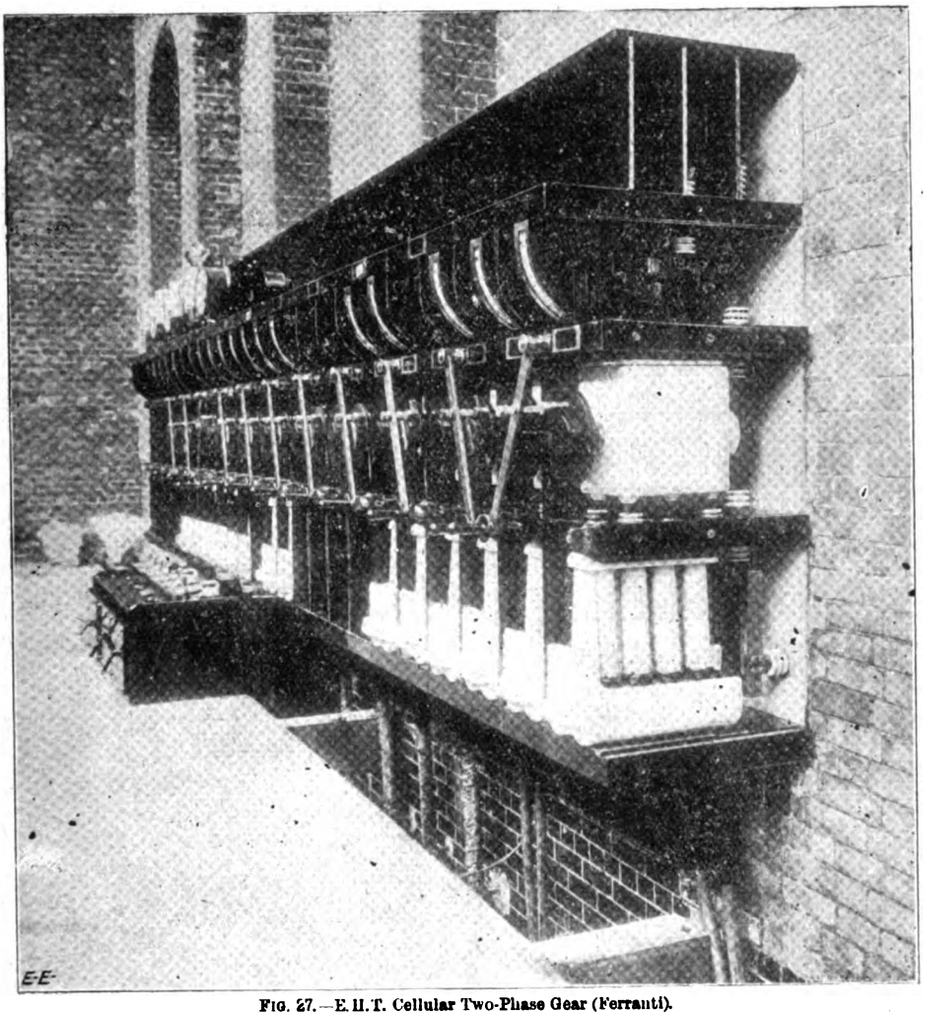

FIG. 27.—E.H.T. Cellular Two-Phase Gear (Ferranti).

The instrument operates without the aid of a current transformer, and by reason of the contacts which project from the coil at the back, it can be pushed into its panel or removed therefrom in a few moments. A zero adjustment is obtained by a small ebonite screw turning in a nut cemented into the lower slate, the screw point touching the front part of the case, so that the meter can be moved vertically on account of its contacts being of the clip type.

In the assembly of this gear a number of horizontal slates are cemented into the wall to form supporting ledges for the various fittings, and the whole combination is divided into any number of cells by the use of vertical division slates, which slide in grooves cut at right angles to the wall in the horizontal slabs. This method of construction enables the particular switches, fuses, etc., forming a complete panel to be maintained in a vertical straight line down the board, and the indiscriminate dotting of the parts about is entirely avoided. This last-mentioned feature not only greatly simplifies operation, but tends to lessen the chance of mistakes, while it affords a ready means of reducing the space occupied by the complete gear. In Fig. 27 a board for controlling a number of two-phase feeders and generators is shown, and the construction of the gear will be readily understood. At the top is the 'bus-bar chamber, capable of containing from one to three bars. Each bar is supported on insulators in the top slate (and not in the wall), and complete isolation from adjoining bars is obtained by ambroin plates running parallel to the wall, and held in position by a slate which forms the cover to the chamber. Directly below the 'bus bars are the ammeters, and their top contacts projecting into the bar chamber, admit of connection to the bar by a removable plug passing through a socket on the bar and entering a hole in the ammeter fitting. The withdrawal of this plug completely isolates the particular panel, which it connects to the bar, from the live bar, so that inspection or cleaning can be readily carried out. The ammeters below the bars are fitted to their respective panels, as already described, and below the instruments the switches are placed. The operating handles project from the slate slightly, and are moved in a direction parallel to the length of the gear. In its passage from "off" to "on" the handle engages with a small switch, closing the circuit of the synchroniser (low tension) and placing the particular generator in connection with the synchronising transformer. This switch is only fitted to dynamo panels, and corresponds to the "half-cock" position common to gears of this class. A front view of a similar board is illustrated by Fig. 28, and the arrangement of the fuses can be seen below the switch panels. This form of fuse is of smaller capacity to that described above, and is incorporated with the main gear, and not set apart from it, as is the case with larger fuses. A cable receiver is mounted underneath the lowest slate, to permit of a neat connection being made to the conductors from the generators or feeders. The feeder panels are fitted with a volt indicator, taking the shape of a vacuum tube, so connected as to glow when the cable is

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charged, thus informing the switchman if the switch is closed at a sub-station or some other outside spot on the line. The generator panels are also fitted with a regulating table mounted on the gallery floor and projecting from the main board to facilitate operation. A rheostat hand-wheel, field ammeter, and field switch are fitted to each dynamo table, the resistance proper being fixed in the most suitable position below the gallery. The voltmeters and synchroniser stand on the slate in front of the 'bus-bar chamber, where they can be easily seen, and are also out of harm's way. The voltmeters are electrostatic, protected by a special device known as a water resistance cut-out, comprising a glass tube containing a column of water and a suitable holder with contact clips. The device protects the voltmeter in case of sparking taking place across the vanes, the momentary current passed under such circumstances causing the water to escape through a rubber valve at the bottom of the water-tube. The synchroniser with a portion of its transformer is mounted between the voltmeters, and its high-tension windings are protected by a removable oil-break fuse. Wattmeters are fitted to the gear to register the energy passing from the dynamos to the feeders and also to a motor-generator occupying a panel in the centre of the gear. The boards described are suitable for dealing with pressures up to 12,000 volts and currents ranging from 10 to 100 amperes, the various capacities being met by two sizes of panel, one of 9in. centres (Fig. 28) and the other of 12in. (Fig. 27) centres, these figures being the width of the panel in each case.

A comparison of the foregoing example of extra high pressure gears will serve to illustrate the manner in which various makers' ideas are worked out in practice as well as indicating the improvements which have been effected. The control of such high potentials is a matter of extreme importance, now that the recognised wants of the industry lie in the direction of large power stations distributing energy over wide areas. In conjunction with the essential features of safety and space occupied, the continuous efficiency of the board has to be considered, as breakdowns for even short periods result in disastrous consequences. The shutting down of a 10,000-kw. station through failure of the controlling appliances does not bear contemplation, and even the stoppage of one plant would seriously affect a large number of consumers. The types of gear described in the foregoing lines clearly point to the transitory condition of switchgears for high-pressure control, and in many ways bring home the fact that this portion of the station equipment has not received the share of thought as has been bestowed on the generating plant proper. Unless some decided steps are taken to level the development of this section of the station plant, the power-houses of the immediate future will be supplying current from first-class plant through controlling apparatus unfitted to deal with the demands likely to be made upon it. The designs which were suitable for dealing with pressures to 3,000 volts are

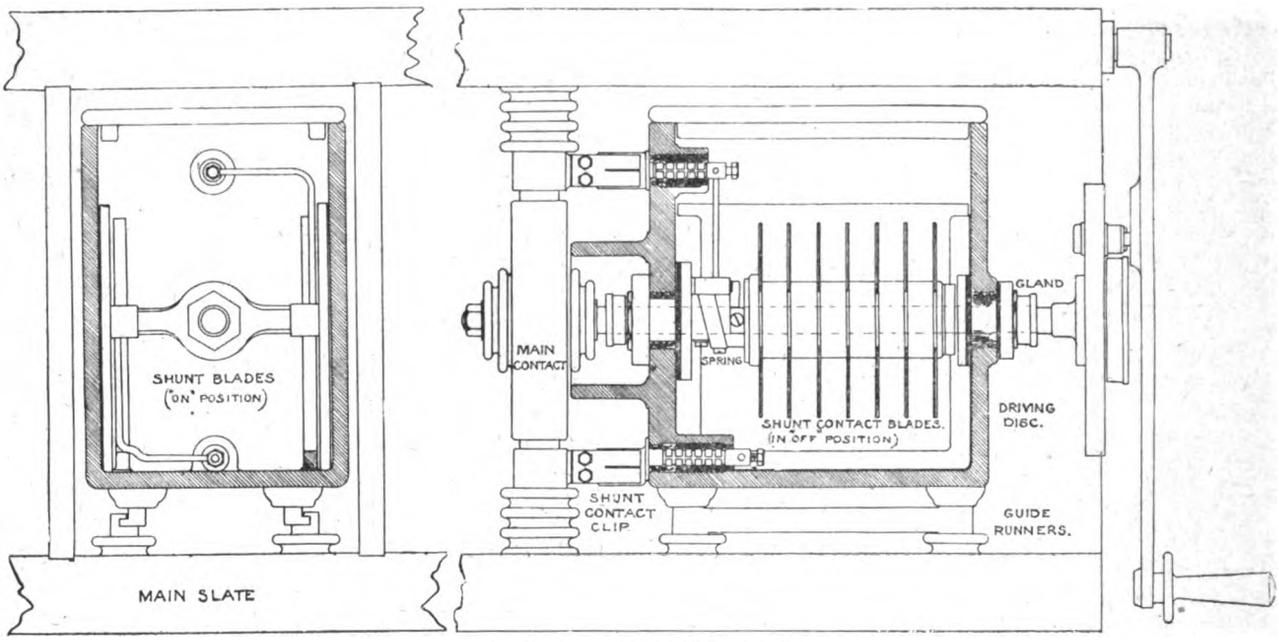

FIG. 26.—Ferranti Multi Oil-Break Switch.

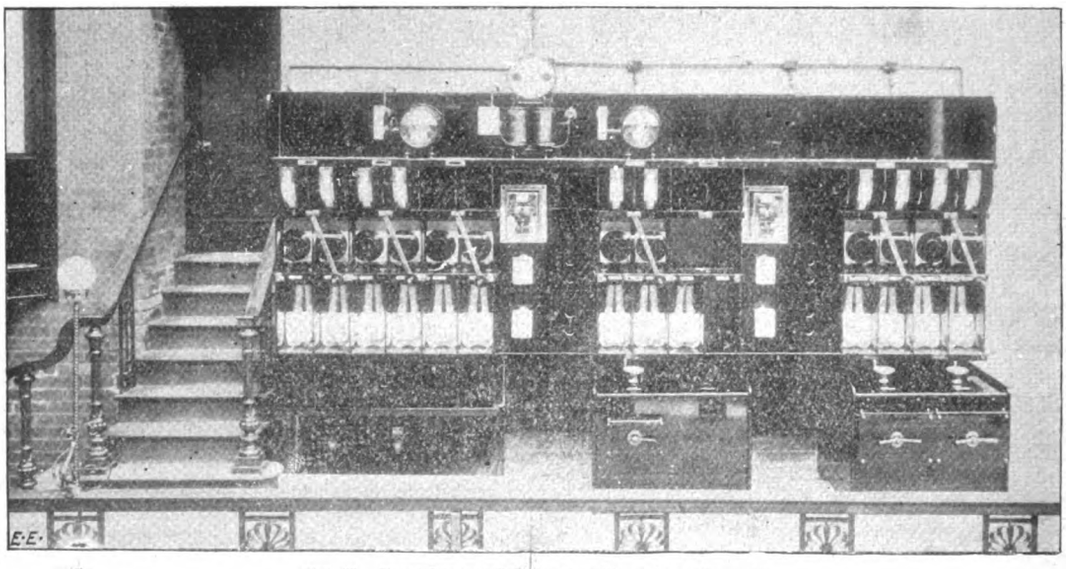

FIG. 28.—Front View of Cellular Two-Phase Gear (Ferranti).

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totally unfit to control higher voltages, and the principle underlying the construction of such gears will also serve no other purpose. This is, of course, only to be expected, but it is nevertheless noticeable that many, in fact, most, of the boards now made are based on the earlier types.

For controlling currents at pressures to about 10,000 volts, experience seems to uphold the arrangement of the panels in concentrated form, and for this reason no doubt the cellular gear has met with extended favour. Beyond this limit of pressure, however, there is a growing tendency to return to the isolated type of gear, once used in single-phase stations, this consisting of a set of switching appliances for each machine placed directly in line with that particular unit in the station. The chief difference in the two methods is found in the system of operation. The old type had a long gallery, and necessitated considerable attention from the electricians, whereas the new form, though scattered as regards the apparatus, is concentrated in the means of control, this being effected from a central board fitted with either levers or switches, according to the operating medium adopted. American experience with these distance control gears seems to be of a favourable nature, and most of the very large power schemes have been equipped with them. The enormous output dealt with certainly justifies something elaborate in the controlling arrangements, and it would seem as if this was fouud in the electrically-operated gear.

In examining the position of affairs logically, there can be little doubt that the extra high tension gear will resolve itself into some definite form of electrically-operated apparatus, situated in an isolated position, which will be kept under strict supervision, though only by those authorised and competent to do so. A close inspection of a lay-out of one of these gears points to a distinct consideration of the factor of safety, and as the whole of the controlling switches and indicating instruments are placed in a low-tension circuit, the risk of shock to the operator on the gallery, at any rate, is reduced to a minimum, though there would still be doubts as to the safety of the electricians handling the extra high tension portions of the arrangement. The vexed question of the advisability of fuses in the high-tension circuit will probably never be satisfactorily settled, though there are prospects of the fuse receiving its death-blow from the electrically-operated switch. The latter has been successfully built to open the circuit automatically, and can be relied upon to deal with either overload or reverse-current occasions in a manner which no fuse could ever equal. The fuse must always be a clumsy device, and one difficult of immediate replacal, no matter how effectually it may open the circuit; and should the high-tension circuit breaker come into extended use, the necessity for a separate switch and fuse will at once disappear. It must not be thought for a moment that fuses will not continue to be employed, as they have a sphere of action peculiar to themselves, and must remain an integral part of switchgear for some time to come. The point for emphasis is, that the combination of a switch and fuse (or some automatic means of interrupting the supply) when successfully accomplished, as in the majority of electrically-operated switches, will so materially reduce the working parts of the board as to admit of no return to two separate devices performing the same operation. There seems to be little doubt now, that the oil switch is the correct device for safely opening the circuit, and flare switches, though still much used for medium voltages, cannot be continuously relied upon to break the arc they occasion when connected to extra high tension lines. It is not often that the oil fires in carefully designed apparatus, and when it is contained in tanks which lower away from the mechanism there is practically no leakage.

It is not intended in this article to deal with the connections of these gears, as that is a subject requiring separate consideration, but it may be noted that in the case of generators little or no provision is made for isolated running, as it is impossible to increase the number of 'bus bars in a polyphase station in the same manner as has been done with some single-phase. The machines are run in parallel, and though a duplicate set of bars may be provided, this number is seldom exceeded.

In looking back on the past and forward into the future, there is a decided prospect of a standard switchgear being produced for controlling extra high tension currents, but it is difficult to speculate on the merging of present designs into such a standard yet awhile. The principles underlying the design may become grounded within the next few years, but there would yet be that variety of production which a competitive commerce gives to every manufacture. Still, even before that state of affairs exists, much now considered of value will need to be discarded, and many pet theories, dear to the hearts of professors and consulting engineers, will be ruthlessly trampled under foot. The issue of *carte blanche* to manufacturers would, it is not too much to say, do a great deal to free the market from designs which can only act as a hindrance to the industry rather than a help. It is in the development of the large power schemes springing up on every side that the solution of the switchgear problem will be found, and the present tendency to adopt the distance control board will, no doubt, be then fully justified.

A NEW SINGLE-PHASE MOTOR.*

Since the polyphase alternating motor has come into general use, attempts have often been made to apply the principle of a rotating field to single-phase motors. It is well known that a polyphase motor can be driven from single-phase mains if it is first brought up to full speed, the rotary field being maintained by the rotating short-circuited rotor. The difficulty, however, lies in starting, as the rotating field must be artificially produced at first. This is usually accomplished by employing an additional starting winding, and setting up a current in the starting winding which is out of phase with that in the main winding. At the best, however, the phase difference, and consequently the starting torque, cannot be made large. Normal torque with double the normal current at starting seems to be about the best result obtainable with these split-phase motors, and this is insufficient in many cases, such as crane and traction work.

Through this endeavour to discover a workable rotary-field single-phase motor another type, the repulsion motor, has been somewhat overlooked. This is also partly due to the fact that after the simplicity of the short-circuited rotor, there is a distinct objection to introduce a commutator into alternate-current motors. The advantages obtainable by the aid of a commutator are, however, considerable.

The working principle of the repulsion motor may be explained by the aid of Fig. 1—*a*, *b*, and *c*. The two-pole magnet shown diagrammatically is excited by means of an alternating current, and the short-circuited armature is consequently acted upon by an alternating flux. The induced alternating current is, owing to the high self-induction of the coils, almost 90deg. in phase behind its voltage, and since this voltage is, of course, about 90deg. in phase behind the flux, the induced armature current is approximately in phase with the flux. A pull is, therefore, exerted in the direction of the arrow on those armature wires which lie under the pole (Fig. 1 *b*). If left to itself, the coil would set itself in such a position that no current was induced in it—*i.e.*, in the position shown in Fig. 1 *a*. The current is a maximum in the position of Fig. 1 *c*, but there is no torque in this position, as the wires under the two poles oppose one another. The maximum torque occurs when the product of current into number of wires under one pole is a maximum, which is approximately the case in the position shown in Fig. 1 *b*.

In order to obtain a continuous torque, a continuous armature winding must, naturally, be provided and arrangements made to maintain the relative position of the short-circuited coils and the magnetic axis constant. For this purpose an ordinary continuous-current armature with commutator can be employed. The brushes are permanently short-circuited, and, by shifting them, the relative position of the short-circuited coils to the magnetic axis can be altered at will (Fig. 2).

* L. Schüler in *Elektrotechnische Zeitschrift* for July 16, 1903.

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Up to the present the armature has been assumed to be at rest, and the armature current strength under these circumstances is determined by the flux passing through the coils and the resistance and self-induction of these coils. When the armature is in motion, however, the wires under the poles cut the flux. The voltage induced in this way reduces the armature current, so that as the speed increases this gradually falls. At the same time the torque is, of course, reduced until a speed is reached at which the armature current is just sufficient to produce the torque required. Such a motor is consequently far from being a constant-speed one, like the rotary-field motors. The speed, on the contrary, depends on the load.

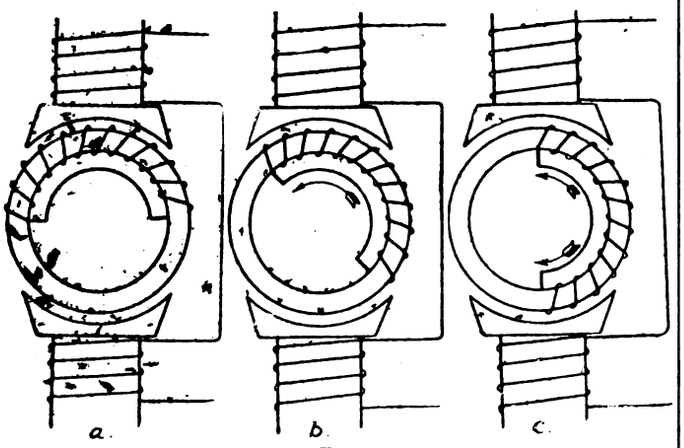

FIG. 1.

The commutation of a repulsion motor is naturally less satisfactory than that of a continuous-current machine, as the coils short-circuited under the brushes are traversed by an alternating flux, which tends to set up large short-circuit currents, which cause sparking. By employing a large number of commutator segments, and by inserting resistances between the winding and the commutator, these short-circuit currents can, however, be kept within reasonable bounds. There is, besides, a method of entirely avoiding this harmful short-circuiting current. It consists in the use of a so-called Weston winding, in which two distinct windings are used on the armature, the commutator plates being connected alternately to one and the other winding. If the brush width is made small enough to touch no more than two sections at one time, no coil will become short-circuited, since neighbouring segments belong to different windings. There are, however, practical objections to this method, such as the extreme accuracy with which the brushes must be set, so that an ordinary winding is usually preferable. In practice, a repulsion motor can be made as sparkless as a fairly good continuous-current machine, and it is a mistake to suppose that this sparking difficulty forms the principal bar to the more general introduction of such motors.

Turning next to the question of the torque produced by a repulsion motor, the writer preferred to deal with the question experimentally rather than analytically, and so constructed a motor whose principal dimensions are shown in Fig. 3 (dimensions given in millimetres). The armature had an ordinary continuous-current winding, but besides the ordinary commutator it was fitted with three slip-rings connected to the winding at three equidistant points. The object of these rings will be explained later. The magnets had no definite projecting poles, but were slotted continuously, and wound to produce six poles. The motor is of a size suitable for developing 5 b.h.p. at 960 revolutions (220 volts and 50 ~) if wound as an ordinary three-phase motor. The machine was first tested as a repulsion motor at 220 volts, and the connection between torque, current, and speed is shown in Fig. 4. The load can be found from the torque and speed. It will be seen that

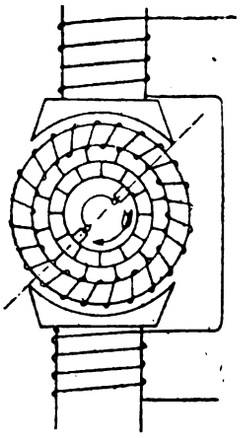

FIG. 2.

when at rest the torque is considerable, but falls off rapidly as the speed increases. The maximum power is developed at about 500 revolutions, and is about $2\frac{1}{2}$ b.h.p. The current is 50 amperes at starting and 26 amperes at normal load. The product of efficiency $\times$ cos ϕ is only 32 per cent. as a maximum. The cause of this unsatisfactory value is the high wattless component, which in repulsion motors is greater the greater the load on the machine. On this account it would seem impossible to construct a rational motor on the pure repulsion principle.

Since the repulsion motor is very satisfactory at starting, but not good when running, whilst, on the other hand, the rotary-field motor has just the opposite properties, the question of using the repulsion principle only for starting and the rotary-field principle for the normal running conditions at once suggests itself. The conversion of a repulsion motor into a rotary-field motor is a very simple matter: the only change necessary being the short-circuiting of certain commutator segments together so as to form a short-circuited armature. Such motors have been, in fact, employed in practice with more or less success. The American Wagner Company, for instance, employs an armature with a centrifugal apparatus fixed inside arranged to short-circuit certain commutator segments as soon as a certain speed is reached. The brushes are at the same instant automatically raised from the commutator. The same problem has been dealt with in another way by Deri. In his motor the exciting winding is arranged so that it can

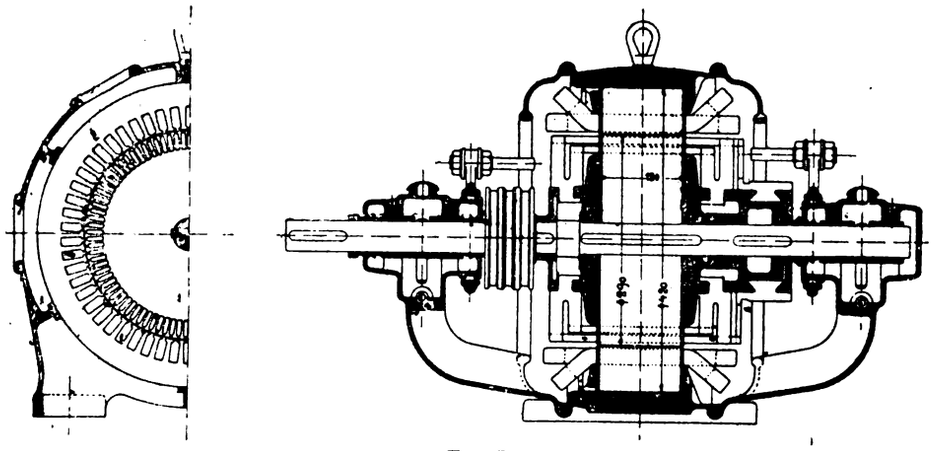

FIG. 3.

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be coupled up for two different numbers of poles. The exciting wire can, for instance, be arranged for either four poles or six poles whilst the armature is wound for six poles, and consequently acts as if short-circuited when running in a four-pole field.

The machine can, therefore, start as a six-pole repulsion motor, and if the field is then converted into a four-pole one the machine will continue to run as a four-pole rotary-field one. The change over is accomplished by means of a special centrifugal apparatus operating when a definite speed is reached. The question next arises as to the correct speed at which to change over. It would, of course, be best to change over at the speed at which the machine will continue to run as a rotary-field motor—*i.e.*, at

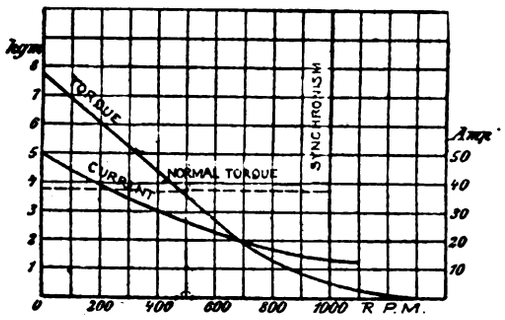

FIG. 4.

synchronous speed. It will, however, be seen from the torque curve (Fig. 4) that this is impossible, or at least only possible when running light. Since the motor is six polar and running off a 50 ~ circuit its synchronous speed is 1,000 revolutions, so that the change over would have to occur at about 960 revolutions. At this speed the torque is only ·7 kg.-m., or less than one-fifth of the normal torque corresponding to 5 h.p. If the motor has to exert a greater torque than ·7 kg.-m. at starting it will not reach full speed as a repulsion motor, and must be changed over at some lower speed. If starting at full torque, for instance, a speed of only 470 revolutions could be reached as a repulsion motor, and at $1\frac{1}{2}$ times full torque only 250 revolutions. After changing over at these low speeds, the machine must be in a position to exert the required torque as a rotary-field motor

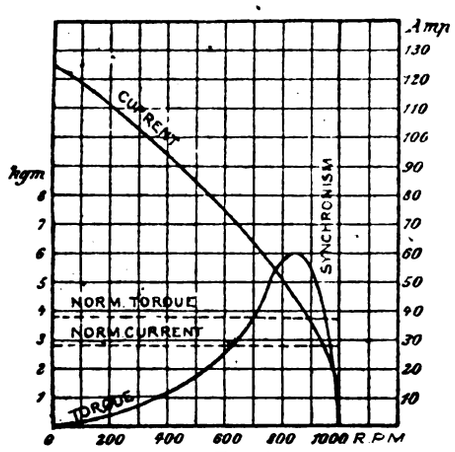

FIG. 5.

at the same speed. To decide whether this was feasible, the writer studied the starting characteristics of a single-phase rotary-field motor with short-circuited rotor experimentally. The same motor as before was employed, but the commutator was short-circuited by means of a thick wire band. The relation of torque and current to speed is shown in Fig. 5. The curve shows what is well known—viz., that when at rest there is no torque, and that the torque only becomes considerable in the neighbourhood of synchronism. On the other hand, the current is excessive when at rest and falls gradually as the speed increases.

Suppose the motor is required to drive machinery taking 5 h.p. normally, and a torque corresponding to double this horse-power at the instant of starting. Fig. 4 shows that the motor will start with 50 amperes and run up to a speed of 470, when the current will have fallen to 26 amperes. At this speed the change over should take place, but Fig. 5 shows that as a rotary-field motor the torque has not reached half the normal value at 470 revolutions, so that if changed over at that speed the motor would come to rest again. In other words, the motor is unable to exert its normal torque during the whole of the starting period. The starting conditions attainable with such a motor are shown in Fig. 6, which is a combination of Figs. 4 and 5. The change over is shown as occurring at a point at which the repulsion motor torque curve crosses that of the rotary-field motor—viz, at 610 revolutions. It will be seen that the torque drops as low as 2·6 kg.-m. (or to two-thirds of the normal), whilst the current reaches a momentary value of 74 amperes, or over $2\frac{1}{2}$ times the normal. Even

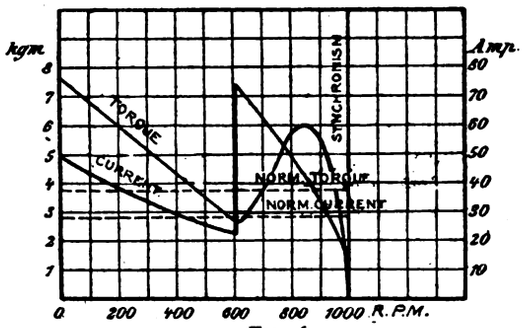

FIG. 6

neglecting the drop in torque, the large momentary current is very objectionable, on account of its effect on neighbouring lamps. This current can be somewhat reduced by increasing the resistance of the armature and the slip. As, however, the losses in a single-phase motor increase as the square of the slip, and the overload capacity falls in the same ratio, this method can only be employed to a limited extent.

It will, of course, be understood that the figures given do not apply generally, as they are experimental results for a particular motor. By strengthening the field, for instance, the repulsion motor torque could be increased, but, unless the dimensions of the motor are considerably increased, this takes place at the expense of the efficiency and power factor. The sparkless running of the machine also, to a certain extent, prevents a higher torque being attained.

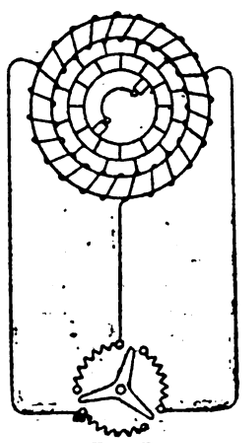

FIG. 7.

The motor employed for the tests was constructed to meet all requirements in the best all-round manner. It runs absolutely sparklessly at all speeds. Its efficiency is 79 per cent., and cos ϕ 78 per cent. The results obtained may, therefore, be considered as a fair example of such motors.

The improvement introduced by the writer consists in changing over from repulsion to rotary-field motor gradually by first connecting points on the armature winding together through resistances, which are then gradually cut out and finally short-circuited (Fig. 7). Two advantages are attained by this means: firstly, a rotary-field motor is known to be capable of exerting a considerable torque even at low speeds and currents if its armature is short-circuited through suitable resistances; and, secondly, the repulsion motor torque continues to be

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exerted until the resistances are quite short-circuited, the machine thus working for a time as combined repulsion and rotary-field motor. The results obtained from the above motor employed in this way are given in Fig. 8. As mentioned above, this motor is fitted with three slip-rings as well as the commutator. These rings are connected to three points on the armature 120deg. apart. For the first test the slip-rings were connected to a three-phase starting resistance, and the torque and current for each speed were noted, the most favourable starting resistance for each speed being first determined. The resistances were short-circuited at a speed of 900. The advantage obtained can be seen by comparing Fig. 8 with Fig. 5. During this last-mentioned test the brushes were raised from the commutator, so that the repulsion principle was absent. When the brushes are down, both the current

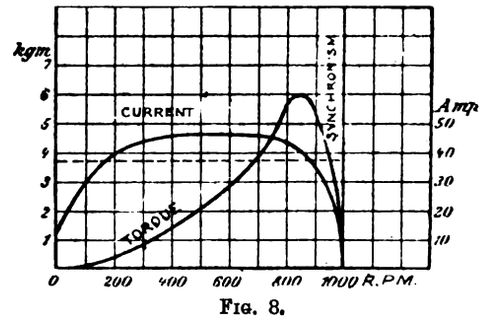

FIG. 8.

entering at the slip-rings and that entering at the commutator flow in the armature winding. It would be an interesting analytical problem to determine how these two currents combine in the separate armature coils, and what their resultant reaction amounts to. The writer has, however, confined himself to the experimental results, and these indicate that the value of the torque at each instant is approximately equal to the sum of the separate torques due to the repulsion and the rotary field actions.

The next test was carried out by permanently short-circuiting the commutator brushes together, whilst the slip-rings were gradually short-circuited as the speed increased. The measured torque and current at various speeds are shown in Fig. 9.

The motor has a torque at the instant of starting of double the normal, and at no time throughout the period of starting does it fall below 1·4 times the normal. The

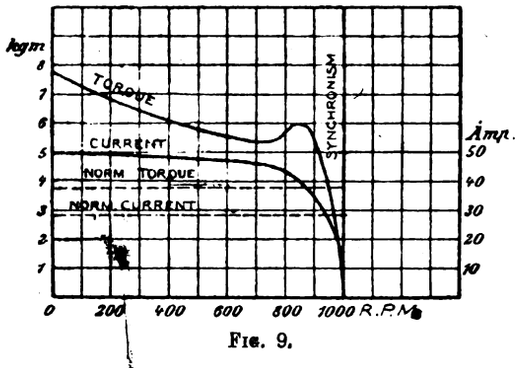

FIG. 9.

starting current, even at the first instant, does not exceed twice its normal value, and gradually falls off as the speed increases until it reaches the correct running value for the load employed. The objectionable instantaneous rush of current noticed with the ordinary change-over repulsion motor is entirely avoided. The speed of the motor can be regulated within a considerable range by inserting resistance into the slip-ring circuits, just as in the case of a rotary-field motor. This insertion of resistance has the effect of transferring some of the current to the commutator brushes, and the machine works as a combined repulsion and rotary-field motor. It is well known that in the case of an ordinary rotary-field single-phase motor no such regulation is admissible, as the torque falls off rapidly with the slip, whilst with the older type of change-over repulsion motor (Arnold, Deri) speed regulation is naturally impossible.

The practical construction of the motor is comparatively simple. The armature has an ordinary continuous-current winding fitted with a commutator and three slip-rings in the same way as a rotary converter armature. The commutator can be very small, as it only carries current when starting. If required, the commutator brushes can be raised when running, but, for the sake of simplicity, this would not usually be done. Fig. 10 is a photograph of the motor, which was constructed by Messrs. Ferranti Limited, Hollinwood, the holders of the English patents. The motor is started in exactly the same way as an ordinary induction motor with slip-rings; the main switch is closed, and then the armature starting resistance is gradually short-circuited. Occasionally the latter action is made automatic. As the motor is more especially suitable

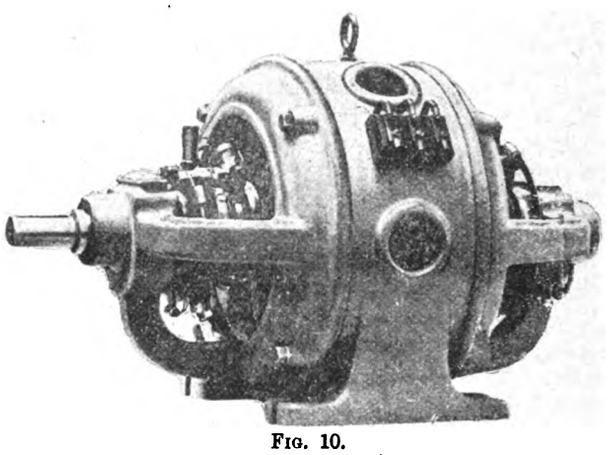

FIG. 10.

for crane and traction purposes, a simple method of reversing it is indispensable. A consideration of Figs. 1 and 2 will show that the direction of rotation depends on the relative positions of the axis of the field and that of the short-circuited armature winding. Reversal can, therefore, be obtained by simply moving the brushes through 90deg. If, however, brush shifting is inadmissible (railway work), two sets of brushes can be fitted—one for right-handed and one for left-handed rotation—and one or the other of these sets can be short-circuited according to the rotation required. Reversal can also be obtained by shifting the magnetic axis. Thus, two sets of exciting windings 90deg.

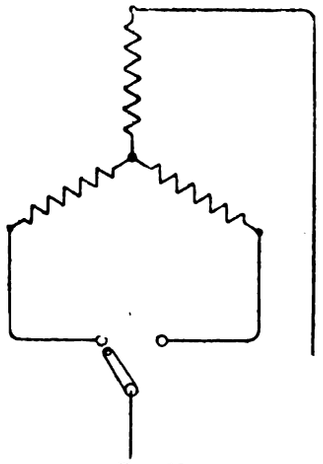

FIG. 11.

apart can be employed, and one or the other switched in to suit the rotation required; or a three-phase exciting winding could be employed, as shown in Fig. 11, and two out of the three phases employed for each direction of rotation. In this case the field is only shifted 60deg. instead of 90deg., but a saving in copper and in winding space is effected.

The first-mentioned method of reversal, by means of two sets of brushes, possesses especial advantages in the case of high-tension railway motors, as by its means the controlling gear need not be connected in any way with the high-tension mains. There would, for instance, be no objection to building a 50-h.p. motor of this type for, say, 10,000 volts. There are no crossings in the exciting coils, so that these can be thoroughly insulated,

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and as one end of the winding is earthed it is only necessary to connect one high-tension lead through a single-pole main switch and fuse to the trolley. The main switch is only used during the longer stops, and the whole regulation is consequently carried out on the low-tension winding.

THE EVOLUTION OF THE STARTING SWITCH.

BY A. H. M.

During the last five or six years the direct-current motor has made rapid and well-deserved advances in popular favour, and as a consequence the demand for starting switches has proportionately increased, and also the demand for improvements in them, the necessity for which has been demonstrated in the course of experience in the hands of both user and manufacturer. A glance at the principal defects of many starters dating some years back may prove of some value in assisting designers to avoid errors of the past.

A mistake frequently met with was that of dividing up the resistance into too small a number of sections, frequently only three or four, the consequence being (even in those days of low-voltage supply) that the potential difference between the contacts was so great that disastrous sparking took place when working, and also the acceleration of speed of the motor was too violent from step to step. Another error was that of dividing up the rheostat into equal parts as regards ohmic resistance; as an instance, if the total resistance was 40 ohms and the number of contacts on the switch five, then 10 ohms would be allowed between each contact, with the result that the motor would not have nearly attained its full speed when the switch arm reached the last contact but one; and when this last section was cut out and the full voltage of the circuit came upon the motor terminals, a rush of current would momentarily take place, with sparking at the brushes. The most up-to-date manufacturers have now realised that about eight to ten contacts is the average number required for a satisfactory starter, and also that the resistance value of the sections should gradually decrease towards the "all out," or armature contact, in order that but very few volts may be absorbed by the last one or two sections.

A necessity which speedily made itself manifest was that of providing some mechanism for causing the switch arm to return to the "off" position should the supply of current to the motor cease from any cause—such as the melting of a fuse. In such a case the attendant would probably open the main switch, replace the fuse, and then close his main switch again, entirely forgetting that all resistance was cut out of the armature circuit, and with results which may readily be imagined. A considerable number of devices for effecting this purpose have been introduced by various makers, but the best and simplest is undoubtedly that of an electromagnet, the winding on which is in series with the shunt coils of the motor, and against the poles of which the contact arm rests when in the running position—thus being held against the action of a spring. The above device has the recommendation of being extremely simple—in fact, cannot fail in its action, as there is no mechanism to get out of order.

Although performing its own particular duty in a thorough manner, this device does not prevent the motor from being overloaded, and various attachments were invented for this purpose, the principle of the action being in most cases an electromagnet, the winding of which is in series with the main motor circuit, and an armature lifted by it when the current exceeds a certain value, the lifting of the armature closing two small contacts, and short-circuiting the coil holding the arm, thus allowing it to fly back and stop the motor. The writer has had some experience of these various forms of "overload preventers," as they are termed, but must candidly say that he has not found them sufficiently reliable in their action to be of much practical value. When quite new and properly adjusted they are useful enough, but one prolific source of failure is that after a time the hinge upon which the armature works becomes clogged with dust or oil, and it then requires a dangerous excess of current to move it. Of course, some means must be provided for preventing the motor suffering from excess current, and this should undoubtedly be effected by the provision of a properly-rated and easily-renewed fuse, and where the cost does not render it prohibitive, by the addition of a circuit breaker, which should be set to open the circuit at about 15 per cent. less current than the fuse will carry, the golden rule in this connection being—never omit the fuse.

Another item of great importance in every switch are the contacts, and although these have undergone but slight change during the last few years, and are not altogether satisfactory, it is not easy to see in what direction improvement is to be effected. For currents up to 40 or 50 amperes the round button contacts do fairly well, but a carbon point should always be fitted to take the spark at the final break, For heavier currents, hard-rolled brass segment-shaped contacts should be provided, these exposing a considerable area of contact, and being, in the writer's opinion, superior to copper, as they are more easily kept clean.

Whilst upon this point, it is important to emphasise the fact that if the contacts never receive any attention (as is so often the case) excessive sparking is bound to occur, and the arm is very likely to stick when half-way over, and cause a burn-out of the resistance. The occasional application of a piece of emery cloth will keep the contacts in good order and prevent accident. The contact-making device on the arm is frequently a flat springy piece of copper, but where the current exceeds 25 amperes this is far from satisfactory, as the front edge soon becomes fused and curled up, and is liable to stick. A more satisfactory substitute is a spring-controlled block of carbon, which is finally cut out of circuit when the arm is in the running position. For currents exceeding 60 amperes the carbon block alone will not suffice, but must be assisted by a copper contact piece, to reduce the sparking and heating, and the relative positions of the two must be such that the make and break on each contact is taken by the carbon. The success of the electric motor in our works and factories has largely depended upon the fact that it lends itself to a subdivision of power that could not be accomplished by any other means, and it therefore follows that the vast majority of starting switches are under 50 h.p. capacity, for which power the combination of carbon and copper contact blocks, with hard-rolled brass segments, will be found satisfactory.

In one extremely important particular the rheostat of to-day shows no improvement over that of 10 years ago; the writer refers to the resistance itself, which still consists of coils of iron or other resistance wire. The trouble which has always existed in connection with wire coil resistances is due to the fact that they cannot be made really substantial without being at the same time bulky and expensive, and the consequence is that they are usually constructed from the finest gauge of wire which will carry the current long enough to start up the motor, and such small gauges of wire are ill adapted to stand against the alternate heating and cooling they have to undergo. There is also another source of destruction, if anything more effective than the above—that is, the continual rusting process, which is always in progress and which soon causes a breakdown.

Many attempts have been made to introduce a satisfactory motor starter of the liquid type, but to the engineer the idea of a pot of liquid in connection with his work is objectionable. Apart from its messy character, there is always the fact to be dealt with that every time the starter is used the level of the liquid must be slightly reduced owing to vapour being given off when it is heated, and it therefore follows that the total resistance is constantly varied. Under certain forms of application it becomes absolutely necessary to provide some means of preventing the resistance from being cut out too quickly when starting the motor. This is particularly required in the case of motors of large horse-power the manipulation of which are in the hands of unskilled persons. The writer has had considerable experience with the various devices which have been evolved, generally consisting of some application of worm gearing, but has only recently found a really satisfactory slow starting attachment and one in which the human element is done away with. The device in question is simple in action, it merely being necessary to pull out a knob from the case of the starter, and the attachment then automatically starts the motor at any rate of cutting out which may be desired, and at which it is set to work. The above is combined with an automatic release action, and is described as Gibbings's patent. Where there is a

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likelihood of switches being tampered with by irresponsible persons, a protective iron covering, allowing only the handle to project, is supplied by most makers on demand.

To briefly sum up, it appears that the essential requirements of a satisfactory starting switch are as follows: (1) the resistance must be of ample capacity and of lasting material; (2) the contacts and contact maker must be properly designed according to the current to be dealt with; (3) automatic release for no voltage must be fitted; (4) when the switches will be handled by inexperienced persons an automatic starting device must be provided.

RADIUM AND OTHER RADIOACTIVE SUBSTANCES WITH A CONSIDERATION OF PHOSPHORESCENT AND FLUORESCENT SUBSTANCES. THE PROPERTIES AND APPLICATIONS OF SELENIUM AND THE TREATMENT OF DISEASE BY THE ULTRA-VIOLET LIGHT.*

BY WILLIAM J. HAMMER.

(Continued from page 318.)

An interesting experiment is shown in Figs. 13 and 14. In the former experiment, I have placed strips of various metals such as brass, iron, copper, tin, lead, tinfoil, aluminium, platinum, magnesium, etc., and strips of

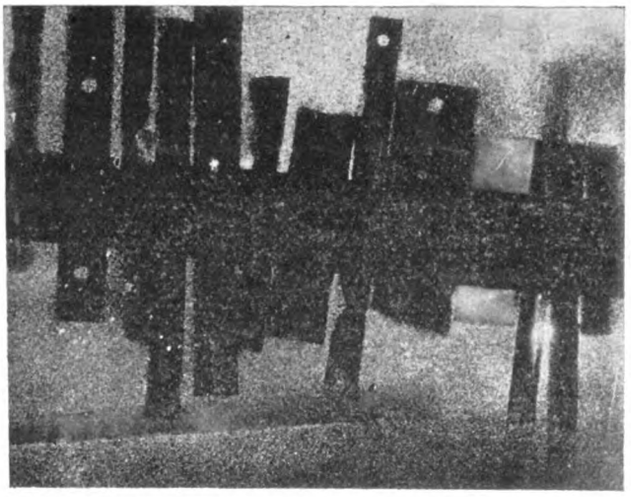

FIG. 13.—Photograph made by Phosphorescent Sulphide of Calc'um of Iron, Brass, Copper, Tin, Lead, Aluminium, Platinum, Tinfoil, Magnesium, Carbon, Glass, Mica, Celluloid, Vulcanite, etc., and Strip of Black Paper. (See Fig. 14).

carbon, vulcanite, glass, mica, and celluloid. Across the middle of the plate I have placed a strip of thick black paper cut from an X-ray plate envelope. I then sprinkled over the entire plate by means of a sieve sulphide of calcium, which I had made brilliantly phosphorescent by exposure to burning magnesium ribbon. The only substances which allowed the light to pass through at all were the glass, mica, and celluloid, the other substances, including the paper, being very opaque, showing apparently only the presence of ordinary light rays. This plate was placed for 24 hours in a dark room. In Fig. 14 are shown some substances similarly arranged, but exposed to a tiny tube of radium of 7,000 radioactivity, which was placed 3in. above the plate and near the centre. The exposure was made for 24 hours, and it will be noted that the strip of black paper has entirely disappeared, and the various substances underneath it have been penetrated to a greater or less degree, particularly those nearest to the radium.

A bibliography of "radioactivity," even at this early date, would be very extensive. Among the publications containing the most important contributions are the *Phil. Mag*, *Comptes Rendus*, *Ann. der Physik*, *Revue Gen. des Sciences*, *Nature*, *Jour. de Phys.*, *Soc. Francaise Phys. Bulletin*, *Chem. News*, *Phys. Ges. Verk*, *Phys. Zeit.*, *Science Abstracts*, *Wied. Ann.*, *Proc. Royal Soc.*, *etc.*

* A lecture delivered at a meeting of the American Institute of Electrical Engineers and the American Electrochemical Society, New York, April 17, 1903.

THE PROPERTIES AND APPLICATIONS OF SELENIUM.

The extraordinary property which selenium possesses of varying its electrical resistance on exposure to light is a phenomenon which has been known for a long time, but the commercial applications of this peculiar property possessed by selenium have not been properly appreciated up to the present time. It is my purpose to invite your attention this evening to a number of applications of selenium which the writer believes will prove of no small interest to the electrical engineering profession, and perhaps stimulate investigations in this most promising field. The Swedish scientist, Berzelius, discovered selenium in 1817, as a by-product from the distillation of sulphuric acid from iron pyrites. The proximity of the earth and moon suggested to Berzelius the name "selenium," after the Greek "selene" (moon), this being the result also of the striking similarity of the properties of selenium with those of tellurium, which is a term derived from the Latin "tellus" (earth). Its atomic weight is 79·5; specific gravity when crystalised, 4·788; its observed vapour specific gravity at 2,588deg. F. 5·68. It is a non-metallic element, which possesses characteristics similar to phosphorus, sulphur, and tellurium. When melted at 212deg. C. and allowed to cool rapidly, it forms a brown amorphous mass of conchoidal fracture. In this condition it is a high-class insulator. It has been said that a small piece of it would represent the resistance of a wire stretched from the earth to the sun. When heated for quite a time at a temperature of 100deg. C., selenium becomes a con-

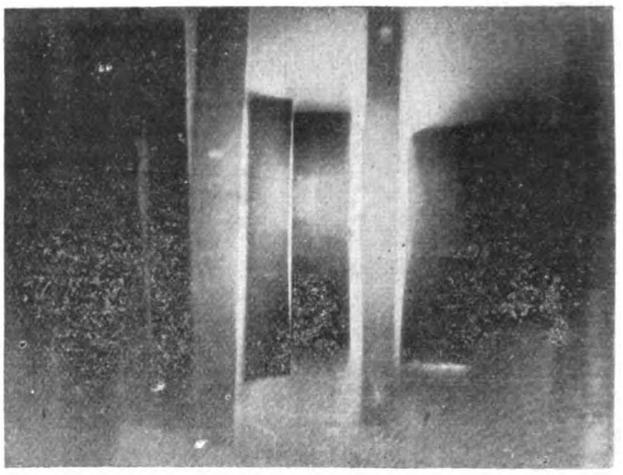

FIG. 14.—Radiograph made by Radium of same substances as in Fig. 9. Note Black Paper is Transparent, as are certain of the other substances, especially those directly below the Radium.

ductor of electricity to a limited degree, this increasing with an increase of current and varying according to the direction. Selenium has neither taste nor smell. The red vapour rising from selenium when subject to intense heat is exceedingly poisonous, and care should therefore be taken when experimenting with selenium in liquid form. Selenium is usually supplied commercially in a vitreous form. Here are some samples of it, and you will note that it is as structureless as glass and resembles black sealing-wax. I also have here some amorphous selenium in which form it is a finely-divided brick-red powder. This changes into vitreous selenium when exposed to a temperature of from 80deg. to 100deg. C. In order to obtain crystalline selenium, in which form it is useful for selenium cells, it must be kept, as already stated, at from 100deg. to 200deg. C. for some time, the black mass being changed into a hard slate-coloured metallic-looking substance. In this form even the thinnest films are opaque to light, whereas in the vitreous form the film would be transparent and ruby red in colour. I have some of these films here for your examination. Selenium is to-day employed to a considerable extent for the coloration of glass.

In 1851 Hittorf first discovered the effects of temperature on selenium, but it was not until Feb. 12, 1873, that Mr. Willoughby Smith sent a communication to President Latimer Clark, of the Society of Telegraph Engineers, of London, calling attention to the effect of light in reducing the resistance of selenium. An assistant of Mr.

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Willoughby Smith—a Mr. May, who was a telegraph clerk at Valencia—called attention to the fact that some pencils of selenium, which had been used to give a high resistance in connection with some of the cable testing work conducted by Mr. Willoughby Smith, showed a marked change in resistance when the sliding cover of the box which held the selenium was removed and the selenium was exposed to sunlight. These selenium pencils varied in length from 5cm. to 10cm., and were 1mm. to 1½mm. in diameter; they were hermetically sealed in glass tubes with connecting wires of platinum at each end. Little credence was given to the original announcement, and it was only after Earl Ross verified this statement, and proved that the action was due solely to light, and showed the effects of the light of different portions of the spectrum, that it met with serious consideration. Since that time much work has been done in investigating the properties of selenium, especially by Messrs. Shelford Bidwell, J. W. Giltay, Lord Ross and Sale, Draper and Moss, Hittorf, Adams and Day, Ayrton and Perry, Sir W. C. Siemens, Dr. Werner Siemens, Mercadier, Fritts, Minchin, Ruhmer, Webb, Bell and Tainter, and many others. Alexander Graham Bell some 20 years ago made some interesting experiments with his radiophone, a diagram of which is shown in Fig. 15, in which a mica or glass diaphragm covered with a silvered foil was used to reflect a powerful beam of light upon a selenium cell placed in the focus of a silvered reflector. To the selenium cell were connected a pair of telephones and a battery. At the back of the silvered diaphragm was a flexible tube and mouthpiece, into which words were spoken. The sound waves causing the diaphragm to

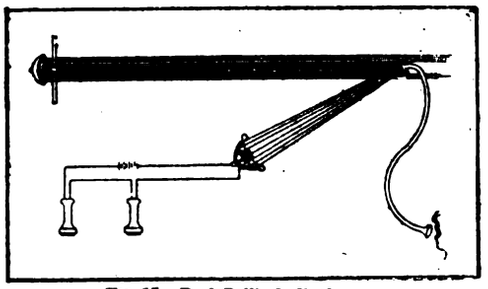

FIG. 15.—Prof. Bell's Radiophone.

vibrate sent pulsations of the reflected light upon the selenium cell, producing corresponding variations in its resistance and reproducing audible sounds in the telephone. Prof. Bell only used this over very short distances.

In 1898 Prof. H. T. Simon, of the University of Göttingen, discovered that an arc lamp, the circuit of which was in proximity to a telephone circuit, was caused to vibrate very perceptibly, and he devised his interesting speaking arc, by means of which he superimposed the sound waves produced by the telephone upon the circuit in which the arc was placed. He connected the lamp circuit with the secondary winding of an induction coil, the primary circuit being connected with the carbon transmitter, and a battery. The sounds thus produced originally were very weak; but by employing a suitable carbon microphone, the sound was reproduced to large audiences. Conversely, the arc could also be used in conjunction with telephone receivers to receive sounds. It is also found that the transmitter battery may be omitted, and a shunt taken from the arc circuit may be used with the transmitter and a suitable resistance. Again, this resistance may be displaced by storage batteries; and in this case, to secure the most satisfactory results, self-induction ("reaction coils") should be placed in the circuit of the arc lamp, allowing the direct current to pass without obstruction, but offering extremely high resistance to the alternating currents produced by the carbon transmitter. By compensating in this way any disadvantage in the use of the shunt is done away with. The transmitter may also be placed in shunt with the reaction coil instead of in shunt connection with the arc lamp, and this has the advantage that the rheostat used with the storage batteries may be omitted, provided the windings of the reaction coil are suitable for use as a resistance. By this arrangement the lack of self-induction in the transmitter circuit permits of a very clear and distinct reproduction, sufficient to be heard by large audiences. Mr. W. Duddell, of England, has made some most successful talking arcs, which the writer had the privilege of seeing in London over two years ago. In his arrangement in the secondary circuit is placed a condenser, which prevents the lamp current entering the induction coil, but allows the induction current in the transmitter circuit to pass without obstruction, and this arrangement

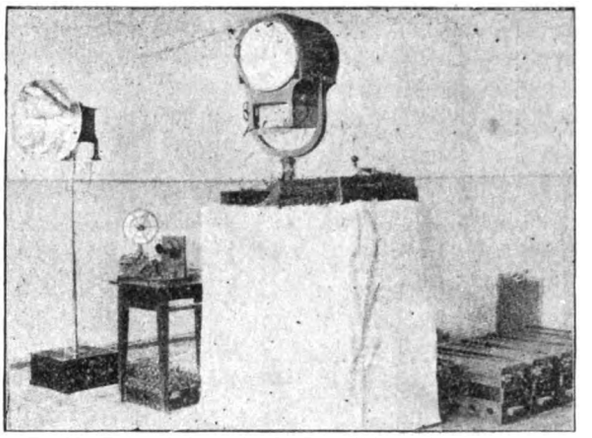

FIG. 16.—Ruhmer's Apparatus for Long-Distance Telephony over a Beam of Light.

has the effect of greatly increasing the sound. By employing a condenser of from three to five microfarads, he compensates for the difference of phase produced by the self-induction in the circuit, thus producing the highest effect in the arc. When Duddell uses the arc for transmitting sound waves, he employs in the shunt circuit to the arc a condenser and receiving telephone. It is advisable to employ as long an arc as possible. It has also been found that the Moore vacuum tube and the various types of mercury arc, such as Arons, Hewitt, and Weintraub, are very suitable for this class of work, as well as the carbon arc; and, where the latter is employed, either cored or treated carbons are advisable.

The theory advanced to account for the phenomena of the speaking arc, is that variations in temperature of the arc are produced by the variations of the current, and the change in the Joule effect produces a corresponding variation in the volume of the conductive gases in the arc. The most successful and most extensive experiments which

FIG. 17.—Ruhmer's Wireless Telephone Receiving Station at Wannsee, Berlin (taken at night).

have been made with the speaking arc are those of Mr. Ernest Ruhmer, of Berlin, Germany, who has employed it in conjunction with his selenium cells for wireless telephony and with remarkable success. In Fig. 16 is shown the apparatus employed by Mr. Ruhmer, with which he has succeeded in transmitting speech over a beam of light 4¼ miles in length.* Mr. Ruhmer's apparatus

* Mr. Ruhmer has recently written the author that he has succeeded in talking over a beam of light a distance of over 10 miles.

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is shown in the illustrations thrown upon the screen, and in Fig. 17. In his experiments he employed an arc lamp with a flaring arc 6mm. to 10mm. long, using an E.M.F. of 220 volts. The current varied from 4 to 5 amperes at 1 km. to 2 km., 8 to 10 amperes for 3 km. to 4 km, and 12 to 16 amperes for 5 km. to 7 km., and the resistance of his selenium cell was 120,000 ohms in the dark, this falling to 600 ohms in full sunlight. For the transmitting end Mr. Ruhmer employs a carbon

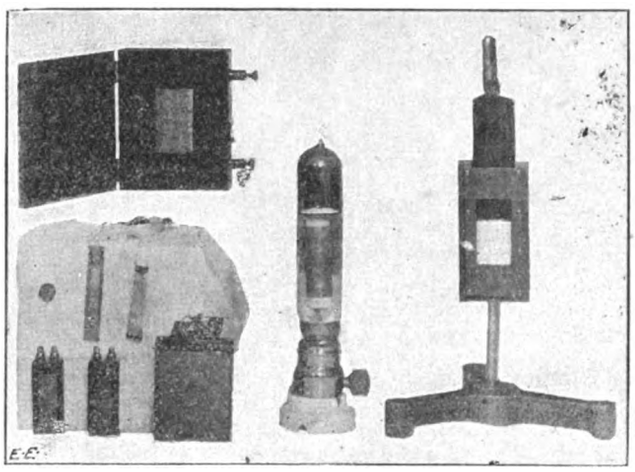

FIG. 18.—Types of Selenium Cells.

transmitter and a battery superimposing waves on the arc light circuit, and the beam of light is reflected to some distant point, where it is received by a parabolic reflector, in the focus of which is placed a selenium cell connected with a battery and a pair of very sensitive telephone receivers. Mr. Ruhmer has conducted extensive experiments both by night and by day, and even during fog and rain on the Wannsee, near Berlin. On the screen you will see an illustration of his apparatus in actual work at night (Fig. 17). Some time ago I suggested to Mr. Ruhmer the employment of Edison's tasimeter, the extraordinary sensitiveness of which is well known. He informed me that he had tried this, but had found it too "lazy," and stated that he has secured most promising results by the employment of the thermopile, and with this he expects to be able to transmit sound over many miles. Mr. Ruhmer is about to commence extensive experiments under the direction of the German Government in connection with the Imperial fleet in the Baltic Sea. Mr. Ruhmer has also suggested the employment of his photographophone, which I shall describe later, as a means of recording messages received at a distance.

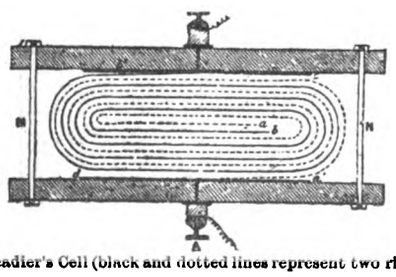

FIG. 19.—Mercadier's Cell (black and dotted lines represent two ribbons of brass).

Doubtless many present remember the interesting experiments made by Mr. Hayes at the electrical exhibition held in Madison-square Garden in May, 1899, in which music was transmitted over a beam of light. At one end of the garden was placed a telephone, before which a cornet was played, causing waves of current in the telephone circuit to be superimposed upon those in a neighbouring arc light circuit. The light rays from this arc lamp were reflected across the garden, where they were received in a parabolic reflector in the focus of which was a glass bulb containing filaments of carbon. This bulb was connected to a pair of ordinary phonograph listening tubes. The varying light which fell upon the carbon caused variations of temperature inside of the glass bulb which produced the original sounds in the listener's ear. A bulb simply coated with lampblack and containing nothing but air would answer the purpose just as well. Selenium cells may vary in resistance from 2,000 to 500,000 ohms or more in the dark; and certain cells may be five to twenty times as good conductors of electricity in light as in the dark; and in the case of other cells, notably that of the Fritts cell, which I have here this evening, and that of the Ruhmer cell used in his Wannsee experiments, will have 200 times the conductivity in light that it has in the darkness; and the ratio may be even higher. They are usually made by winding carefully two separate lengths of wire, either of copper, brass, German silver, or platinum, equidistant throughout their entire length upon such substances as slate, glass, mica, or porcelain. The selenium is then spread thinly over the wires, forming an insulation between the two windings. This form of cell was invented by Mr. Shelford Bidwell, F.R.S. No small amount of skill is necessary to wind these fine wires evenly and equidistant, and to cover successfully these wires with the selenium coating. One way of coating frequently employed is to warm the cell on a metal plate or sand bath heated by a Bunsen burner. When the stick of selenium laid on the plate shows evidence of melting, which takes place at about 120deg. C., it is drawn slowly over the wires, coating the same thinly and evenly. A steel spatula or a strip of mica can be used with advantage. Or the strip of material on which the wires have been wound would be laid upon a brass plate covered by a strip of this

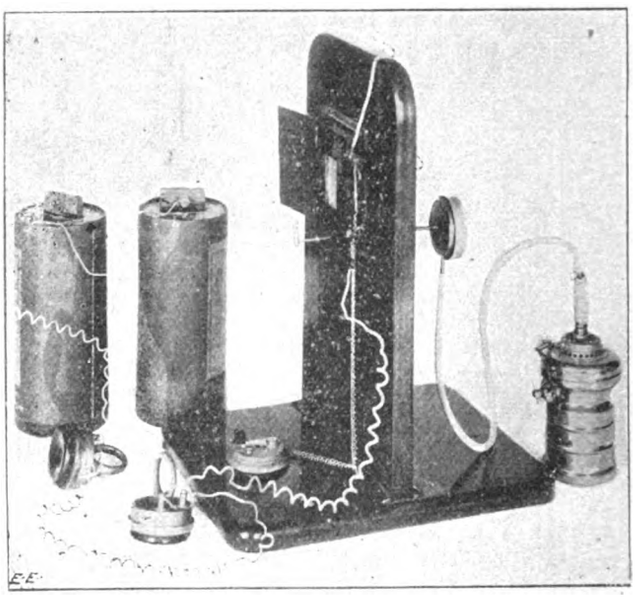

FIG. 20.—Manometric Acetylene Flame Transmitter, with Solenium Cell, etc. (a battery of about 24 volts employed).

mica, this being placed upon a tripod with a Bunsen burner underneath. Powdered vitreous selenium may thus be spread evenly over the wires, and the selenium will shortly melt, and where the portions of it crystallise, forming hard lumps, it will be necessary to continue the heating until these disappear. Then the selenium may be spread uniformly with a piece of steel, or, better still, a strip of mica, care being taken to cover up the edges. Mr. Bidwell states that the temperature should be carefully regulated, as when it is too low, hard crystalline lumps will form, and when too high, the surface tension causes the selenium to form in drops, and it is then as difficult to spread as if it were mercury. The proper temperature should be only just above 217deg. C., and then the selenium is in a plastic semi-fluid condition, and can be easily manipulated. When a satisfactory surface is secured the cell should be placed upon a thick copper plate to cool quickly, when the selenium becomes black and lustrous. The Bunsen flame should then be turned down to give a temperature of about 120deg., and the cell is then placed upon the hot plate, and shortly the whole surface of these turns to a dull grey colour. The temperature is then cautiously raised until signs of melting begin to appear, generally near one of the edges. When this occurs, the burner is instantly with drawn and the flame lowered. The dark spot recrystal-

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lises in the course of a few seconds, and the burner is then replaced and left for four or five hours, during which time the Se should be only a few degrees below the melting point. The coil should then be gradually cooled by lowering the flame gradually for an hour. This process of long heating and slow cooling is generally spoken of as "annealing."

In Fig. 18 is shown an illustration of a number of types of selenium cells, including the Bidwell, Ruhmer, Giltay, Webb, Clausen and Bronck, Mercadier, and Fritts, which I have brought with me for your consideration. The two cells to the extreme right and left are modifications of Mr. Shelford Bidwell's cells, the original form of which consisted of two fine copper wires wound side by side on oblong strips of mica with melted selenium spread over the surface, the one to the left being manufactured by Ernest Ruhmer, of Berlin, and by Messrs. Clausen and Bronck, which consists of copper wire wound on slate. The one to the right is manufactured by Mr. J. W. Giltay, of Delft, Holland, and consists of platinum wire wound on slate and covered with selenium. The four tiny shells shown against the white background are made by Mr. Hartwell W. Webb, of New York City, and consist of German-silver wire wound on slate. The cell to the right is placed in a sealed flat glass tube. The two lower Webb cells are encased in ebonite. The small round cell is a tiny Mercadier cell made by Mr. Webb. The method of making the Mercadier cell is to use two narrow ribbons of sheet brass or foil, separated by a ribbon of parchment paper rolled up like a spiral spring. This is held between wooden clamps, one surface being ground and polished off smoothly, and a thin layer of selenium being spread over it. An excellent idea of this cell may be had by noting Fig. 19, which shows the standard form. In the centre of the picture is shown a cell by Mr. C. E. Fritts, of New York City, for which I am indebted to my friend Prof. Geo. F. Barker. In the Fritts cell a very thin layer of selenium from one one-thousandth to one five-thousandth of an inch in thickness is spread upon a plate of metal—generally zinc or brass. The selenium and metal plate form a chemical combination sufficient at least to cause the selenium to adhere and make good electrical connection. The upper surface of the selenium is then covered by a transparent conductor of electricity—preferably a thin film of gold leaf. Platinum or silver may also be employed. Thus, the two surfaces of the selenium are covered by a metal, and are connected to the two ends of the circuit. The upper or gold leaf surface, however, permits the light to pass through and affect the resistance of the selenium beneath. The tall cell in the lamp socket shown is the latest form of Mr. Ruhmer's cell, and this type represents, I believe, the most important development which has been made in the selenium cell, and it has now become most stable, and responds most rapidly to variations in illumination. He employs two copper wires, wound spirally side by side around a cylinder of porcelain, which, after the wires have been covered with selenium, is placed inside of a globe, from which the air is exhausted, and it is mounted with a butt similar to an Edison incandescent lamp, and resembles a candelabra lamp. This makes a most convenient method of handling the cell, and by keeping it from the air, the disadvantages inherent in all cells heretofore have been very largely done away with. Another form of Ruhmer cell consists of two fine platinum wires wound on a glass cylinder 1¼in. long and ¾in. in diameter; the wires, which are $\frac{1}{32}$in. apart, are coated with selenium.

Selenium cells are very susceptible to moisture, and it is largely this taking up of moisture which produces the electrolytic effect in the cell, enabling one to connect it with a galvanometer and produce a current by merely focussing the light upon the cell. This phenomenon gave rise to the designation of the photo-electric cell. Those who have worked with selenium cells know that heretofore they have been most unreliable, varying their resistances from time to time enormously; and in the case where copper wires are employed, there is a selenide of copper formed, which often renders the cells inoperative in a comparatively short time. To some extent, the cells made originally have been protected by covering them with mica or lacquer or varnish, but placing them in an exhausted receptacle and mounting them in the manner devised by Mr. Ruhmer is, it seems to the writer, a most important step in the commercial development of the selenium cell. Prof. Bell has made a number of types of selenium cells, his standard form consisting of alternate discs of brass and mica, with the mica discs slightly smaller than the brass, forming a recess for holding the selenium, which is spread over the surface. All the evenly-matched discs are connected to one end of the circuit, and all the odd discs to the other end. The cylindrical form of the cell enables it to be acted upon from all directions when placed lengthwise in the focus of a parabolic reflector. This is also of great advantage in the Ruhmer type of cell. Selenium cells possess the remarkable property of recovering the original resistances upon the removal of the source of light.

(To be continued.)

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

ELECTROLYSIS OF ZINC.

SIR,—My attention has been drawn to certain remarks made by Mr. A. Philip in a book on "The Electro-plating and Electro-refining of Metals," which seem likely to convey the wrong impression that the idea of utilising zinc dust for regenerating zinc electrolytes originated with him. Permit me to say that this is not the fact, and also to point out that Mr. Philip omits to mention that at the time he refers to he was employed by the company with which I was associated.—Yours, etc.,

SHERARD COWPER-COLES.

WIRELESS FIRE-ALARMS.

As stated in our last issue, we then wished to conclude all correspondence on the above subject until Mr. Guarini could give actual results from trials on a commercial scale. Since then we have received from him a very long letter, which we do not see our way to print. In the first part of it he complains of the treatment we have accorded to him, and accuses us of showing undue preference to Mr. Oatway. In reply to Mr. Oatway he makes statements which can well be condensed as follows. With regard to the interference, he thinks no further answer is required until further trials have been made in London, which will cover his critics with confusion. With respect to the fire detector which is to set in motion the wireless signalling apparatus, Mr. Guarini claims the right to use the best fire-detecting apparatus on the market. With respect to Mr. Oatway's remarks as to the Postmaster-General, Mr. Guarini thinks his consent will easily be obtained after the trials have been made, as the wireless system will be less likely to interfere with the telegraph wires than the fire-alarm system would with wires. He quotes an Italian expert to the effect that having individual wires to each house to be protected makes a fire-alarm system very complicated. He also thinks that Mr. Oatway has under-estimated the cost of providing lines between the fire brigade station and subscribers. This cost with underground wires Mr. Guarini estimates at from £20 to £40 per line. If the firemen's objection to depending on Morse code signals is maintained, Mr. Guarini would employ a professional telegraphist at each station at the cost of the firms protected. In conclusion, Mr. Guarini bids us "au revoir" and not "adieu." We await, with him, the practical trial of wireless fire-alarms, and much regret that the exigencies of our space prevent us from reproducing his letter in full.—ED. *E. E.*

FORTHCOMING EVENTS.

Municipal and County Engineers.—Meeting at Hastings on September 11 and 12.

British Association.—Seventy-third annual meeting, September 9, Southport.

Sanitary Institute.—Sept. 16, lecture by Dr. E. J. Steegmann, "Natural Forces: Light, Heat, Electricity; Chemistry."

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THE

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TO CORRESPONDENTS.

All Rights Reserved. Secretaries and Managers of Companies are invited to furnish Notices of Meetings, Issues of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration.

All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed*

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PRODUCTION IN QUANTITY.

At the present time, when everyone in business is anxiously awaiting statements from the Government as to their new fiscal policy, a few words on the question of manufacturing articles in large quantities will be of interest. It is intimately connected with the dumping of foreign manufactured goods on our markets. The argument, which can be supported by a number of facts, is that certain of our foreign competitors organise their works so that they can produce at exceedingly cheap rates large quantities of standard articles. They then supply their home markets at a profit, and interfere with the legitimate development of English manufactories by dumping the surplus in this country at, or even below, cost price. The same method of procedure cannot be adopted in England, because our manufacturers are hampered by the import duties when sending goods into the very countries in which their rivals have their works. Quite apart, however, from these questions of Imperial policy is that of the internal organisation of the electrical industry in this country. It is a regrettable fact that the individuality of the English engineer, of which we have every reason to be proud, has in the electrical industry seriously hampered the manufacturer. For instance, at the present time, when the electric supply undertakings, whether municipal or company, are beginning to realise the fruits of their development work in electric power supply, the demand for electric motors is very great. Manufacturers who have adopted electrical driving find that it is economical, and that it enables them to organise in an entirely new way the work in their factories. They accordingly look for cheap motors, and most frequently demand quick deliveries. The essence of quick delivery is that the manufacturer should be able to manufacture in quantity and supply from stock, which only too frequently cannot be done. Taking small motors for instance, it is almost an even chance as to whether the supply voltage will be 200, 220, or 230, while voltages of 210, 240, and 250 are also to be found. With larger motors working across the outers of a three-wire system, the supply voltage will be equally varied by multiplying the above figures by 2. As a consequence, if the manufacturer is to be able to supply from stock electric motors, he must stock them with a comparatively large number of voltages. This as a rule it does not pay him to do, and we find instead that only a few machines are stocked in a completed state, and that those for other voltages have to be wound after the order is given. In other words, manufacturers are compelled by the conditions prevailing in this country to stock motor frames rather than completed motors. The same applies to lamps and other accessories used in connection with the supply of electricity as a means of providing light, heat, and power. Matters become even worse when alternate-current systems are concerned, as in that case the frequency is varied quite as widely as the voltage. It is to be hoped that the Engineering Standards Committee, the electrical section of which is presided over by Sir William Preece, will be able to recommend standard voltages and frequencies, which will in time reduce the confusion which now exists, which hampers our manufacturers and increases cost of electrical accessories. This committee has circulated amongst manufacturers and other prominent electrical engineers a number of proposals as to standardisation. In due time, after replies have been received as to how far these standards are suitable, the committee will issue its recommendations on the subject. It is to the interest of the whole profession that these recommendations should not be as inoperative as have other efforts towards the

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standardisation of electrical machinery. From the reply given to the deputation from the Engineering Standards Committee by the First Lord of the Treasury last year, we gather that the War Office and the Admiralty are in accord with the committee and prepared to heartily co-operate with its efforts. We are afraid that the same cannot be said for the electrical engineers, whether consulting or resident, who are responsible for the variations of supply voltage, frequency, etc., in our supply systems. Leaving restrospective changes on one side for the moment, it seems to us that the Board of Trade has the power to prevent new works being started which do not conform to the standards soon to be recommended. Up to the present the Board of Trade has, we believe, approved of practically every system of supply submitted to them as required by the provisional orders. We trust that for the good of the industry they will in future not be so lenient, but that consent will be refused unless the voltage of supply and the frequency conform to certain definite standards. If this is done, there is a hope that those older undertakings which find themselves at variance with the standards will be induced to change. The Board of Trade could hardly force this change, but an association of manufacturers could do so by charging by mutual consent a slightly increased price for all accessories which are not to standard. It remains to be seen how far this latter proposition is within the scope of practical politics, but it would conduce to the production of electric accessories in great quantity, and hence to the cheapening and improving of the same.

REVIEWS.

Electricity as Applied to Mining. By ARNOLD LUPTON, G. P. ASPINALL PARR, and HERBERT PERKIN. Crosby Lockwood and Sons.

The ever-increasing use of electricity in mining has led the authors to write a text-book, having for its object the presentation of the main principles of electricity and electrical engineering in such a form that a mining engineer or colliery manager may obtain a sufficient grasp of the subject to enable him to deal with the many questions involving the use of electricity arising in his daily work. The difficulties in achieving this object, without overweighting the book with detail, are very great, and require skilful treatment in order not to confuse a non-electrical reader, and at the same time furnish him with accurate information.

Difficult as the authors' task is, it is none the less difficult for a reader to acquire this knowledge when presented to him in such necessarily abbreviated form, and in the book before us these difficulties are materially added to by reason of the vague and slipshod manner in which fundamental principles are stated—*e.g.*, the authors on p. 8 say, "We shall denote the extreme difference in pressure of any circuit by the term electromotive force (abbreviated to E.M.F.), while that between any two other points, which must necessarily be lower, by the term potential difference (abbreviated to P.D.)" The mining engineer or colliery manager who understands the difference between E.M.F. and P.D. after reading this statement, can hardly require any assistance from the authors. We doubt very much, however, whether anyone would understand the difference from such a statement, and we think a simpler and more easily understood explanation would be, that the E.M.F. of any source of electricity is its voltage on open circuit, as measured by an electrostatic voltmeter; P.D. being simply what the name implies, the difference of potential between any two points in a circuit. Again, we are told "when two or more cells are joined together 'end on' or 'in series' with each other, the arrangement is termed a 'battery.'" This appears to us to be a definition which is scarcely needed, and is barely accurate, the term "battery" in practice being used for any number of cells exceeding one, however connected. Further, on p. 31 we have a statement, "In practice there are two distinct kinds of current . . . one is called alternating current . . . the other continuous." This in a text-book is, we think, likely to give an erroneous idea; the current, *per se*, of course being the same whether alternating or continuous. There are many such ambiguities, particularly in the introductory chapters of the book, but we have indicated sufficient to show what we believe will prove stumbling blocks to many readers.

The subject of electromotors, which, in many cases, is the most important in connection with mining, is dealt with much too briefly, and could, we think, with great advantage be considerably amplified. For instance, in the case of the direct-current motor, practically no information is given on the all-important question of speed regulation or how variations of speed are to be obtained, as is so often required in practice. This same paucity of information is also noticeable in the authors' treatment of polyphase motors. The illustration of the principle of the alternating current motor, given in Fig. 39 and the accompanying description, is clear so far as it goes, but, in our opinion, will not enable a reader to understand how the polyphase current provides the equivalent of a rotating field magnet. To many engineers the action of an induction motor, particularly if it has a squirrel-cage armature, and consequently no slip-rings, is uncanny. Here, again, a great deal might be said with advantage on the question of speed regulation.

In dealing with the generation of electricity the authors discuss very briefly the various types of power available. This subject, we consider, should either have been dealt with more briefly or much more fully, depending on the point of view. For instance, on the one hand, most mining engineers would be quite competent to decide the question of the best power to employ, in which case the greater portion of the information given in Chapter 3, will already be known to them; on the other hand, such engineers are probably not in touch with the latest developments in prime movers as employed in central stations, and space devoted to a more detailed description of such central-station plant would doubtless prove useful. To a slight extent this has been done in connection with steam-turbines. The above remarks apply even more forcibly to the authors' treatment of switchgear. Every electrical engineer knows the many pitfalls in connection with the switching arrangements of even the smallest generating station.

The discussion of the various systems of distribution is fairly complete, and provides much useful information. We do not agree, however, with the authors that the size of a cable for transmitting electricity is chiefly determined by the number of amperes it can carry, without the temperature being raised to a dangerous amount. Neither can we agree that Table I. proves this. It is well known that a current density of 1,000 amperes per square inch in transmission cables is perfectly safe, but in practice this density is not admissible, because in the case of lighting the drop in the cable is fixed, and in the case of power the questions of regulation are paramount. These considerations, in practically every case, determine the working density, and this, as is shown in Table I., seldom approaches 800 amperes per square inch.

The illustrations and descriptions of electrically-driven machinery as used in mining are very clear, and will doubtless prove of great assistance to those employed in such work, and should, we think, lead to a much more extensive use of similar plant in this country.

In conclusion, we would like to point out to the authors, the apparent irrelevancy of the titles of some of the chapters, and would particularly instance Chapter 6; also the tiresome repetition of the most elementary facts—*e.g.*, on p. 143 in the section devoted to the "Reasons for Economy of High Tension." In less than 10 lines we have four equivalent statements that $E \times C$ = watts = power, and a little further on five lines of print are devoted to showing that, in a line working at 600 volts with a 5 per cent. drop the pressure at the far end is 570.

The book is well printed and illustrated, and if in a new

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edition the defects, such as we have pointed out, are rectified, will fill a distinct gap in our technical literature.

G. W. G.

THE BRITISH ASSOCIATION.

The following is the provisional list of papers to be read before Section A (physics and mathematics) of the British Association at the forthcoming Southport meeting: "On the Treatment of the Thermo-Dynamics of Irreversible Processes," by Mr. J. Swinburne; "Granular Structure in Solids," by Mr. G. Beilby; "Explosive Pressure and Rate of Combustion of Cordite," by Mr. J. E. Petavel; "Simultaneous Solar and Terrestrial Phenomena," by Sir N. Lockyer; discussion on "The Nature of the Emanations from Radioactive Substances," opened by Prof. Rutherford—Profs. J. J. Thomson, Dewar, Soddy, and Armstrong will take part; "Report of Electrical Standards Committee," by Dr. R. T. Glazebrook; "On the Use of Vectorial Methods," by Prof. Henrici, with discussion; "On the Use of Condensers as Multipliers to Extend the Range of a Multicellular Voltmeter," by Prof. Marchant; "On Design and Working of Ballistic Galvanometers," by Mr. P. H. Powell. Meteorology will be strongly represented owing to the meeting of the International Meteorological Committee taking place at Southport at same time.

Following are the provisional arrangements for Section F (economic science and statistics): Thursday, Sept. 10—presidential address of Mr. E. W. Brabrook, chief registrar of Friendly Societies; Friday, Sept. 11—discussion on "The Wealth of the Country and what should be done with it," opened by Sir Robert Giffen. Monday, Sept. 14—papers and discussion on the economic aspects of the fiscal controversy, as follows: "Modern Economics and Free Trade," by Dr. E. Cannan; "Failures to Attain the Ideals of Free Traders," by Prof. W. Cunningham; "Statistical Methods and the Fiscal Controversy," by Mr. A L. Bowley; "Comparative Statistics of our Trade with our Colonies, U.S.A., and the Protected Countries of Europe," by Mr. B. Etlinger; and probably papers on "History of Retaliation," "History of Commercial Relations with Canada," and "Statistics on Production." Thursday—final report of committee on "The Economic Effect of Legislation Regulating Women's Labour"; "Physical Deterioration and the Poverty Line," by Mrs. Bosanquet. The following other papers will probably also be read before this section: "Depreciation and Sinking Funds in Municipal Undertakings," by Mr. S. H. Turner; "The Growth of Rates," by Dr. Ginsburg; also a paper on "Garden Cities." It is not quite settled yet on which day the papers on the fiscal controversy will be taken, but, so far as can be stated at present, Monday, Sept. 14, will probably be devoted to this subject. The discussion of social questions is expected to occupy the following day, Sept. 15, but it is very possible that this order of things may be reversed and the social questions disposed of before the fiscal controversy is entered upon.

The preliminary programme of papers in Section G (engineering) is as follows: "The Problem of Modern Street Traffic," and "An Account of the Manchester Municipal School of Technology," by Lieut.-Colonel Crompton, R.E., C.B.; "Protective Devices for High-Tension Circuits," by Mr. W. B. Woodhouse; "Permanent Set in Cast Iron, due to Small Stresses, and its Bearing on the Design of Piston Rings Springs," by Mr. C. H. Wingfield; "Refuse Destructors and Power Production," by Mr. W. F. Goodrich; "The Rebuilding of Kew Bridge," by Mr. C. A. Brereton; "Parallel Running of Alternators," by Mr. B. Hopkinson; "Balancing of Large Engines," by Prof. J. Perry; "Pendulum Apparatus for Testing Steel as Regards Brittleness," by Captain H. Riall Sankey, R.A.; "A New Form of Mirror Extensometer," by Mr. J. Morrow; "Clutches," by Prof. H. S. Hele Shaw; "Ventilation of Tube Railways," by Mr. J. W. Thomas; "Liquid Fuel," by Mr. A. M. Bell; "The Potable Waters of S.W. Lancashire," by Mr. J. Campbell Brown; "A History of the Discovery of Natural Gas in Sussex," by Mr. R Pearson; "The Manchester and Liverpool Express Railway," by Mr. F. B. Behr; "Aluminium as an Electrical Conductor," by Mr. J. B. C. Kershaw; "The Water Supply of South-West Lancashire," by Mr. J. Parry; "The Tidal Régime in the Mersey" and "Electric Traction," by Mr. J. N. Shoolbred; "A Further Note on Gas-Engine Explosions," by Mr. H. E. Wimperis; "The Single-Phase Repulsion Motor," by Mr. W. Cramp; "Steam Traffic on Common Roads," by Mr. T. Clarkson; "The Rate of Fall of Rain at Seathwaite," by Mr. H. R. Mill; "Smoke Abatement," by Mr. W. G. Popplewell; "Illustrations of Graphical Analysis," by Mr. J. Harrison; also reports of the Small Screw Gauge Committee and the Road Traction Committee. In connection with Section G, visits have been arranged to the following, among other, places of engineering interest: the Manchester Municipal School of Technology; the works of the British Westinghouse Electric and Manufacturing Company, Trafford Park; ss. "Lucania," Liverpool; the British Insulated Wire Company's Works, Prescot; the L. and Y. Railway Company's works, Horwich; the Wigan Deep Coal Pit.

In Section L, devoted to educational science, it is proposed to devote two days (Sept. 10 and 11) to a discussion on "School Curricula," based on a series of short papers. Introductory papers have been promised by Miss Burstall and Messrs. M. E. Sadler, J. L. Paton, W. L. Fletcher (Liverpool Institute), John Adams, T. E. Page, and others. A joint meeting with the Geographical Section will be held to discuss the "Teaching of Geography." In addition to the above subjects, there will also be discussions on the reports of committees on the conditions of health essential to the carrying on of the work of instruction in schools; the teaching of natural science in elementary schools; the influence exercised by universities and examining bodies on secondary school curricula, and also of the schools on university requirements; the teaching of botany in schools.

BRADFORD CITY TRAMWAYS AND ELECTRIC TRACTION.*

BY J. H. COX, M.I.C.E., CITY SURVEYOR, BRADFORD.

During the last few years the subject of electric traction has been dealt with most exhaustively by numerous tramway engineers, and this short paper is, therefore, merely intended as a brief general statement of the present position of electric traction in Bradford. The total route length of tramways worked by the Bradford Corporation is 43 miles 513 yards, mostly double track, equal to nearly 75 miles of single track. Of the above route length, 5 miles 1,672 yards is outside the city boundary, and of this 1 mile 815 yards belongs to the Shipley District Council.

Shipley Tramways — Terms of Lease. — The tramway belonging to the Shipley District Council extends from the city boundary at Frizinghall to Moorhead-lane, at Saltaire, and is leased to the Bradford Corporation on the following terms, which were fixed by arbitration—viz.: (1) Lease to be for a period of 30 years. (2) The Bradford Corporation pay the Shipley Council interest and sinking fund charges at the rate of £5. 14s. 6d. per cent. per annum for 30 years from May 17, 1903, on £27,614, the sum expended by them on the construction of the tramway. (3) The Bradford Corporation pay Shipley Council interest and sinking fund at the rate of £4. 10s. 3d. per cent. per annum on the capital sum of £12,642 expended by them on street improvements. (4) Shipley Council are to supply sufficient electrical energy for the proper working of the tramways at 1¾d. per Board of Trade unit, measured at the station, but the price chargeable is subject to revision every five years. (5) The Shipley Council to maintain the tramway track, cables, feeders, and posts; but the overhead equipment is to be maintained by the Corporation. The Corporation have also to contribute the sum of £100 per annum per mile of double track towards the cost of maintenance, and in consideration of this payment they are to be relieved of all

* Paper read before the Congress of the Sanitary Institute at Bradford.

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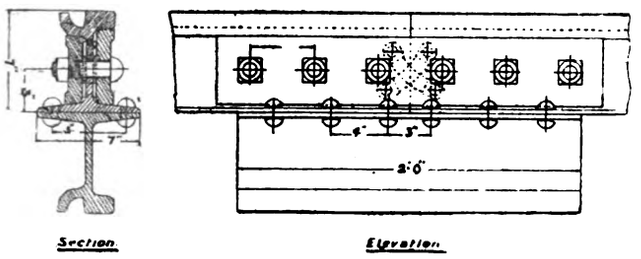
liability in respect of any accident arising from the defective condition of the tramway. (6) Cost of arbitration to be borne equally by both parties.

Overhead Equipment.—The overhead equipment is of the usual standard form, and centre pole, side bracket, and span wire construction have been used to meet the varying conditions of the several tramway routes. Flexible suspension fittings have been fixed to all the bracket arms. Experience has shown that it is not advisable to erect centre poles, except in streets where the carriageway is at least 45ft. in width. It will be interesting to compare the working of the overhead system with that of the underground conduit system, as adopted by the London County Council, and also with the Lorain surface-contact method, as laid on a portion of the Wolverhampton tramways. At present the advantages as regards cost of construction and working appear to be in favour of the more popular system.

Rails.—The section of girder rails now used in Bradford is supplied by Messrs. Walter Scott and Co., Limited, Leeds Steelworks, No. 15 in their list. It is 7in. deep, with a groove 1⅛in. in width and 1⅛in. in depth. The rails are rolled mainly in lengths of 45ft., and weigh 102lb. to the yard. The chemical constituents of the rail are as follows: carbon, ·4 to ·55 per cent.; silicon, traces; sulphur, not more than ·06 per cent.; phosphorus, average ·08 per cent.; manganese, ·7 to 1·10 per cent. The specification states that the tensile stress must be 40 to 44 tons per square inch, with an elongation of not less than 15 per cent on a length of 8in., and a contraction of sectional area of not less than 30 per cent.

Rail Joints.—The rails are jointed with steel fishplates weighing 73½lb. per pair. Latterly, Cooper and Howard Smith's patent anchor joints have been largely used in



Rail Joint, Bradford City Tramways.

addition to the fishplates. At present these joints appear to be answering satisfactorily, but they have not been in use sufficiently long to enable one to give a definite opinion

Curved Rails—Manganese Steel.—One or two quick radius curves have been constructed with manganese steel, cast in 12ft. lengths by Messrs. Hadfield's Steelfoundry Company, Limited, of Sheffield. They have only been in use about four months, and up to the present they have justified their adoption.

Points.—The points used on the Bradford lines are 9ft. in length, made of patent manganese steel, with tongues 4ft. 6in. in length; some are straight, and others are made to a radius of 100ft The core hollows in points and crossings are filled with concrete before being laid.

Bonding.—The electrical bonding of the rails is done with short Chicago crown T-bonds, 4in. centre to centre, fixed under the fishplates which act as a protection to them.

Special Lay-outs.—In May, 1902, certain portions of the curves and junctions into Bridge-street, from Tyrrel-street, Market-street, and Leeds-road, were specially made by Messrs. Hadfield's Steelfoundry Company, Limited, of Sheffield, with their patent manganese steel rails, points, and crossings, and they seem to be answering very well, though up to the present they have not been subjected to any great amount of traffic.

Wear and Life of Rails.—Experience at Sheffield tends to show that the wear of rails is greatest on the down tracks; very probably this is accounted for by the greater use of the brakes, especially the slipper brakes, which the Board of Trade require to be used on the downward journey whenever the gradient is 1 in 15, or steeper. Experience in Bradford shows slightly more wear on the downward tracks, but greater damage is done to the track generally on the upward journey. On the comparatively level portions of tramway the damage to the track is mainly due to the speed at which the electric cars run. Under the heaviest traffic, in Bradford, it is expected that a life of eight to ten years will be obtained on straight track, and about three years on curves. Under the lightest traffic 12 to 15 years' life is anticipated on the straight lines, and about five years on curves.

Paving.—In Bradford the tramway tracks are paved with 3in. by 6in. granite setts, except in a few streets near the centre of the city, where Australian hardwood blocks have been used. The granite setts are obtained chiefly from Leicestershire, Wales, Scotland, and Norway, the harder setts being reserved for the level roads and the softer setts for the steeper gradients, which in Bradford are very numerous. Concrete foundations, composed of broken stone and Portland cement in the proportion of 6 to 1, are laid for the paving of all tramway tracks. The wood blocks used for paving tramway tracks are 3in. by 9in. and 5in. deep. They are laid on a concrete foundation which is floated to a smooth surface so as to admit of the blocks being laid directly on the concrete. They are first dipped to a depth of 3in. in hot pitch and set on the smooth concrete surface with at least ⅛in. joint between every course, and also endwise between every block. The space between the ends of the blocks laid between the rails is slightly greater than those at the side, but a space of about 1in. is also left against the kerb on each side of the road for expansion of the blocks, and filled in with pitch, which will compress when expansion of the wood takes place. Some difficulty has been experienced by the rising of the blocks adjoining the tramrails, which appears to be due to water getting into the spaces formed between the end block and the steel rails. To avoid this difficulty, it is proposed to shape the end wood blocks to fit into the web of the rail, and it is hoped that the adoption of this course will more effectually keep out water and prevent any further lifting of those blocks which adjoin the rail.

Speed.—Several months ago an application was made by the Tramways Committee of the Bradford Corporation to the Board of Trade for sanction to run at greater speeds than previously allowed on the Bradford tramways, in consequence of which Major Pringle inspected all the lines in April last, and recommended that regulation No. 6, which limited the maximum speed to nine miles an hour, should be revised and the speed increased to 12 miles. In narrow roads the speed is limited to nine miles an hour; on very steep roads four to six miles; and through facing points, whether fixed or movable, and on quick curves, four miles an hour. There is no doubt that the quicker service and extra speed attained by electric cars cause considerably more wear and damage to the tramway tracks than formerly, but the requirements of the public to-day call for more rapid locomotion than was possible in the days of horse and steam traction. Electric tramways have now become serious competitors with railways for urban and interurban traffic, and railway companies will have to depend more on their long-distance traffic for their revenue in future. The railway companies in the West Riding of Yorkshire, as in other populous districts, have been seriously affected by the great increase in electric tramway traffic during the last few years, and to all appearances it is likely to increase still more rapidly than ever.

QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any questions should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the

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author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

615. Information is required as to the best method of automatic signalling for electric tramways. The system must be equally applicable for use by day or night. Preference would be given to a method by which the current supply to the car it is desired to stop is cut off entirely, so that the car can no longer proceed, and is not merely detained by signals which might or might not be regarded by the driver.—A. G.

616. I have four dynamos, shunt-wound two-brush type, each giving an output of 65 volts 300 amperes. What minimum alterations in windings are necessary to give 120 volts. Would compounding the fields be satisfactory? Give sketches, calculating formula, etc.—H. W.

ANSWERS.

Question No. 607.—What is the best way to doctor small accumulators for electric ignition which have been over-discharged and become badly sulphated?

Best Answer to No. 607 (*awarded* 10*s.*).—Small accumulators which have been badly treated are likely to have more defects than sulphating. Generally the plates are buckled and the paste is loose in places, while some has fallen out. If the paste accumulated at the bottom of the cell is a light brown in colour and extremely fine (not granular), it is likely that the acid is too weak. Many motorists put the accumulators in such a position and pack them so carelessly that acid is spilled at every turn. According to directions water is added, with the result that the acid is diluted in a way never intended by the makers, and immediately sulphating sets in. This is common in celluloid motor-cycle accumulators. As to remedy, add to each cell of, say, 25 ampere-hour size as much *pure* caustic soda as will lie on the surface of a threepenny piece. Charge fully till each cell shows 2·5 volts. Now discharge for, say, an hour and charge up again. Continue this and sulphate will gradually disappear. If the sulphate has taken the form of beads, or looks like a fungoid growth, it will be necessary to scrape the plates carefully. If the cells are vulcanite with pitch tops, place in boiling water for a little time, and the pitch becoming soft the top may be easily taken off with the plates. Wash plates well, and using a piece of window glass or thin hardwood—*not a knife*—gently rub off the sulphate. Wash again, and replace, using a soldering bolt to seal up the cells. If cells are celluloid, paint the joints at the top with "acetone" till soft. In a short time the top may be taken off. The scraping should then be done and plates replaced To cement the tops again, dissolve some celluloid cuttings in acetone till syrupy fluid is formed. This makes a grand cement for celluloid. Clean Kodak films do well if no other celluloid is available.

It has been the writer's experience with motorcar ignition accumulators that where sulphating has set in badly, the paste will soon begin to fall out, especially if vibration is bad. It is a good plan, therefore, when plates are out to stuff the space between them very loosely with spun glass This is now readily obtainable, and though adding slightly to resistance of cell, is perfectly satisfactory for ignition purposes. Another plan is to take dry silicate of soda and drop in between the plates *very loosely* till the level of the plates is reached. Fill up with acid as usual. This forms a jelly "network," and traps powdered paste and supports any paste nodules that tend to fall out. It is preferable to the "solid" jelly sometimes used, as the resistance is not so high.

It might not be out of place to give the following rules for the care of ignition cells: (1) Do not use below 3½ volts for two cells. (2) Do not "overcharge"; it hardens the paste. (3) Keep the specific gravity of acid constant. (4) Protect from vibration by lining cell box with cloth or felt, using three or four layers at the bottom. (5) Never "flash" the terminals to ascertain charge; it may take 20 miles off the running, and shorten the life of cells. (6) Do not leave trembler of coil vibrating any length of time when testing; many high-speed coils take 10 amperes on free circuit, and would soon buckle plates. (7) If cells are not used for some time, say in winter, charge up once a month, or they will sulphate.—POLYPHASE.

Answer to No. 607 (*awarded* 5*s.*).—The old proverb, "That prevention is better than cure," should never be lost sight of when dealing with accumulators, especially small ones, otherwise ruination to the accumulators will be the result. The case stated in the question bears testimony to the above quotation, for it is certainly very much better to prevent sulphating than to cure it, and the prevention is a simple matter and easily performed, while the cure is rather a long and tedious operation. When sulphating has set in, it is a difficult matter to thoroughly cure it. In several bad cases of sulphating which have come under the writer's notice, the final result was a disintegration of the plates, and consequent ruination of the accumulators. This, however, could have been prevented with a little extra attention to the cells.

The term sulphating is applied to the formation of a sulphate of lead on the negative plates caused by over-discharging the cell. The sulphate formed is white in colour, hard, and insoluble in the acid solution. It can be removed by a process of continual charging at a small current. But even this in bad cases is not a complete cure, for if the plates be examined, they will be found to have become rotten. In the case under consideration, if the sulphating is of a bad nature, it would be better and more economical in the end to put in new plates instead of trying to preserve the old ones, as these, after the sulphating has been removed, will be in a poor condition, and will need to be replaced in a short time. The writer has, after a number of cases of bad sulphating, arrived at the conclusion that it is better and cheaper to renew the plates at once rather than try to preserve them, as the time they last when in this condition is very short.

The acid used in the cell should under normal conditions have a specific gravity of 1·180, which can be obtained by adding pure concentrated sulphuric acid *slowly* to water, the proportion being about one volume of the former to nine of the latter. The density of the acid in the cell is a good criterion of the condition the cell is in. When charging, care should be taken to see that the current is not too high, otherwise the paste will be forced out of the plates. When fully charged each cell should give about 2·5 volts, so that a four-volt accumulator should give about five volts at its terminals. The density of the acid rises during the charging, and the phenomenon known as "boiling" (due to the rapid liberation of oxygen during the charging, which causes a spraying of the liquid) is an indication that the cell is charged. The normal voltage of a cell in good condition should be two volts, and this gradually falls when the cell is discharged. The discharge should be stopped when the E.M.F. per cell falls to 1·8 volts, as if this is continued sulphating will result. Accumulators should never be left to stand for any length of time without charging, as this also has the effect of causing the plates to become rotten. Even when an accumulator is not used, it should be given a charge at least once a fortnight in order to preserve the plates. By giving a little extra attention to these points, the life of an accumulator will be very much increased.

The condition of the accumulator should always be determined by the reading it gives when a high-resistance voltmeter is connected across its terminals. Under normal conditions this reading should be about two volts per cell. If the reading indicates 1·8 or 1·9 volts per cell, charging should be proceeded with without delay. If a cell is periodically checked with a voltmeter, and the E.M.F. per cell be not allowed to fall below 1·8 volts, sulphating will be of rare occurrence. It is this little periodic checking (which only requires a *few* minutes to be performed) that forms the "prevention" to sulphating, and which the writer strongly advocates to all users of accumulators. If the "prevention" be not followed, the "cure" will be of a rather expensive nature, and will mean the replacing of the plates in a very short time. As "A. J. R.'s" case seems a fairly bad one, and as the accumulators would not be very large, it would be more economical to replace the plates at once, as even if "doctoring" be tried it will mean the replacement of the plates in a short time. When new plates are installed "A. J. R." will do well if he studies the motto quoted at the commencement, and sees that the voltage per cell is never less than 1·8 volts before commencing to charge, and also to give the cells a charge at least once a fortnight if they have to stand for a time without doing any work.—A. D.

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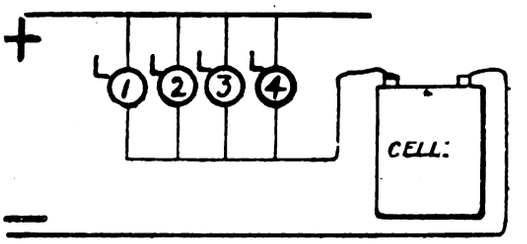
Answer to No. 607 (*awarded* 5*s.*).—Having had long experience with accumulators, the best advice I can give in this case is to pour away the liquid in the cell as received, because there is no knowing what it really is, owing to the various amateurish ideas to which these cells are subject. I have had cells brought to me half full, and in this case probably the acid is much too strong, and I have also had them come with water and practically no acid. Therefore, I advise a fresh start with cold acid solution of specific gravity 1,200, which is the proper strength for the cell; but before putting it in, the cell should be thoroughly washed out at least twice with clean cold tap water and turned bottom up to let any solid particles fall out if possible. The acid solution of 1,200 specific gravity is made by taking about 75 measures of clean cold water and adding to it gradually whilst stirring thoroughly about 25 measures of the best brimstone sulphuric acid (common oil of vitriol is not pure enough). This mixture will be very hot, and must be allowed to cool before it is put into the cell. As soon as it is cool, its specific gravity should be ascertained by a hydrometer. If the hydrometer shows more than 1,200deg, add a little water, but if it shows less, then add a little more acid, and stir well in either case. All being ready, the cell may now be put on to the dynamo as usual and charged, but the more slowly this can be done the better—*i.e.*, use a small charging current. Let the cell give off gas freely for three or four hours, but do not let it get hot. The cell must now be disconnected from the dynamo and discharged at a low rate until its E.M.F. falls to 1·95 volts, when it must be again charged full up as before. It must not be allowed to stand discharged for a single hour. It will most likely be restored to good condition by being charged and discharged in this way twice, or at all events the third time will suffice. To make the cell thoroughly satisfactory, the electrolyte should be poured away and fresh put in as before. When a cell is badly sulphated, both the positive and negative plate are affected. Charging desulphates the grey plate and discharging desulphates the brown plate, but the process is necessarily slow. To prevent sulphating in a good cell, the best plan is never to let it stand empty or half discharged. If the cell will not be wanted for some time, let it be thoroughly charged, then empty out the electrolyte and fill the cell with clean cold water. When the cell is wanted again empty out the water, put in the electrolyte, and charge fully at once, but, of course, with a moderate current.

The following directions were given some years ago for making an electrolyte to prevent and cure sulphating, but I do not consider it better than the above method, and the solution is some trouble to make—viz.: "Add 12 fluid ounces of sulphuric acid to a quart of saturated solution of ordinary washing soda, while stirring well and pouring gently. Add one part of this mixture to 19 of cold water, and then add five fluid ounces of sulphuric acid. This will give a solution of specific gravity 1,200deg."

It remains for me to add that ordinary sulphate of lead is soluble in pure brimstone sulphuric acid, and therefore, provided that the material of the cell itself would not be injured by the acid, a good deal of the sulphate might be dissolved off the plates rapidly by pouring the concentrated acid in, and allowing it to stand for a few hours. This plan could, however, not be recommended in all cases, and the sulphate is not soluble to any great extent in the acid. F. G. A.

Answer to No. 607 (*awarded* 5*s.*).—As a rule, small batteries used for electric ignition get badly treated. The person using the motorcar knows generally nothing about batteries, and often starts on a long journey without seeing that the cells are fully charged, and consequently has to over-discharge them in order to reach his destination. This bad treatment soon causes the plates to be badly sulphated and buckled. To bring them into good condition again is a question of time. I should first carefully examine the plates, and if the sulphating was very bad and the scale in some places bridging across the plates, I should take the battery to pieces and thoroughly clean it. Lift the plates out and at once immerse the negative plates in water, for if they are exposed to the air they will get hot, and on getting the battery together again they will be found to blister. Scrape the plates with a wooden scraper to get as much of the scale off as possible, wash thoroughly, and reassemble the battery together. Avoid having the strength of the acid solution high, for if it is above 1·700 specific gravity, the plates will be sure to be sulphated again. Now start charging at half the maximum rate for a prolonged period. This will gradually reduce the unhealthy sulphate to the healthy form, and finally charge the plates by conversion of the $PbSO_4$ to PbO_2. The white sulphate will be seen to fall off in scales, and if any sticks across the plates, it should be pushed down with a piece of wood. A plate that is sulphated has a very much smaller useful surface than a plate in good condition. If the ordinary amount of current be used to charge a plate badly sulphated, then only part of that current is doing useful work—*i.e.*, changing the chemical composition of the plates—the rest simply being wasted in splitting up the electrolyte. After the battery has been charged and discharged carefully a few times, the plates should assume a healthy colour.

Sir David Salomons recommends doctoring battery solution with sodium sulphate. I have tried it, but not with any very marked beneficial results. "A. J. R." may be more fortunate, however, and at any rate no harm is done. Dissolve 1oz. of sodium sulphate in 5oz. of water, and add this amount for each gallon of electrolyte. It should be added at the conclusion of the charging. Effervescence usually takes place, due to carbonic acid gas being given off, but this is of no consequence. Motorcar cells are usually supplied in vulcanite cases, sealed up, and very little idea can be obtained of the condition of the plates from the voltage and specific gravity reading. The plates may be badly sulphated and yet the cells give a good voltage. There is nothing like having the plates always visible, as the user of the battery can always tell by the colour of the plates when anything is wrong. I have seen battery cases apparently made of celluloid. They were strong, acid tight, and transparent.



The arrangement I have generally used for charging small batteries from continuous-current lighting mains is as shown in the accompanying diagram. L_1, L_2, L_3, L_4 are lampholders wired in parallel, and the current is varied by inserting more or fewer lamps in. The voltage of the mains is immaterial, providing, of course, it is not less than that of the battery. Lamps of the same voltage as the mains should be used. Batteries in vulcanite cases, sealed up, are provided, with little indiarubber bags fitted over the ventholes, which are blown up when the electrolyte starts gassing, thus indicating that charging is completed.—W. A T.

Question No. 608.—An engine I have charge of is constantly breaking one or the other of the cross-head bolts. Can this be remedied? The cross-head has a double guide similar to the marine type. When the keep is screwed up tight there is about ¼in. clearance between cross-head and keep. After working a few days the bolts get loose and then break.

Best Answer to No. 608 (*awarded* 10*s.*).—Presumably, from the question, it is not a case of the bolts being insufficient in area to stand the load, but it is some other cause which ultimately leads to their fracture. The question states, "the bolts get loose and then break." It would seem as if the real cause of the breakage lies in the fact that the bolts do get loose, and the attendant result—viz., hammering at the cross-head pin—is sufficient to break them. This may very possibly be the case. Bolts designed for a steady load will not stand a load of the same magnitude applied as a shock.

Why do the bolts get loose? It naturally suggests the question, Are the nuts on the bolts securely locked to prevent their gradual slacking back owing to the vibration of the moving parts? If the bolts are not already locked

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they should be; and if they are, a careful examination should be made to see if the locking is efficient. It is rather a pity that no dimensions of the cross-head were given, as this would tell a lot one way or other in a decision on the best method of locking. Again, it may be that initial slackness in the gudgeon pin, causing hammering, may be the cause of the nuts slacking back gradually. Of course, as they slack back they would make "bad" "worse," and ultimately the bolts would be no longer able to bear the strain, and would break. The remedy for this lies in "letting-to" the cross-head brasses on to the gudgeon pin.

Are the bolts as "elastic" as they might be for the strain? The most economical bolt for resisting shock would be one in which as much of the shank as possible was turned down to the diameter at the bottom of the screw thread. I should suggest that if the bolts are as at A, Fig. 1, they should be altered as B, Fig. 1. The

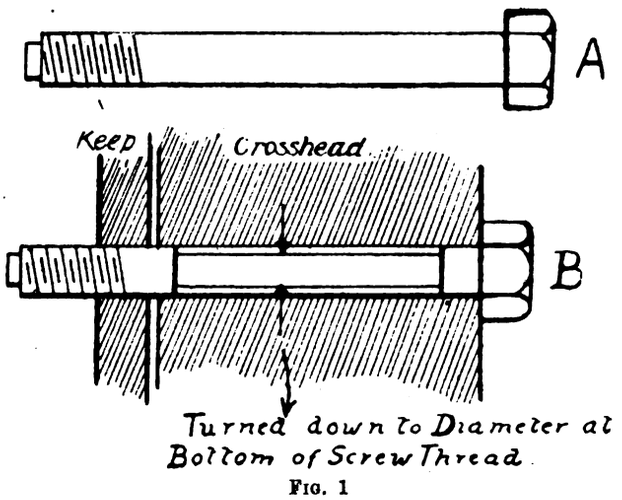


FIG. 1

smallest diameter of the bolt is that at the bottom of the screw thread. Such a bolt as B would absorb shock a good deal better than a bolt like A, and yet be as strong for tensile loads.

There is still another cause it would be advisable to mention as being possibly the reason of the continued accidents. I do not say it is likely, but still it is possible. Supposing one bolt to get tightend a little more than the other, so as to throw the keep across the brass, as in Fig. 2. Then bolt *a* is standing nearly the whole of the load, whilst the slightest screwing up of *b* would produce in *a* a great deal of extra stress. It is easily conceivable, then, that the keep having got across, bolt *a* is in a good deal of initial strain to begin with. When the engine has gone for a bit

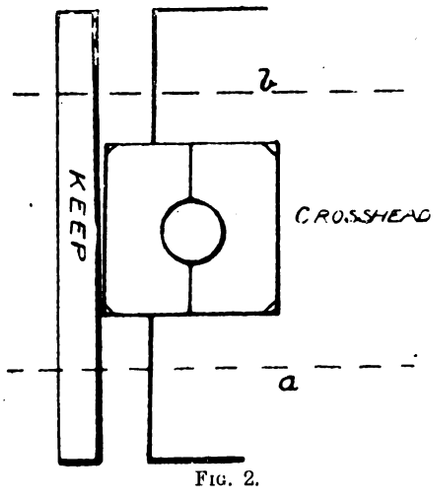


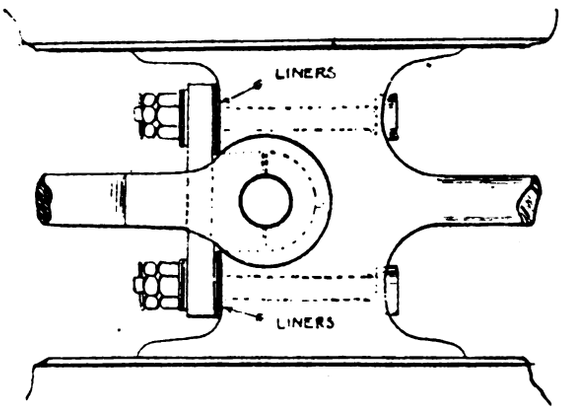
FIG. 2.

the repetition of stress may very probably be sufficient to fracture it. Most engineers will recollect Wöhler's experiments on repetition of stress. If the bolts *have been screwed up unevenly*, then it is within the limits of common sense to understand that this *may* result in fracture, but I think that in the hands of an engineer such a likelihood would not arise frequently, if at all. Any way, it might be the cause, and it is advisable to mention it. But I should rather prefer myself, if I were "C. B.," to find the cause of the slacking back. Prevent that, and then I think the bolts will remain intact.—T. T.

Answer to No. 608 (*awarded* 7*s.* 6*d.*).—In reply to this question, I had the same experience some few years ago with three different engine sets, but all having the same type of cross-head. At that time the cross-heads were continually giving trouble, and causing the shift engineers great anxiety; in fact, on one occasion both bolts broke on one engine, resulting in the piston going up through the cover, doubling up the connecting rod and smashing the columns, etc. The breaking of the bolts was due to two causes: first, the bolts were not a tapping fit in the holes; and, secondly, the nuts and check nuts were too slack on the bolts. After working a little time the nuts came back, allowing the keep and brasses to jump about, subjecting the bolts to excessive strain, and resulting in a breakdown.

Finally, however, I hit upon a plan which thoroughly overcame the difficulty, and the engines are still in use to-day. The brasses were overhauled, squared up, and adjusted in the cross-head, so that the connecting rod swung easily. The distance between the keep and cross-head, which was about $\frac{5}{16}$in., was then carefully taken, and liners cut to make up the space, each one with a hole through to suit the bolt. The bolts were then withdrawn and the liners inserted on each side of the brasses. When screwed hard up, it made a very solid job of it. Then tin washers, besides the ordinary ones, were also put under the nuts, so that when both the thick and check nuts were tightened up, the split pins through the ends of the bolts had to be driven in, making it impossible for the nuts to move.

Another point worthy of note is that as the brasses were not brass and brass, there being about $\frac{3}{32}$in. between them, the work of taking up the cross-head was a very small matter. The liners mentioned were made up of three $\frac{1}{16}$in.,



the rest being $\frac{1}{64}$in. As the brasses wore, all that was necessary was to take out one or perhaps two each side of the brasses, putting, of course, the same thickness washers under the nuts—in fact, the liners taken out were cut to suit for the washers. Reference to the accompanying sketch will show the whole thing at a glance.—F. B. C.

Answer to No. 608 (*awarded* 5*s.*).—Marine engine cross-heads usually have unequal sized slippers, as they are

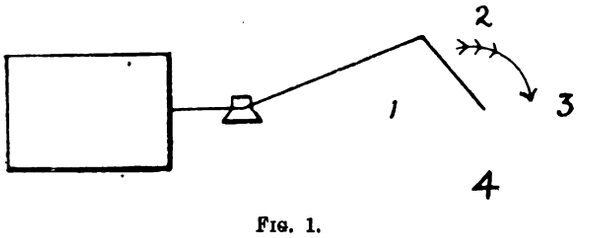


FIG. 1.

really intended to run in one direction only, the greater bearing surface of the cross-head slide taking up the greater thrust. Perhaps the engine described in the query is running in the wrong direction. The arrow in Fig. 1 shows correct direction for running when the larger slipper of cross-head is as in sketch. Another cause of the trouble may be want of alignment of the working parts. The

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cross-head slides must be parallel with the travel of the piston, and the piston-rod gland should be examined to see that it does not throw a twist on the rod. In setting the slippers on the cross-head, care must be taken that they each bear equally on their slides, and do not force the piston rod out of its proper position. It sometimes happens that when the slippers on cross-head do not travel far enough to overlap the slides, slight shoulders are formed. After any repairs to the engine, such, for instance, as taking up the brasses, the slippers will ride on these shoulders and give trouble. If this is so, the bearing surfaces of the slides should be chipped away, so that at each end of the stroke the slippers just overlap. Similar effects are also caused when the piston does not overlap bearing surface of the cylinder at each end of its stroke. To test for proper alignment of the connecting rod, remove brasses at crank end, and see if the end of the rod is equally distant from the shoulder or collar of the crank-pin in each of the positions 1, 2, 3, and 4. If out of line, and crankshaft is at right angles to the cylinder, adjust by means of its brasses on the cross-head pin or gudgeon. If these points are satisfactory, the fault may be looked for in the bolts themselves. They might perhaps be made a size larger. Lock nuts as a rule hold fairly well, but a split cottar is generally fitted behind them for safety. In quick-running engines it is most essential that all bolts and nuts should be a good fit, or they have a greater tendency to become loosened. To prevent nuts and bolts coming slack, some such means should be taken as sketched in Fig. 2. In one

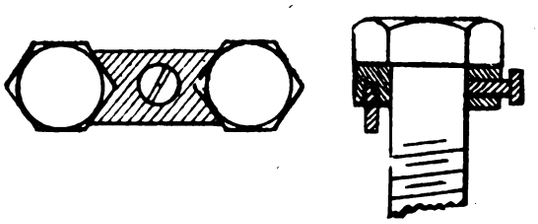

FIG. 2.

case a piece of iron is screwed down which fits the angles of two nuts or bolt heads; this is an old-fashioned but reliable arrangement. The other method, shown here as attached to a set screw but equally well suitable for nuts, is one very much used in marine engineering work. To give a definite answer from the data given in the question is very difficult, although an examination of the engine would probably suggest a remedy at once.—M. M.

GLASGOW TELEPHONE UNDERTAKING.

We have received a copy of the second annual report of the Committee on Telephone Service to the city of Glasgow for the year from June 1, 1902, to May 31, 1903, together with the capital account and balance-sheet. The following abstract will show the position of the undertaking as at the latter date:

Revenue and Expenditure.

Proportion of rentals brought from last year	£12,417	1	5
Gross revenue from rentals for this year, £42,176. 5s. 7d.; less proportion of rentals applicable to year 1903-4 carried to suspense account, £20,714. 15s. 9d.	21,461	9	10
Sundry receipts (including terminal fees, £366. 7s. 5d.)	1,135	11	7
Total revenue	35,014	2	10
Working expenditure (including Post Office royalty, £3,405. 9s. 8d., and terminal fees, £1,497. 15s.)	20,871	2	2
Net revenue	14,143	0	8
out of which the following requirements had to be met:			
1. Interest on loans	£6,642 5 7		
2. Sinking fund	5,806 13 4		
	12,448	18	11
leaving a surplus on the year's operations of	1,694	1	9
Surplus brought from last year	398	7	10
Total surplus	£2,092	9	7

From the above synopsis it will be seen that the surplus for the year just closed amounts to £1,694. 1s. 9d., which, together with the surplus £398. 7s. 10d. brought forward from last year, makes up the sum of £2,092. 9s. 7d., and it is now proposed that the whole amount be carried into a general reserve fund. The capital expenditure for the year just ended has amounted to £78,244. 16s. 2d.; adding the capital expenditure of £192,693. 14s. 3d. previously incurred, there is a total capital expenditure of £270,938. 10s. 5d. The following statement gives the work completed and the remarkable progress the undertaking has made in the last two years:

	Original scheme.	Actually completed. 1901-02.	1902-03.
Completed instruments to be provided	5,250	5,479	9,122
Partially completed lines	1,200	8,787	7,387
Switchboard accommodation (lines)	6,050	7,060	10,826
Number of pairs of cable wires	6,450	14,572	18,171
Mileage of pairs of wires in cables	4,938	11,061	14,029¼
Length of trenching (miles)	22	94	127¾
Number of pipes going out of exchanges	32	126	135
Capacity of pipes going out of exchanges (pairs of wires)	6,900	27,000	31,000
Length of pipes (miles)	32	104¼	127¼
Length of underground cable (miles)	31	113¾	162
Number of ground poles	2,326	691	1,799
Number of roof standards	456	228	243

The service generally continues to be acceptable to subscribers, as may be shown by the fact that during the year now ended the number of orders received was considerably in excess of the preceding year, and the traffic during the year has steadily increased, and now reached the rate of 31½ million messages per annum. The messages per subscriber per day vary in the different exchanges from six to twenty-one, the average throughout the system being 13 per subscriber per day. The traffic in trunk messages, particularly in incoming calls, also shows a considerable increase on the previous year. Considerable attention has been devoted to opening public telephone offices for the use of the public throughout the city, there being now 115 in operation. At May 31 there were 9,112 instruments connected, these being subscribed for by 8,145 persons and firms, of which about 4,600 have never been telephone subscribers before. About 800 orders remained to be executed. Below we give abstracts of the revenue and capital accounts:

REVENUE ACCOUNT.

Dr. Expenditure.	£	s.	d.
Inspection and repairs—wages, materials, etc.	4,371	14	9
Reconstruction—wages, materials, etc.	274	14	1
Post Office commission	21	5	3
Post Office royalty	3,405	9	8
Trunk and telegram fees	9	17	11
General expenses	7,563	7	8
Printing, stationery, etc.	685	6	1
Rents, rates, and insurance	2,789	10	3
Fuel and light	252	1	6
Terminal fees	1,497	15	0
Balance carried to net revenue account	14,143	0	7
	£35,014	2	9

Cr. Revenue.	£	s.	d.
Post Office commission—amount received on trunk fees	221	13	9
Exchange rentals	33,474	3	5
Private rentals	404	7	10
Local tolls	177	1	1
Public telephones	225	8	4
Profit on shifts and sales	52	13	9
Miscellaneous receipts	51	19	0
Rents, rates, and insurance	40	8	2
Terminal fees	366	7	5
	£35,014	2	9

BALANCE-SHEET.

Dr.	£	s.	d.
Capital account	270,938	10	5
Stores	7,275	17	4
Tools	1,772	12	11
Stationery	66	5	7
Insurance	187	8	8
Sundry debtors	4,701	2	11
Union Bank of Scotland	758	19	9
Cash in hand	310	8	1
	£286,011	5	8

Cr.	£	s.	d.
Loans fund	242,533	6	8
Sinking fund	7,766	13	4
Retention account	9,454	13	7
Sundry creditors	4,301	15	0
Mrs. Macdonald's fund	18	16	6
Unpaid interest	339	5	10
Unpaid Post Office royalty	750	0	0
Unpaid terminal fees	81	3	9
Rentals suspense account	18,673	1	5
General reserve fund	2,092	9	7
	£286,011	5	8

APPOINTMENTS VACANT.

Engineer-in-Charge, Darlington Corporation, £78 per annum, 14th inst.

Designer, well up in both alternating and continuous currents. See advertisement.

Resident Engineer, Morecambe Borough Council, £150, rising to £200, Sept. 14.

Second Engineer-in-Charge, Bermondsey Borough Council, £125, Sept. 15. See advertisement.

Shift Engineer, Middleton Corporation, Sept. 10.

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TRADE NOTICES AND NOVELTIES.

Rectifiers.

In our last issue we described the principle of a new type of rectifier (Koch's system) supplied by Messrs. Siemens Bros. and Co., Limited, 12, Queen Anne's-gate, Westminster, S.W. By the courtesy of this firm we are now able to illustrate several classes of the apparatus constructed for specific purposes. The rectifier (Fig. 1) is used exclusively for charging small accumulator batteries from an alternating-current circuit of any ordinary potential or frequency, and is designed for a maximum charging current of eight amperes. In our next illustration (Fig. 2) the parts of the rectifier are shown arranged in switchboard form, the interrupter, three-pole switch, adjustable resistance (for varying the direct current used for excitation), the phase regulator, and the terminals being fixed to a white marble slab 350mm. (13¾in.) by 450mm. (17¾in.). The condenser is fixed in a polished case behind the marble slab and the choking coil in a separate perforated iron case. It can be employed with any ordinary voltage, and gives a maximum charging current of 15 amperes. The rectifiers (Figs. 3 and 4) are designed exclusively to work induction coils from alternating-current circuits. If the primary is suitably wound, the coils may be worked up to their maximum sparking distance, and by the insertion of a resistance in the secondary, the softest of Röntgen tubes will give clearly defined images. This apparatus renders it possible for alternating currents to be employed for X-ray work in a manner hitherto unattainable. The armature of the polarised interrupter operates the contact in such a manner that only currents in one direction pass through the primary coil, the "makes" and "breaks" occurring exactly at the zero periods of the potential of the main current. In consequence, however, of the inductance of the circuit, the direct rectified current flowing through the primary coil lags behind the potential of the main current and is interrupted shortly after its maximum value has been reached, but, as the interruption occurs in the falling part of the curve, sparking at the contact is minimised and a relatively long life for the contact secured. While, however, the apparatus Fig. 3 utilises only one of the alternations of the current, that shown in Fig. 4 utilises both alternations, and so doubles the frequency of the sparks given by the coil. In photography, the times of exposure are greatly reduced by the use of this apparatus with Röntgen tubes constructed for very rapid interruptions. The armature of the interrupter operates the contact in such a manner that the positive portions of the rectified current flow through one division of the primary in one direction, and the negative portions through the other division of the primary in the other direction, the sparks in the secondary circuit being thus always in the same direction. The number of sparks is double that of the periods of the alternating current, but it may be halved by switching off one of the primary circuits. The introduction of the above type of rectifier into this country is extremely welcome.

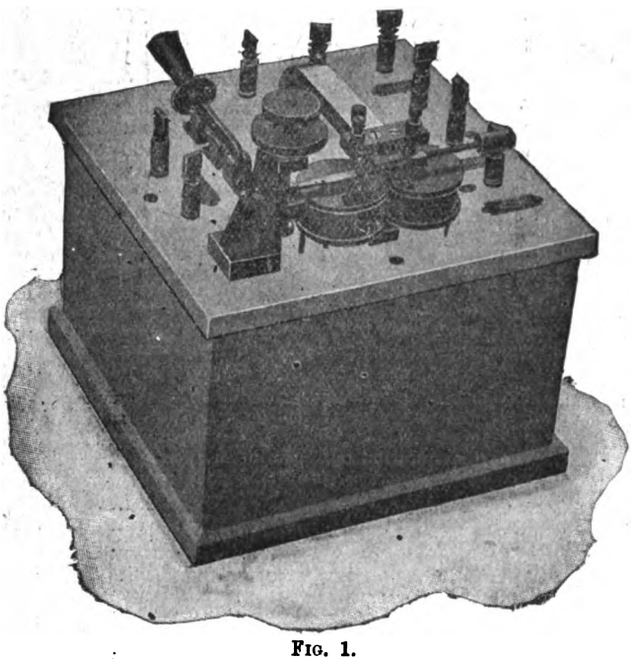

FIG. 1.

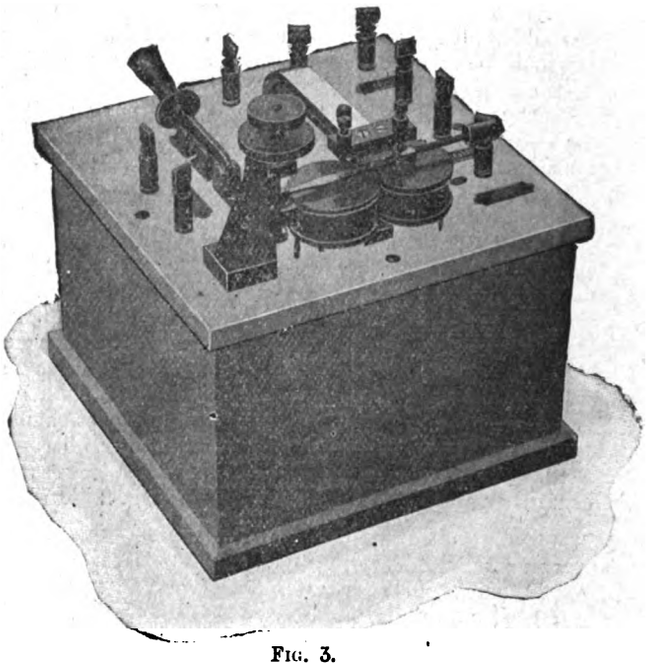

FIG. 3.

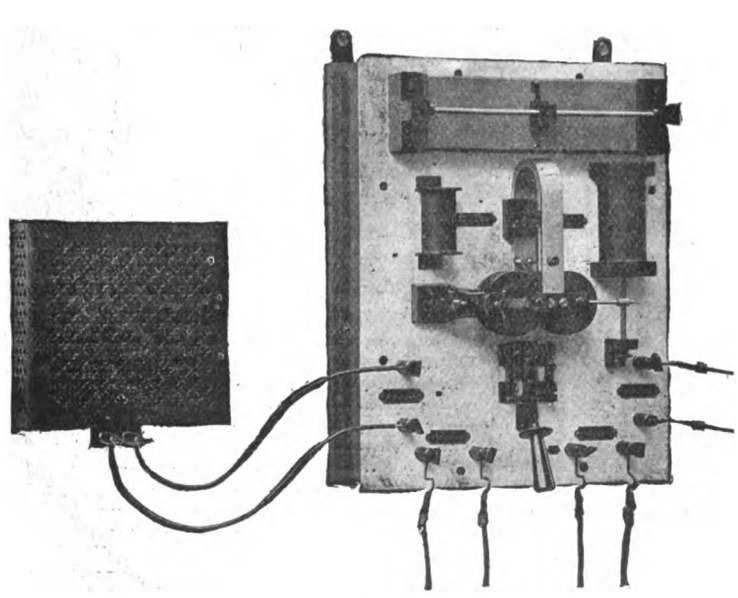

FIG. 2.

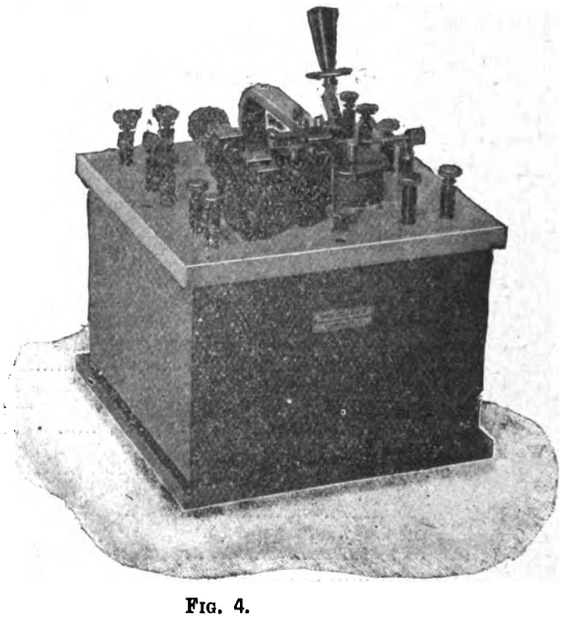

FIG. 4.

Small Motor Manufacturing.

Our English firms are now well to the fore in the manufacture of small motors, and have recognised the vast scope there is for electric motors now that electric supply systems are so common throughout the country. Amongst the firms in question, Messrs. Crompton and Co. may be specially mentioned. The illustration we give herewith is intended to convey the fact that it is only by manufacturing in quantity that the present

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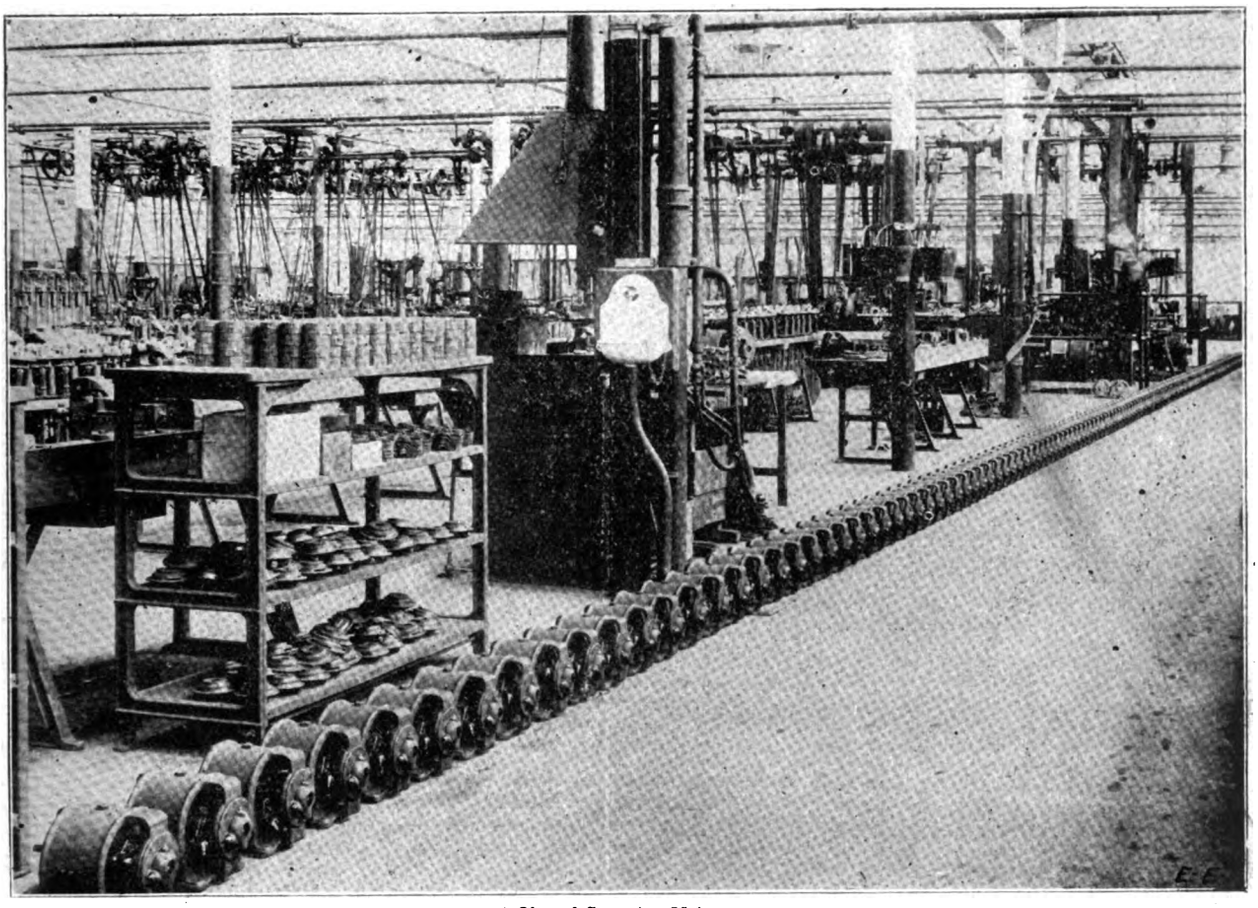
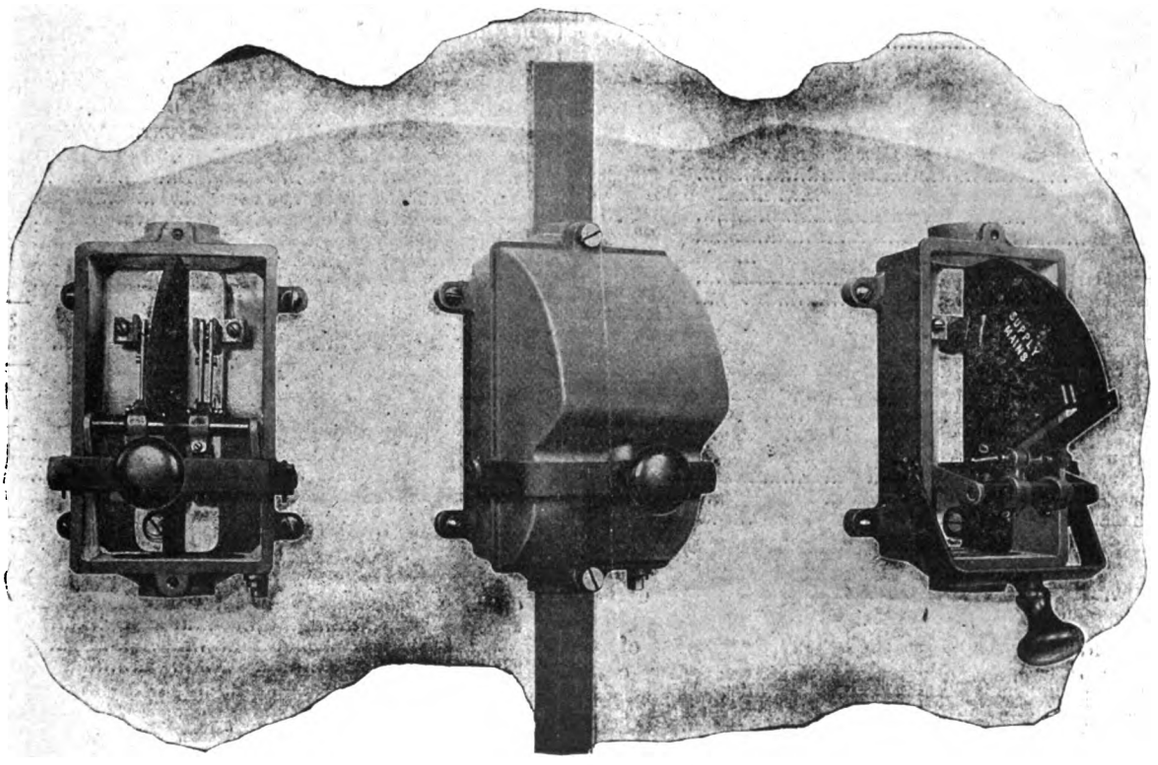
demand can be met for small motors at low prices. The semi-automatic tools with which Messrs. Crompton and Co.'s new works are so completely furnished enables them to carry through the vast amount of repetition work most economically. We need only add that the care bestowed on the manufacture of these motors is no less than that which is given to the larger Crompton machines. These motors are standardised for three different voltages—*i.e.*, 110, 220, and 440. With small alterations of speed these standards are suitable for working on 100, 200, and 400 volt circuits.



A Line of Crompton Motors.

The Holmes-Page Switch.

Through the kindness of Messrs. J. H. Holmes and Co. we are able to give the following illustration of the Holmes-Page patent switch as enclosed in cast-iron boxes. The combination of the box and switch makes it suitable for connection to electric supply companies' mains, and they are also in accordance with the various fire insurance companies' regulations for controlling 460-volt motors. The switch is arranged so as to embody all the features of the Holmes-Page chopper switches. The box is of cast iron and is made practically watertight, and screwed holes are provided at the ends to receive insulated bushes or iron pipes carrying cables. The switch is operated by means of a stirrup handle, which fits outside the box when the cover is on, and it is so arranged that the box cover cannot



The Holmes-Page Patent Switch.

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be removed without first opening the circuit. The entire switch parts, excepting the two top contact jaws, are dead when the switch is open. The inside surface of the box is thoroughly coated over with a specially-prepared insulated japan, which will not crack or blister when subjected to severe heat or rough usage. The box is provided with suitable means for earthing. The special points worthy of mention are: neatness in appearance; switches are carried on porcelain bases, and are separated by substantial partition, thereby securing a very high insulation resistance. The switch has self-adjusting contacts, and is easy to wire. Another important feature is that the supply main may be brought in at either end, and still be connected to the top contact jaws. The sample switch will comfortably carry 12 amperes at 500 volts, and considerably more at lower voltages. It has been tested to earth and between poles with 2,000 volts alternating current.

GLOUCESTER ELECTRICITY ACCOUNTS.

The accounts of the Gloucester electricity undertaking for the year ended March 31, 1903, show a total expenditure on capital account of £59,332. Abstracts of the revenue account, general balance-sheet, and statement of electricity generated, sold, etc., are appended.

REVENUE ACCOUNT.

Dr. Expenditure.	£	s.	d.
Coal and other fuel	589	17	6
Oil, waste, water, and stores	108	2	9
Wages at generating station	527	3	4
Repairs, etc., of buildings and plant	357	19	9
Repairs, etc, of mains and meters	118	17	11
Public lamps—repairs, etc.	291	14	6
Rent, rates, and taxes	238	5	4
Management expenses	478	17	1
Insurance	55	13	11
Free wiring rental	10	4	10
Total expenditure	2,776	16	11
Balance of revenue account	2,215	4	11
	£4,992	1	10

Cr. Receipts.	£	s.	d.
Sale of current, less discounts	4,714	13	0
Rental of meters and free wiring	144	6	2
Miscellaneous receipts	133	2	8
	£4,992	1	10

GENERAL BALANCE-SHEET.

Dr. Liabilities.	£	s.	d.
Capital account—loans received, less paid off	50,900	8	7
Cost of provisional order	285	12	7
Sundry creditors and interest on loans	1,839	3	4
Due to treasurer	8,331	16	5
Surplus, being amount of loan repaid	1,974	11	5
	£63,331	12	4

Cr. Assets.	£	s.	d.
Capital account—amount expended for works	59,332	11	8
Stores on hand	214	5	3
Sundry debtors for current, less discounts	1,379	11	7
Public street lamps	291	5	0
Other debtors	98	1	3
Cash in hands of engineer	10	0	0
Balance at debit of net revenue account	1,378	16	3
Suspense account	627	1	4
	£63,331	12	4

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T. units		329,522
Quantity sold: Public lamps	79,566	313,875
Quantity sold: Private consumers by meter	234,309	
Quantity used on works		15,647
Total quantity accounted for		329,522
Number of public lamps		3
Total maximum supply demanded (kilowatts)		304

WALLASEY ELECTRICITY ACCOUNTS.

Attached we give abstracts of the accounts of the Wallasey electricity undertaking for the year ended March 31 last. The total expenditure on capital account on that date amounted to £78,985.

Dr. REVENUE ACCOUNT.	£	s.	d.
Coal or other fuel	2,130	19	4
Oil, water, and engine-room stores	119	10	7
Wages at generating stations	619	6	7
Repairs and maintenance	556	6	10
Lighting and water for works	162	0	6
Wages to linesmen, fitters, labourers	300	2	8
Repairs, maintenance, and renewals of mains	104	6	2
Repairs, maintenance, and renewals of transformers, etc.	1,916	12	4
Repairs, maintenance, and renewals of apparatus	1	18	2
Attending and repairs to public lamps	202	13	8
Rates and taxes	510	7	8
Salaries—Engineers' department	659	11	8
Accountant, clerical staff, and collectors	175	0	0
Stationery and printing	92	15	1
Advertising	14	3	8
General establishment charges	85	2	8
Insurances, etc.	48	1	9
Bad debts	17	17	10
Expenses for certification of meters	161	18	0
Charges and stamp duty on loan	99	19	6
Total expenditure	7,978	14	8
Amount carried to net revenue account	6,349	18	2
	£14,328	12	10

Cr.	£	s.	d.
Sale of current per meter	11,537	0	8
Public lighting	875	8	3
Rental of meters	343	8	1
Sale and repair of lamps and other apparatus	1,546	3	10
Rents receivable	26	12	0
	£14,328	12	10

GENERAL BALANCE-SHEET.

Liabilities.	£	s.	d.
Capital account—amount received	78,985	0	0
Reserve fund account	1,469	0	9
	£80,454	0	9

Assets.	£	s.	d.
Capital account—amount expended for works	62,910	11	7
Cash with treasurer	17,543	9	2
	£80,454	0	9

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T. units		1,337,518
Quantity sold: Public lamps	74,460	1,164,693
Quantity sold: Traction	743,260	
Quantity sold: Private consumers by meter	346,973	
Quantity used on works		13,301
Total quantity accounted for		1,177,994
Quantity not accounted for		159,524

Total maximum supply demanded—lighting, 315 kw.; traction, 450 kw.
Number of public lamps: 48 arcs, 96 incandescents.

RATHMINES ELECTRICITY ACCOUNTS.

The accounts of the Rathmines electricity undertaking for the year ended March 31, 1903, show the total amount expended on capital account to that date to be £74,261. Abstracts of the revenue account, general balance-sheet, and statement of electricity generated, sold, etc., are appended.

REVENUE ACCOUNT.

Dr. Expenditure.	£	s.	d.
Generation of electricity	2,110	11	3
Distribution of electricity	60	15	4
Attending and repairs to public lamps	604	0	11
Rents, rates, and taxes	215	0	0
Management expenses	671	16	3
Special charges—insurance, etc.	49	16	0
	3,711	19	9
Amount carried to net revenue account	2,614	2	7
	£6,326	2	4

Cr. Income.	£	s.	d.
Sale of current to private consumers	3,254	10	8
Public lighting	2,841	4	6
Rental of meters and other apparatus	182	6	5
Sale and repairs of lamps	48	0	9
	£6,326	2	

GENERAL BALANCE-SHEET.

Dr. Liabilities.	£	s.	d
Capital account—amount received	71,000	0	0
Sundry creditors	969	1	0
Sinking fund account	3,394	6	3
Cash due to treasurer	5,206	7	2
	£80,569	14	

Cr. Assets.	£	s.	d
Capital account—amount expended for works	74,261	8	8
Stores on hand	143	17	10
Sundry debtors for current supplied	2,350	9	6
Amount in sinking fund	3,394	6	3
Balance at debit of net revenue account	419	12	2
	£80,569	14	5

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STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T. units		506,292
Quantity sold { Public lamps	243,542	422,769
Quantity sold { Private consumers by meters	179,227	
Quantity used on works		13,807
Total quantity accounted for		436,536
Quantity not accounted for		69,716
Total maximum supply demanded (kilowatts)		256

Number of public lamps: 108 arcs, 273 incandescents.

LEITH ELECTRICITY ACCOUNTS.

Below we present abstracts of the accounts of the Leith Corporation electric lighting undertaking for the year ended May 15 last. On that date the total expenditure on capital account amounted to £82,080.

Dr. REVENUE ACCOUNT.	£	s.	d.
Coal and other fuel	2,600	6	3
Oil, engine-room stores, etc.	62	5	2
Wages at generating station	982	5	0
Repairs and maintenance	222	18	9
Distribution—Wages	103	16	3
Repairs, maintenance, and renewals of mains	42	18	6
Repairs, maintenance, etc., of transformers, meters, etc.	173	9	0
Public lamps—Wages	664	1	6
Carbons	350	19	8
Repairs	217	0	11
Rents	106	9	8
Rates and taxes	1,020	2	11
Salaries—Engineer's department	145	16	8
Accountant and clerical staff	169	12	8
Burgh general account	244	7	4
Stationery and printing	20	5	3
General establishment charges	57	10	5
Special charges—insurances	29	1	9
	7,213	7	8
Balance carried to net revenue account, £6,384. 4s. 2d.; to provide for bad debts, £40	6,424	4	2
	£13,637	11	10

Cr.	£	s.	d.
Balance from last account, less bad debts	12	12	6
Sale of current per meter, less discounts	5,762	12	4
Motor power	2,488	1	0
Public lighting—Arc lamps (burgh), at £20 per annum	4,784	19	7
Arc lamps (Harbour and Dock Commission)	147	7	11
Meter rents and guarantees	62	17	0
Miscellaneous receipts	379	1	6
	£13,637	11	10

GENERAL BALANCE-SHEET.

Dr. Liabilities.	£	s.	d.
Amount due on mortgage	79,072	0	0
Interest on mortgage debt	370	19	0
Sundry creditors	113	10	0
Balance at credit of revenue account	40	0	0
Balance at credit of net revenue	661	15	2
	£80,258	4	2
Surplus.			
Contributions from revenue for instalments of mortgage debt repaid	7,957	10	8
	£88,215	14	10

Cr. Assets.	£	s.	d.
Capital account—amount expended for works	82,080	5	6
Stores on hand	290	16	2
Sundry debtors for current	3,408	7	6
Union Bank of Scotland, Limited	2,436	5	8
	£88,215	14	10

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T. units		1,341,635
Quantity sold { Public lamps	495,167	1,232,496
Quantity sold { Private consumers by meters	737,329	
Quantity used in station		15 379
Total quantity accounted for		1,247,875
Quantity not accounted for		93,760
Number of public lamps		270
Total maximum supply demanded (kilowatts)		725

LEIGH ELECTRICITY UNDERTAKING.

Mr. D. M. Kinghorn, the borough electrical engineer of Leigh, has presented his report to his committee on the working of the Electricity Committee for the year ended March 31 last. It shows that the capital expenditure on that date amounted to £22,271. 6s The total length of mains was 7 miles 1,606 yards, and the number of services laid during the year, 26. A comparative statement of annual progress shows that the number of consumers last year increased to 154; number of 8-c.p. lamps, 11,875; number of motors, 75; number of units sold, 344,880 (plus 453 public clock); maximum load in kilowatts, 264, the load factor being 14·9 per cent. The progress made during the year has been very satisfactory, the increase in the number of units sold being 129 per cent. greater than in the preceding year. The load factor also shows a better demand. A table showing the number of units sold at the various prices indicates a slight falling off in the number of units sold at 7d. and 2½d., but this is more than counterbalanced by the increase of 93·5 per cent. in the units sold at 5d. The increase in the demand for power is exceptional and very gratifying, being nearly four times greater than last year, with a corresponding increase in revenue, which shows that, though the rates are very favourable, the price per unit sold is well maintained. Following we give an analysis of accounts for year ending March 31, the figures in brackets being for 1902: capital expenditure to March 31, £22,271 (£17,373); revenue from electricity supply, £3,466 (£1,989); revenue from meter and motor rents and other sources, £150 (£70); total revenue, £3,617 (£2,060); total costs, £2,184 (£1,150); gross profit before providing for interest charges and sinking fund, £1,433 (£910); percentage of gross profit to capital (outlay during year being averaged), 7·22 (6·43); interest on loans, £635 (£419); sinking fund, £534 (£410); percentage of sinking fund to capital (outlay during the year being averaged), 2·69 (2·89); financial result after payment of all charges, £263 profit (£80 profit); capacity of dynamos, etc., March 31, 450 kw. (200 kw.); maximum load reached, 264 kw. (140 kw.); load factor, 14·9 per cent. (12·31 per cent.); number of 8-c.p. lamps connected March 31 (arcs, incandescents, and motors, equivalent in 8 c.p.), 18,166 (15,853); number of units sold and public clock, 344,880 (151,048); units sold per 8-c.p. lamp (connections during year being averaged), 22·9 (13·8); price charged—private lighting, 7d. and 2½d., or 5d. less 10 per cent. and 3d., power, 3d. and ¾d. and 1½d.; average price obtained—private supply, 4·56d. (4·13d.), power, 1·4d. (1·45d.). From an analysis of costs we find that the generation and distribution costs in 1902 amounted to £635 (1·01d. per unit sold), and last year to £1,526 (1·061d. per unit sold). The general costs in 1902 were £985 (1·56d.); in 1903, £1,896 (1·318d.). The total costs in 1902 amounted to £1,815 (2·88d.); in 1903, £3,066 (2·131d.). Special charges brought the total up to £1,979 in 1902 and £3,260 last year. A summary of financial results shows that for 1903 the principal figures were: capital expended, £22,271; average charge per unit, 2·51d.; gross profit, £1,433; percentage to average capital outlay, 7·22 per cent.; interest and sinking fund, £1,169; surplus, £263.

LEGAL INTELLIGENCE.

METROPOLITAN ELECTRIC SUPPLY.

Compensation for Displacement.

The dispute which had been going on between the London County Council and the Metropolitan Electric Supply Company for considerably over two years with regard to the acquisition by the former of the company's property in Sardinia-street in connection with the Holborn-to-Strand improvement has at length been finally settled by arbitration. Sir John Wolfe Barry was the umpire, and he has just issued his award, which, it may be said at once, is a complete victory for the London County Council, the amount of the award being considerably less than half what the company claimed. The history of the arbitration is very generally known. In pursuance of the powers conferred upon them by Parliament, the London County Council proceeded to compulsorily acquire the generating station and other premises of the Metropolitan Electric Supply Company in Sardinia-street, Lincoln's-inn-fields, for the purposes of the new thoroughfare from Holborn to the Strand. Then arose the question of the amount of compensation the company were to receive for being displaced and having to seek other and suitable premises to carry on their business. The difficulty in the way of an early settlement of the matter was the clause in the County Council's Act of Parliament, which provided that they should reinstate the company elsewhere and pay compensation which was to be assessed on this basis: "A sum equal to the costs and expenses of erecting and fitting a new generating station upon the new site, with new plant of a capacity to generate and supply electrical energy to an output of not less than 4,000 kw., and all expenses." Each party, not unnaturally perhaps, placed its own construction on this clause, the one holding that it was only compelled to pay the cost and erection of four new engines graded up to a capacity of 4,000 kw., the other contending that it was entitled to be compensated for all expenses "contingent" to the displacement of their machinery in Sardinia-street, and the erection of the new plant on the other site. Being unable to agree between themselves the parties had recourse to the law, and in the first place Mr. Justice Farwell, in the Chancery Division, was invited to place his construction upon the clause in question. He held that the arbitrator was debarred from allowing anything more than would cover the cost of four engines graded up to a capacity of 4,000 kw. This decision was appealed against by the company, and the Court of Appeal decided the other way. Then the County Council took the matter up to the House of Lords, and the final decision was given on March 10 last year. It was in favour of the company, the Lord Chancellor explaining that the question was not whether it was reasonable and proper to make provision for contingencies, but whether it had been agreed to between the parties. He held that it had, and the matter thus went to Sir John Wolfe Barry to say how much the company were entitled to receive on this basis. The arbitration proceedings commenced on Jan. 7 this year at the Surveyors' Institute, Westminster, and the hearing lasted several days. The claim of the company amounted approximately to £400,000. Their

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legal representatives were Mr. Balfour Browne, K.C., Mr. Cripps, K.C., Mr. Ernest Moon, K.C., Mr. C. H. Sargant, and Mr. A. T. Lawrance. For the London County Council, Mr. Fletcher Moulton, K.C., Mr. Boyle, K.C., and Mr. Edward Morton appeared. Mr. C. H. Gadsby, of Victoria-street, London, acted as consulting engineer to the London County Council in the arbitration. Sir John Wolfe Barry, the umpire, had the assistance, as arbitrators, of Sir Frederick Bramwell, Bart., F.R.S., and Mr. Andrew Young. Among those who were called as witnesses during the hearing were Sir William H. Preece, Mr. S. Z. de Ferranti, and Mr. Robert Hammond. As above stated, Sir J. Wolfe Barry's award amounts to £183,150, which averages out at just over £45 per kilowatt, while the sum claimed by the company amounted to £100 per kilowatt. Although no definite offer was made by the County Council, they were advised by their experts that a sum of, say, £150,000 would fully meet the case. The result, notwithstanding the adverse legal proceedings, is, therefore, an all-round victory for the London County Council.

ELECTRIC TRAMWAYS TRUST.

In the Vacation Court on Wednesday Mr. Justice Walton had before him the petition of W. Bratby for winding up the Electric Tramways Trust, Limited.

Mr. Hodge, for the petitioner, asked for an opportunity to answer the evidence of the respondent, which was only filed the previous morning. He was entitled to three days for reply.

Mr. Bramwell Davis, K.C., for the respondent, the liquidator, said he could not resist the application, and the petition stood over accordingly.

NEW COMPANIES REGISTERED.

Wave Power Company, Limited.—Capital, £12,000. Objects: to adopt an agreement with the Morley-Fletcher Wave Power System, Limited, and to carry on the business of an electric light and power and hydraulic power company in all its branches. Registered office: 33, St. Swithin's-lane, E.C.

Whithorn Lighting Company, Limited.—Registered in Edinburgh. Capital, £400. Objects: to acquire the business and assets of the Whithorn Gas Company, and to supply and light with gas, electricity, or otherwise the burgh and vicinity of Whithorn. Registered office: 23, George-street, Whithorn.

Tokio Construction Company, Limited.—Capital, £150,000, in £10 shares. Object: to enter into contracts for the construction, etc., of tramways, light railways, electric lighting works, etc. Amongst the signatories are Mr. A. McIlwraith, 3-4, Lime-street-square, E.C.

Electrical Indicator Syndicate, Limited.—Capital, £5,000. Object: to adopt an agreement with C. Baxter and W. H. Callow to acquire and turn to account patents, etc. Registered office: Dock House, Billiter-avenue, Billiter-street, E.C.

CONTRACTS FOR ELECTRICAL SUPPLIES.

Macao.—The Colonial Office at Lisbon invite tenders for the electric lighting of Macao. Tenders by Oct. 21.

Lisbon.—The Public Works Department require tenders for the public electric lighting of Macao. Tenders by Oct. 21.

Bucharest.—The Government Railways require tenders for the installation of electric lighting and plant for their workshops. Tenders by Oct. 10.

Queensland.—The Deputy Postmaster-General at Brisbane invites tenders for the supply of material for the postal and telegraph service by Sept. 30.

Paris.—The Post and Telegraph Department, Rue de Grenelles 103, invite tenders for (1) 190,000 ko. bronze or copper wire and 94,000 joints, and (2) 12 kilometre submarine telegraph cable.

Kirkcaldy.—The Corporation invite tenders for supply of all fittings for installing the electric light into the memorial halls in Bennochy-road. Tenders by Sept. 12. See advertisement.

Croydon.—The Council invite tenders (1) for the building works and (2) for the smith and ironfounders' work in connection with the extension of the electricity works, Factory-lane, Croydon. Tenders by Sept. 14. See advertisement.

Dublin.—The Port and Docks Board invite tenders for the supply of a 100-ton electric crane. Specification can be obtained at the office of the engineer to the Board, Mr. John P. Griffith, M.I.C.E., Eastwall, Dublin. Tenders by Oct. 5.

London, E.—The Whitechapel Guardians invite tenders for electric lighting of a portion of the infirmary. Specifications, etc., from Mr. F. J. Tootell, clerk, Union Offices, 74, Vallance-road, N.E. Tenders must be sent in by Sept. 12.

Huddersfield.—The Corporation invite tenders for the supply and delivery of about 30 tons of steel tramway rails (girder section), with fishplates, tierods, bolts, trolley poles, bracket arms, overhead-line material, &c. Tenders by Sept. 16. See advertisement.

Worthing.—The Corporation invite tenders for the reconstruction of their storage battery at the electricity works. Specification of the work can be obtained from Messrs. Burstall and Monkhouse, 14, Old Queen-street, Westminster. Tenders by Sept. 7. See advertisement.

Shanghai.—The French Colony propose to instal motor-propelled tramways. Tenders may be sent by Oct. 31, 1903, to Secrétariat de la Municipalité Française de Shanghai. Particulars may be obtained from l'Office National du Commerce Extérieur, Rue Feydeau, 3, Paris.

Brussels.—The Post and Telegraph Department require tenders for 111,500 ko. galvanised iron wire, 5,100 ko. wire cable, 1,875 ko. copper wire, 532,900m. copper wire, 153,650 insulators, etc. Specification No. 200 at above. Tenders by 11 a.m. on Sept. 16 at the Bourse.

Russia.—The Russian Minister of the Interior has sanctioned a plan for the reconstruction of three lines of municipal tramways—namely, those in Newsky, Sadovaïa, and Wassiliostrow districts. Each car is to provide for two classes of travellers, and will accommodate 52 persons.

Utrecht.—The Town Council will receive tenders for supply and erection of a central electric establishment for lighting, power supply, and working tramways. Contract, conditions, etc., to be obtained at the "Gemeente Secretaire" of Utrecht, on payment of 5fl. (8s. 4d.). Tenders by Oct. 1.

Southend-on-Sea.—The Corporation invite tenders for steam dynamo, boiler, and condenser. Specification, etc., may be obtained from Mr. W. E. J. Heenan, M.I.E.E., borough electrical engineer and general manager, Southend-on-Sea. Tenders by noon on Sept. 14. See advertisement.

Bermondsey.—The Borough Council invite tenders for the erection of buildings in connection with extensions to the dust destructor house, electric light station, boiler-house, etc., at the Council's works rear of town hall. Specifications, etc., can be obtained at the Town Hall, Spa-road, S.E. Tenders by Sept. 8.

West Ham.—The Guardians invite tenders for the supply of various articles to the workhouse infirmary and schools for 12 months from Sept. 29, including asbestos goods, electrical fittings, engineers' sundries, etc. Tenders to the Clerk's Office, Union Workhouse, Leytonstone, N.E., by 10 a.m. on Sept. 16.

Johannesburg.—The Municipality require tenders for gas generating plant or for steam generating plant and for gas motors or steam motors, with electric generators and accessories. Particulars may be obtained from the Town Clerk, Johannesburg, or from Messrs. Mordey and Dawbarn, 82, Victoria-street. Tenders by Oct. 19.

Launceston (Tasmania).—The Mayor and Aldermen invite tenders for the supply of 500 or more electric meters. Particulars may be obtained on application to Mr. William Corin, city electrical engineer, Launceston, Tasmania, or to Messrs. John Terry and Co., 7, Great Winchester-street, London, E.C. Tenders by Sept. 28.

Cienfuegos (Cuba).—The Municipal Authorities require tenders for the installation and working of electric lighting. They will pay an annual subsidy of 24,000 piastres for 150 arc lamps of 1,500 c.p. each and 350 incandescent lamps of 50 to 100 c.p. each for street lighting, and 16 to 25 lamps in public buildings. Tenders by 1 p.m. on Sept. 28.

London, E.C.—The East Indian Railway Company invite tenders for the supply and delivery of (1) engine turntables; (2) electric overhead travelling crane, etc.; (3) electric pumping installation; (4) steel material; and (5) feeder panel, insulated cables, etc. Tenders to Mr. C. W. Young, secretary, Nicholas-lane, London, E.C., by 1 p.m. on Sept. 9.

Madrid.—Tenders are invited for a concession for a telephone system with a central station at Palamós and subsidiary stations at San Feliú de Guixols and Palafrugell. A deposit of 2,000 pesetas is required, and tenders must be presented within 30 days from Aug. 14 to the Registry of the Directorate of Posts and Telegraphs, 10, Calle de Carretas, Madrid.

Pietermaritzburg.—The Corporation invite tenders for the supply, delivery, and erection of the necessary poles and overhead equipment for about 5¼ miles of tramway route. Specifications may be seen at Messrs. Mordey and Dawbarn, 82, Victoria-street, S.W. Tenders to Messrs. Ford Bros., 12, Southampton-street, Fitzroy-square, W., by Sept. 7 (noon).

Edinburgh.—The Council invite tenders for the following works in connection with the proposed extension of Macdonald-road electric power station: (1) building works, including excavator, mason, brick, joiner, slater, plasterer, plumber, and glazier's work; and (2) smith and ironfounder's work. Tenders must be sent to Mr. R. Morham, city architect, by 10 a.m. on Sept. 14.

London, S.E.—The London County Council invite tenders for the supply, delivery, and erection in the electricity generating station to be established by the Council at Greenwich of four 5,000-h.p. vertical-horizontal steam-engines, each suitable for driving a three-phase generator. Particulars, etc., may be obtained at the County Hall, Spring-gardens, S.W. Tenders by 10 a.m. on Oct. 6.

Bradford.—The Corporation invite tenders for the construction of about 13 miles of light railways and tramways in connection with the Angram storage reservoir works. Plans may be seen and specifications, etc., obtained at the office of Mr. James Watson, M.I.C.E., waterworks engineer, Town Hall, Bradford. Tenders to Mr. Frederick Stevens, town clerk, Town Hall, Bradford, by 10 a.m. on Oct. 1.

Birmingham.—The Tramways Committee require the names of contractors who are desirous of tendering for the supply and delivery of materials and fittings as follows: (Section A) manganese steel points and crossings; (B) tapered steel side poles and bracket arms; (C) suspension ears, pull-offs, section insulators, and other overhead materials; (D) hard-drawn copper trolley wire and stranded steel span wire. Mr. John Price, city engineer, Council House, Birmingham.

Stoke-upon-Trent.—The Corporation invite tenders for the supply and erection of the following plant in connection with the proposed electricity and destructor works: (Contract 10, Section A) pipework; (B) non-conducting covering; (C) water-softening plant. Persons are at liberty to tender for any single section. Specifications, etc., can be obtained from Mr. P. J. S. Tiddeman, Field-place, Stoke-upon-

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Trent. Tenders to Mr. Jno. B. Ashwell, town clerk, Town Hall, Stoke-upon-Trent, by 5 p.m. on Sept. 11.

Bermondsey.—The Borough Council invite tenders for (Contract No. 12) the construction, supply, and erection of two dust-destructor cells, with furnaces, flues, etc., and storage bins, one water-tube boiler and brickwork settings, one water storage tank, with supports for same, and extensions to the steam, feed, and exhaust piping system; (13) the construction, supply, and erection of two 300-kw. steam generators, two 20-kw. feeder boosters, one 15-kw. motor-balancer, and sundry switchgear and connecting cables. Specifications can be obtained from Mr. Fredk. Ryall, town clerk, and may also be inspected (but not obtained) at the offices of the engineers, Messrs. Kincaid, Waller, Manville, and Dawson, 29, Great George-street, Westminster. Tenders by Sept. 21. See advertisement.

London, E.C.—Tenders will be received until noon on Sept. 28 (a) for the supply of Swedish, Norwegian, or Finland red fir telegraph poles, to be delivered in London, at Northumberland Dock (River Tyne), West Hartlepool, Hull, or Grimsby, at Leven, Fifeshire, and at Swansea, Cardiff, or Newport; and (b) for creosoting the poles with 10lb. or 12lb. of creosote to the cubic foot, as may be directed. The poles to be felled during the winter of 1903-4, and to be delivered during the following summer at the port at which the creosoting is to be performed. Butt sections, 2in. thick, stamped with the shipper's mark, from not less than three poles, to show the quality of timber offered, must precede or accompany the tender of any person who has not already supplied the Postmaster-General with poles. Forms of tender may be obtained from Mr. S. C. Hoolley, controller of stores, Stores Department, 17-19, Bedford-street, London, W.C.

RESULTS OF TENDERS.

Barnstaple.—The contract for the electric lighting of the music hall has been obtained by Messrs. Alger and Sons at £202.

Henley.—The tender of the Alliance Electrical Engineering Company for a small dynamo, at £149. 10s., has been accepted.

Cheadle (Cheshire).—The following tenders have been accepted by the Council for tramways works: Steel, Peech, and Toser, The Ickles, Sheffield, (Contract No. 1) rails, fishplates, etc.; Askham Bros. and Wilson, Sheffield, (2) points and crossings.

BUSINESS NOTES.

LIGHTING AND GENERAL.

Westminster.—Large extensions of electric street-lighting have been decided upon.

Hull.—Mechanical stokers are being fitted to the boilers at the electric light station.

Brecon.—The Board of Trade have revoked the Brecon Electric Lighting Order, 1900.

Commercial Cable Co.—The directors have declared a quarterly dividend of 2 per cent., payable on Oct. 1.

Worksop.—The Urban District Council have completed the loan of £2,500 for the extension of the electricity works.

St. Helens.—The Corporation have obtained sanction to the borrowing of £3,440 for electric lighting purposes.

Worthing.—An enquiry has been held into the application of the Town Council to borrow £2,835 for electric lighting.

Dublin.—At a special meeting of the Municipal Council last week the two reports given in our last issue were read a first time.

Burnley.—Ten electric arc lamps are to be erected in Sheffield-road, at an estimated cost of £117, in place of existing gas lamps.

Aberdeen.—The Lord Provost's house in Crown-street has been purchased by the National Telephone Company for a new exchange.

Russia.—According to a recent consular report, electric machinery, both for technical and medical purposes, offers a promising field in Russia.

Porthcawl.—The British and American Electric Lighting Company intend to apply for a provisional order for supplying Porthcawl with electricity.

Ventnor.—The Isle of Wight Electric Lighting and Power Company, Limited, are improving the lighting service at Ventnor. A new main cable has just been laid.

Dartford.—A report by Mr. Tait, C.E., upon the question of the lighting of the proposed extension of the workhouse buildings, lighting, etc., is under consideration.

Newton.—The Rural District Council have consented to the Urban Electric Supply Company laying the mains to Kingsteignton, subject to the approval of the Board of Trade.

Fire.—At a fire on Thursday morning at Wintershill Hall, near Bishop's Waltham, the residence of Mr. J. S. Moss, the engine-room and electric lighting plant were destroyed.

Merrow.—The Guildford Electricity Supply Company's application for permission to supply Merrow by means of overhead wires has been referred to the Surrey County Council.

Mutford and Lothingland.—The question of supplying the isolation hospital with electricity has been deferred for consideration with the report of the architect of the hospital.

Redditch.—The Council are prepared to supply Alvechurch with the current in bulk or in any other way required at a charge of 6d. per unit at night and 3d. per unit in the daytime.

Hove Electric Lighting Co.—The directors have declared an interim dividend at the rate of 7 per cent. per annum, payable on Oct. 15 next, for the half year ended June 30 last.

New Book.—On Sept. 16 Messrs. P. S. King and Son will publish a book on the "Tariff Question," by Prof. W. J. Ashley, Dean of the Faculty of Commerce at the University of Birmingham.

Partnership.—Mr. W. C. C. Hawtayne has admitted into partnership his managing engineer, Mr. G. A. Zeden, and the business will in future be carried on under the style of Hawtayne and Zeden.

Bristol.—The Electrical Committee have sanctioned several short extensions of mains, and favourably considered the question of extending the power and lighting mains to the extreme end of Cumberland Basin.

Sandgate.—The Council have granted the application of the Folkestone Electric Supply Company to proceed with the laying of the electric lighting cable and the erection of posts as soon as possible.

City Temple.—The electric light fittings just being installed include four main chandeliers, three having five and one four 100-c.p. lights. There will also be pendants over and under each of the galleries.

Falkirk.—The Electric Lighting Committee have agreed to recommend that the cable be extended to Learmonth-street at an estimated cost of £150. The price of current is to be reduced to 4½d. per unit for lighting as from the October survey.

Fleetwood.—The Council are urging the electric lighting syndicate to lay down mains and to supply electrical energy for lighting public lamps in the streets named, under the powers contained in the Fleetwood Electric Lighting Order, 1890.

River Wear Commission.—The North-Eastern Marine Engineering Company, Limited, have obtained permission to lead electric cables underneath Murray-road to their works and foundry, subject to the payment by the company of a yearly acknowledgment.

Lanchester.—The Consett Iron Company have undertaken to take the electric lighting mains to the gates of Langley Park Hospital without any charge, and to supply electricity for lighting at 4d. per unit. The Hospital Committee will take about 80 lamps, and will invite tenders for the work of fitting up the wires and lamps.

Newport.—The Newport Ratepayers' and Property Owners' Association threaten to oppose the application of the Corporation for sanction to borrow a further sum of £58,000 for increase of electricity plant. The loan is sought for in order to pay the cost of the additional plant for electric lighting and the supply of power to consumers, and has nothing to do with the tramways.

Newcastle.—The Newcastle Guardians have received a report in favour of the entire relighting and heating of the union workhouse at a cost of £15,000, the scheme to include electric lighting and the heating of the house by hot water instead of steam. The city engineer's estimate of expenditure on the proposed quay improvements includes an item of £44,000 for electrical equipment.

London Gazette.—The partnership heretofore subsisting between Otto Rennert, Paul Hensel, and Francis Joseph Zelzer, carrying on business as electrical specialities manufacturers, at 12, Long-lane, in the city of London, under the style or firm of P. Hensel and Co., is dissolved from Sept. 1, 1903. Otto Rennert and Paul Hensel will continue to carry on the business at the same address.

Belfast.—Mr. M'Cowen has been instructed to find out how many customers there would be in the Old Lodge-road district before a main was laid. There has been an increase in the use of electric current during the past year. On the 28th ult. the number of lamps connected was 135,133, as compared with 104,505 for the corresponding period last year, while 43,010 motors were served, as against 30,014.

Ashington.—The Council have accepted an offer from the Northern Electric Supply Company for the supply of electric light for the district. The lamps are to be of 40 c.p., and will be placed 50 yards apart. The scheme will double the lighting of the district at a cost of 30 per cent. less per lamp than under the old system of gas and oil lighting. The Ashington Coal Company will waive their agreement with the Council to supply gas for another two years.

Electric Cableways.—A contract has been obtained by the Brothers Patent Electric Cableway and Crank Company, 26, Victoria-street, S.W., to supply an electric cableway over the Zambesi River at Victoria Falls, for conveying passengers and railway materials pending the erection of the bridge. The span of the cableway is 850ft., and the load to be carried is 10 tons. The site of the cableway is in full view of the falls, and spans a gorge 360ft. deep.

Stourbridge.—Good progress is being made with the electric lighting scheme. The Board of Trade have consented to extend the term of the provisional order by one year. The electric lighting plant is to be laid down on the land recently purchased adjoining the main drainage pumping station, in combination with the proposed refuse destructor. Plans and estimates for a combined scheme for the electric lighting plant and a refuse destructor are now to be obtained.

Radiators.—We have received a new illustrated price-list from the Dowsing Radiant Heat Company, Limited, 24, Budge-row, Cannon-street, E.C., showing a number of elegant prints of their luminous electric radiators, including improved types, for which it is claimed that they give out about 99 per cent. in heat of the energy consumed. We are informed that the firm have had another order from H.M. the King for the Royal yacht, and their patent radiators are also in use at Buckingham Palace.

Fort William Electric Light Co.—The directors recommend a dividend of 2½ per cent. The report states that in comparison with last year the revenue has increased, while the working expenses have been diminished. To meet the increased demand for current for lighting and power purposes a 40-h.p. oil-engine for driving the auxiliary electric plant at Fort William has just been installed. Arrangements

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have also been made with the principal hotelkeepers that the charge for lighting should now be based on a minimum sum per annum.

New Company.—The business of Stern Bros. has as from June 17 last been converted into a company, in which Messrs. J. Stern, L. Stern, and J. Sonneborn are directors, and will continue their same active interest in the business. No change has been made in the personnel of the firm or its officers, and Messrs. Wallach Bros. will continue to act as the general managers for Great Britain and Colonies. Messrs. Wallach Bros. will continue to sign per procuration for the new company. The style of the new company will be the Stern-Sonneborn Oil Company.

Rochdale.—Messrs. Shepherd and Watney, electrical engineers, of Leeds, in their report upon the electric lighting installation, state that the three engines and dynamos, the booster, and the commutators are all in very good condition. Certain changes are recommended in the switchboard, so that the dynamos and storage cells might be run in parallel. Most of the mains, they say, are defective. The minimum expenditure is estimated at £157, while there is a possible maximum cost of £550. Messrs Shepherd and Watney have been engaged as consulting engineers, and advertisements will be issued for tenders for cable, etc.

Wrexham.—The borough electrical engineer's last report contains the following figures: units generated July, 1903, 29,143; units generated July, 1902, 6,960; used for tramways, 12,725; used for lighting, etc., 16,418. One consumer had been connected during the month—32 lamps of 8 c.p. Total number of consumers connected to date, 131—10,370 lamps of 8 c.p. (exclusive of public lighting). The borough electrical engineer is about to prepare plans and estimates of the cost of a scheme for an extension of the main cables, including suggestions for providing for public lighting, with a view to an application being submitted to the Local Government Board for sanction to a loan for carrying out such extension.

Stock Exchange.—The Stock Exchange Committee have appointed Sept. 10 a special settling day for Marconi's Wireless Telegraph Company's further issue of 39,028 shares of £1 each fully paid, Nos. 157,084 to 196,111; and have ordered the British Electric Traction Company's further issue of 37,500 6 per cent. cumulative preference shares of £10 each fully paid, Nos. 318,938 to 356,437, to be quoted in the official list. Applications have been made to the Exchange Committee to appoint a special settling day in and to grant a quotation to Bruce Peebles and Co.'s 20,000 6 per cent. cumulative preference shares of £5 each fully paid, Nos. 20,001 to 40,000; and the Metropolitan Electric Tramways, Limited, further issue of 185,984 5 per cent. cumulative preference shares of £1 each fully paid.

Blackpool.—Mr. C. Furness, the electrical engineer, in his monthly report for July says: "The output for July was 23,325 units more than for the same month last year—namely, 187,157. We are now able to dispense with the assistance of the Blackpool-Fleetwood Company. The Corporation trams have taken 97,290 units, an increase of 7,686 over last year. Then we have sold to the Blackpool, Lytham, and St. Annes Company 8,770 units. For electric lighting we have produced 81,097 units, an increase of 6,369 units. Yet, in spite of this, wages are down by £75, being £491 against £560 last year. This economy was effected by unloading coal into the bunkers instead of carting it. The coolers or condensers, about which we have heard so much, are expected by some sanguine members of the committee to save £2,000 a year, so that we may yet see the electricity department competing with the gas department as to which can contribute the biggest sum to the relief of the rates."

Hackney.—At last night's meeting the Council received a letter from the London County Council, dated July 21, enclosing the following resolution passed by the County Council: "That, subject to the Borough Council agreeing by resolution to provide out of a sinking fund established for that purpose, or from maintenance account for all renewals and replacements during the currency of the loan, of any of the plant and machinery provided with the proceeds thereof, the borrowing by the Borough Council of the sum of £6,500 to defray further part of the cost of installation of the electric light within the borough, be sanctioned, such sum to be repaid by equal yearly or half-yearly instalments of principal, or of principal and interest combined, within a period of 42 years from the date of the borrowing; and that the seal of the Council be affixed to the formal order in duplicate sanctioning the borrowing, but that such order be not issued until the clerk of the Council shall have received a certified copy of the resolution of the Borough Council agreeing to the condition upon which the sanction is given."

Outing.—On Saturday last, Aug. 29, the first annual outing of the staff of the Stepney Borough Council electricity works took place, the rendezvous being Clacton-on-Sea, on the invitation, we understand, of Mr. Alderman Kearsey (chairman of the Electricity Committee), Mr. Alderman Osman, and Mr. W. C. P. Tapper. The day was gloriously fine, the sun shining brilliantly the whole time. The party travelled from Liverpool-street by special saloon, arriving at Clacton shortly after 10 a.m. A stroll on the fine front of this rapidly rising and attractive seaside resort was followed by an excellent repast at the Osborne Hotel, the chairman for the occasion being Mr. W. Young, with Mr. A. J. Squire in the vice-chair. The toasts of the "King and Queen and Royal Family," "The Electrical Engineers" Mr. Arthur Wright and Mr. W. C. P. Tapper), and "Success to the Undertaking," were proposed and drunk with great gusto, after which the chairman commented on the success which had attended their first outing, and trusted that it was but the forerunner of many such enjoyable meetings. He was sure they all regretted the unavoidable absence of their engineer, Mr. Tapper, who was away on holiday. In the afternoon many of the party enjoyed a pleasant drive round the neighbourhood, visiting Great and Little Clacton, Wherley Woods, and pretty St. Osyth, with its crumbling remains of a seventh-century priory standing amidst beautiful gardens.

TRACTION.

Eccles.—The Monton tramway route will be opened for traffic in the course of a fortnight.

Coatbridge.—Operations have been begun in connection with the laying of rails for the Coatbridge tramways. Messrs. Dick, Kerr, and Co. are the contractors.

Aston.—No time is to be lost in pushing on the work of erecting the new electric tram-sheds in Elkington-street. The whole of the work has to be completed before the end of the year.

Stockton Heath.—A private meeting of the Parish Council has considered plans submitted by the Warrington Tramways Committee respecting the proposed light railway to Victoria-square.

Cheltenham.—Mr. T. A. Nevins has arrived in Cheltenham, and developments in connection with the extension of the Cheltenham and District Light Railway to Leckhampton may be expected.

Tottington.—The Urban District Council has decided to give notice to the Bury, Rochdale, and Oldham Tramway Company requiring them to sell to the Council so much of their undertaking as is within the Tottington district.

Shelf.—There is still no service of cars from Bradford into the district. Last week the public had generally expected the commencement of the service early this week, but the wet weather during the week has again interfered with the little work to complete.

Halifax.—The Town Council have authorised the Tramways and Electricity Committee to purchase and lay a cable in connection with the tramway to Brighouse, at an estimated cost of £4,066. 1s. 6d. It is decided to invite tenders for advertisements on the cars.

Colchester.—The Tramways Committee have appointed Mr. E. A. Jones, of Brussels, rail inspector and tester of rails and fishplates, which are to be supplied by a Belgian firm, the inspector's remuneration to be at the rate of 7d. per ton for rails and 1s. per ton for fishplates.

Overcrowded Tramcars.—At Brentford Police Court a conductor in the employment of the London United Tramways Company has been fined 10s. for allowing overcrowding on his electric tramcar at Twickenham on August Bank Holiday. Nine passengers were fined in connection with the same offence.

Leith.—At the meeting of the Town Council on Tuesday it was finally decided to purchase the undertaking of the Edinburgh Street Tramways Company at Leith, the purchase price being £60,000. The undertaking will in future be worked by the Corporation, and a proposal has been put forward to electrify the system.

Portsmouth.—The Finance Committee, which acts as the Parliamentary Committee of the Town Council, met last Thursday and gave its approval to the draft order for the Hayling Light Railway. The order has already been passed by the Joint Sub-Tramway, Roads and Works, and Finance Committee, which has had the matter in hand.

Paris Metropolitan Railway.—A panic occurred on the Metropolitan Railway at the Hotel de Ville Station on the 27th ult., says a Paris correspondent, owing to a shower of sparks beneath one of the coaches. A number of passengers jumped out of the train, which was just moving off. Many were injured, but none of the cases are serious.

Newcastle.—The members of the Tramways Committee have made a survey of the proposed car route from Scotswood-road to Arthur's-hill, Park-road, Edgeware-road, and Cundercum-road. Afterwards the city engineer was instructed to report as to whether it was possible to alter the level of Edgeware road so as to allow cars to go up to that district.

Eastbourne.—The introduction of motor 'buses by the Corporation has led to a great conflict of opinion in the town, which had its outcome at an "indignation" meeting held on Wednesday, at which there was a crowded attendance. The motor 'bus service was generally condemned, and a resolution was carried, with two dissentients, calling upon the Corporation to provide "a proper system of electric trams."

South Shields.—The Town Council have had submitted to them a new offer from the South Shields Tramway and Carriage Company. They ask for a lease of the tramway lines for 28 years, and offer to relieve the borough of the debt of £9,000 against the tramway account, besides paying interest and sinking fund on the capital cost of electrical equipment by the Corporation. The matter has been deferred to a special meeting on Monday next.

Additional Traffic Returns.—Anglo-Argentine, £1,648 increase; Barcelona Ensanche y Gracia, £200 increase; Barcelona, £13 decrease; Brisbane, £64 decrease (month of July, £10,160, increase £4); British Columbia Electric (month of March), gross earnings £10,352, net income £2,658; Buenos Ayres and Belgrano Electric, £189 increase (month of July, £13,269, increase £1,142); Calcutta, £508 increase; Cape Town (month of April), receipts £16,003, expenditure £8,313; Isle of Thanet Electric, £216 decrease; Mexico Electric (month of June), receipts £46,270; Perth Electric, £161 increase; Port Elizabeth (month of April), receipts £4,292, expenditure £2,281.

Stockport.—The report of the Tramways Committee presented to the Town Council on Wednesday indicated friction with the Manchester tramways authority. The manager of the Manchester tramways had written stating that the Manchester Finance Committee were not prepared to lend money for the construction of new tramways in the district of Stockport, as in the case of reconstructed lines leased to them, and asking for a cheque for £6,892 in respect of lines in Mersey-square and Daw Bank. In reply, the Stockport Committee had written that before payment of the account was made Manchester would be required to put the line in repair at various points in Wellington-road, South Mersey-square, and also carry out their agreement to convey passengers into St. Peter's-square, Stockport.

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Snowdon.—The North Wales Power Company has contracted with a Scotch firm for six powerful Pelton wheels to drive generators by water power in connection with 13 miles of tramway to be constructed round Snowdon. The route will be in operation next season, and will be useful for tourists. It extends to Beddgelert and Portmadoc, and is narrow gauge.

Cleckheaton.—The Yorkshire (Woollen District) Tramways Company have introduced the ½d. fare on the section of their line in Cleckheaton between the town hall and Moorend. The fare has hitherto been 1d., as on all the other stages, but the distance is comparatively short, and the cars have travelled for several months for the most part empty.

Bilston.—At the last meeting of the District Council the Council decided to support the memorial of the Wolverhampton District Electric Traction Company, Limited, to the Board of Trade for an extension of time for the construction of the line to Ettingshall, and approved the construction of the proposed line *via* Ward-street instead of Hall Park-road.

Cardiff.—A joint meeting of the Public Works and Tramways Committees of the Corporation was held on Saturday to consider a communication regarding the reconstruction of the Penarth-road tramways. It was decided to proceed with the reconstruction of a single line, and that an arbitrator be appointed with regard to the construction of passing places.

Aberdeen.—At the last meeting of the Tramways Committee the question of providing a suitable top for the cars to be used in rainy weather, in order that the outside seats might be utilised, and so prevent overcrowding inside, was discussed, and it was decided to get information, in the first instance, from those cities where these tops are used at present as to their utility.

London and North-Western Railway.—A correspondent says that the directors of the London and North-Western Railway have decided not to electrify any portion of their main lines between Euston and Scotland or Euston and Holyhead. Such a change would involve an enormous outlay, while steam would still be needed for the heavy mineral trains. It is probable in the near future that several branch lines may be electrified, but steam would still be retained for heavy traffic.

Bolton.—The experiment of the Corporation in establishing a motor omnibus service to Darcy Lever, a little industrial suburb lying about 1½ miles from the centre of the town, is being watched with interest by other corporations in Lancashire. It is understood that the cost of laying electric tramlines to Darcy Lever would prove so costly owing to the difficult nature of the road—the village lies in a hollow—as to preclude the possibility of an electric tramcar service thereto proving remunerative.

New South Wales.—The report of the Railway Commissioners of New South Wales for the quarter ended June 30 last, states that the earnings of the tramways for the quarter were £194,394, an increase of £29,371. The expenditure, however, has increased in a slightly greater ratio, but a number of steam cars had been renewed by electric cars out of working expenses. The tramways during the quarter carried 33¼ millions of passengers. The prospects for the coming year in New South Wales are reported to be very favourable.

Wigan.—A crowded meeting has been held in connection with the National Amalgamated Union of Enginemen to consider the action of the Wigan Tramways Committee in refusing to meet Mr. G. H. Copley, the secretary of the union, in regard to alleged grievances of the Corporation tramway employés. A resolution was passed that in the opinion of the meeting the management of the tramways should furnish reasons why some of the men had been discharged, and that the representatives of the employés should be granted an interview.

Manchester.—The Tramways Committee have undertaken to contribute to the city rate out of their surplus revenue a sum sufficient to meet the annual interest and sinking fund charges upon a loan of £100,000, the first instalment payable by the Corporation to the Royal Infirmary authorities for the infirmary site. The Tramways Committee propose to supersede the "cow-catcher" form of lifeguard on the electric cars for the Hudson-Bowring guard, which is of the "gate and carrier" type. Experiments are at present being made with the new guard.

Scarborough.—The question of the desirability or otherwise of the Corporation acquiring the tramways which are about to be laid at Scarborough is agitating the minds of the ratepayers. On Friday the Streets Sub-Committee recommended to the Streets and Buildings Committee that the tramways company should be approached with a view to ascertaining on what terms the company would sell their rights previous to construction. This recommendation, which the full committee decided to act upon, has reopened the question of municipal ownership.

Soothill Upper.—At the last meeting of the District Council on the subject of the proposed application for a provisional order for electric tramways from Dewsbury to Soothill Upper, a letter was read from the Town Clerk of Dewsbury, stating that he had laid before his Law and Parliamentary Committee the suggestion as to co-operation in a scheme for the construction of tramways from Dewsbury to Leeds-road, Hanging Heaton, and Shaw Cross, but in the present year they could not undertake this work. The scheme will probably be shelved for a time.

Gravesend.—The total number of passengers carried during the first 12 months' operations of the Gravesend and Northfleet electric tramways amounted to 2,479 329, which is equal to about 60 times the population of the whole district. On August Bank Holiday, 1902, Easter Monday, 1903, and the day of the hospital fête, nearly 15,000 persons were carried each day, and as splendid weather was experienced on Whit Monday, 28,000 people patronised the tramways. The second year of electric traction commenced on August Bank Holiday with the issue of over 37,000 tickets.

District Railway.—With reference to the contract which, as announced last week, has been let to the British Thomson-Houston Company for the entire control equipment of the District Railway, we are able to state that the terms of the contract call for the equipment of 40 trains in seven months, so that shortly after that the electric trains will be running on the Inner Circle. The steam trains will be taken out of service as they can be replaced by the electric trains, so that there will be no interference with the regular service. The contract for the motors has not yet been placed.

Motor Regulation.—The Prime Minister has sent a circular letter to the prefects of all the departments, instructing them to exercise supervision over all municipal decrees relating to motor traffic. As a general principle, the issue of local regulations imposing a limit of speed inferior to the average rate of a horse at a trot is not to be sanctioned. It should be explained that, while municipal authorities in France have the right of enacting decrees relating to traffic on public highways, such decrees are by law subject to the veto of the prefect, who is the direct representative in his department of the Home Office.

St. Helens.—At a meeting of the Electric Supply and Tramways Committee the town clerk reported that at an inquest held on the body of a woman killed in Liverpool-road by being knocked down by an electric car, the jury had made a presentment to the effect that the Corporation should take steps to have Arthur-street made into a Board of Trade stopping place owing to the heavy traffic in the neighbourhood. He also reported that the corner of London-road and Peter-street was a Board of Trade stopping place, and the committee gave instructions to the engineer to make observations of the amount of traffic at Arthur-street and Peter-street respectively.

Plymouth.—A report submitted to the Tramways Committee for the five weeks ending Aug. 22 last shows a net increase of receipts over the corresponding period of 1902 of a few pence short of £300. During the five weeks ending Aug. 22 823,997 passengers were carried over the five routes. The total receipts from all systems for the five weeks amounted to £3,409, the total for the year up to Aug. 22 being £12,933. 11s. The expenses, including interest and sinking fund, are given as £10,525. The mileage of the cars for the past five weeks was 68,335 miles, the total receipts per mile being 12·27d., the West Hoe system showing the lowest average per mile (6·88d.).

Barrow.—The ss. "D'Tarmigan" has arrived at Barrow from Ghent with a cargo of 300 tons of steel rails, being the first consignment of rails from the Belgian firm who secured the contract for their manufacture in connection with the electrification of the tramway system. It was expected that the work of reconstruction would be commenced last Monday, but so far nothing has been done in the direction of tearing up the permanent way, and it is not likely these operations will be commenced ere another week is passed. The building operations at the tram depôt are preceding apace, but some time may elapse before they are completed ready for the reception of the cars, which are ready for delivery.

Darlington.—There has been introduced on to the works in connection with the construction of the Darlington tramways a new labour-saving contrivance, which is the invention of Mr. B. J. Pattison. The machine mixes the concrete more satisfactorily, and so facilitates work as to save from 50 to 75 per cent. in labour. The machine is constructed with wheels adapted to run on the rails after they have been fixed to gauge, and the concrete is deposited directly in the trench. In each journey of 40 or 50 yards about two cubic yards of concrete are mixed. During the short test to which it has already been subjected the mixer has proved capable of concreting a pair of rails 45ft. in length within the hour.

An Obstruction Remover.—A patent has been taken out by John Carr, of Hull, for obstruction removers for tramcars. An obstruction remover for tramcars, motorcars, cable-cars, and the like is formed by a tray or shoot supported between brackets by studs on the tray entering slots or grooves in the brackets. Either or both of the slots in each bracket are inclined, so that when an obstruction causes the tray to move backwards the tray dips downwards at the front and lifts the obstruction. The studs may have rollers on them to reduce friction. Guards may be placed at the sides of the tray to prevent the brackets from striking the obstruction. In a modification the tray has only one stud at each end, and is counterweighted to rest normally on a bar.

London United Tramways Co.—On the evening of the 28th ult. 1,500 employés of the London United Tramways Company in the chief depôt, Chiswick High-road, were entertained by the directors on the occasion of the annual meeting of the provident society, which is worked in connection with the Company for their benefit. Dinner was provided, the chair being taken by Mr. J. Clifton Robinson, the managing director of the Company. During the year the subscriptions to the society amounted to £793. The sum of £1,010 had been disbursed in sick pay and funeral allowances. Subscriptions amounting to £390 had been received from the directors. There was a balance of £854. The number of members had increased from 800 to 1,400 during the year.

Manchester Suburban Tramway.—The Manchester suburban tramway scheme, which was so much talked of some months ago, has been definitely dropped. The idea, it may be remembered, was to connect up, by means of a light railway, the suburbs on the south side of the city, the lines running from Stretford through Sale, Northenden, Gatley, and Cheadle to Stockport, and on the other side of Stockport as far as Mottram. It was also proposed to buy up land in the districts thus tapped, so that the syndicate should be able to obtain the benefit of improved values resulting from the tramway conveniences. The Manchester Southern Tramways were

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first in the field in some of the districts, and in others the opposition to parliamentary powers it was thought would have been too strong.

Dundee.—At a meeting of Dundee and District Committee of the County Council the clerk submitted a letter from Mr. Balfour, the promoter of the proposed electric tramway between Dundee and Broughty Ferry, in which he stated that he had now completed agreements with the various road authorities and landowners in connection with the scheme, and that he would now be pleased if the matter was brought before the District Committee in order that he might secure their consent and co-operation in carrying it out. It was pointed out that the route would be from the existing eastern boundary of Dundee along the Broughty Ferry-road to a point where the road first crossed the Dundee and Arbroath Railway. At that point the proposed line would run along a new road through Mr. Guthrie's estate. Consideration of the subject was delayed.

Leeds.—On Saturday a trial run was made over a new tramway route which will be opened for public traffic this week. It has been decided to adopt the Westinghouse type of slipper brake on the electric cars. The Board of Trade, after inspection, has recently permitted the speed of the cars to be accelerated on nearly all the sections, and it is understood that a further concession of the kind will be made by the central authority, if the brake power is increased to warrant it. The Leeds cars are at present provided with two brakes, the ordinary hand one and an electric appliance. The new one will take the place of the latter; but the change will be made gradually, as the old electric brakes are worn out. The steepest gradients, however, will have the first consideration. The cost of this improvement will be between £8,000 and £9,000.

Railway Motors.—The Glasgow correspondent of the *Financial Times* says the Great North of Scotland Railway is contemplating the inauguration of services of motor carriages to supplement the suburban train services, and also to connect outlying districts with the railway. The idea has, no doubt, been suggested by the fact that the Suburban Tramways Company are shortly to open their lines, and the Great North of Scotland Railway is seeking to improve its suburban service before it is actually compelled to do so by a falling revenue. The motor carriages will carry 50 or 60 passengers each. The North-Eastern Railway has commenced its service of motor 'buses in North Holderness, between Beverley and Belford. The 'buses resemble the ordinary electric tramcar, and provide accommodation for 16 passengers. They are propelled by 24-h.p. four-cylinder Stirling motors, giving an average speed of 12 miles an hour. It is proposed at present to make four journeys daily in each direction.

Visitor from Melbourne.—Mr. W. S. Sprigg, who represents the Melbourne Tramways Company, is now in Cardiff after having visited London, Glasgow, Liverpool, Norwich, and other towns. His object is to ascertain the respective qualities of the cable, trolley, and conduit systems. Seen by a *Western Mail* representative, Mr. Sprigg expressed satisfaction with the way in which the Cardiff streets are laid out. He had not seen anything like it in any of the other towns he had visited. After a visit to the electrical works, Mr. Sprigg was not converted to the trolley system. His words were: "I can make more money out of the cable system than you can do in Cardiff with the trolley system." In a general conversation, Mr. Sprigg said, "You have a good system, and it ought to pay, but it never will unless you let it to a company. We know in Australia what these workmen's combinations mean, and they will ruin your business unless you place the tramways in the hands of a company." "Then," he said, "you will have a big amount towards the reduction of your rates."

West Ham.—The labouring classes in this district are greatly concerned about some new by-laws which the Borough Council, as the tramway authority, propose to put into force. "No person," say the proposed by-laws, "shall eat food or fruit upon any car, or deposit remnants of food or fruit in or upon any car." And again, "Any person whose dress or clothing might, in the opinion of the conductor, soil or injure the linings or cushions of a car or the dress or clothing of any passenger, shall not be entitled to enter or remain in or upon a car." The first by-law, according to an official explanation, is to guard against what are called "fish suppers," which the labouring classes have hitherto been indulging in when travelling by the electric cars. There is really no objection to passengers eating fruit or such like delicacies so long as they refrain from depositing the remnants on the cars. With regard to the second proposed by-law, we predict at once that it will be found to be unworkable. After all, the workingman in such a district as West Ham is the chief customer of the tramways, and to debar him from travelling on the cars in his working clothes—that is what the by-law practically means—would not only result in inconvenience and annoyance to the labourers, but would be suicidal on the part of the Corporation, whose first duty to the ratepayers is to make the undertaking pay at all costs. Then to place the discretion of deciding whether a man's clothes would "soil or injure the linings or cushions" in the hands of the conductor—himself a member of the working classes—is too ridiculous. The matter has been taken up by the National Union of Gas Workers and General Labourers of Great Britain and Ireland, and will not be allowed to rest where it is.

London County Council Trams.—The traffic returns of the London County Council's tramways for the week ending the 22nd ult. show receipts amounting to £10,487, as against £8,057 for the corresponding week last year. For the 144 days, ending at this date, of the present financial year, the total takings amounted to £207,489, as against £177,462 for the corresponding period of last year. Passengers carried for the week numbered 2,634,690. The mileage is now 39⅞, as against 26⅝ for the corresponding period of last year. While the new electric tramways on the Tooting lines are proving a great success, some difficulty is being experienced in connection with the altered arrangements on the Streatham cable route. Pending the electrification of this line, the County Council decided to have certain of the new electric cars fitted with special apparatus, so that they could be run from the termini at the bridges to Kennington by means of electricity and then over the existing route from Kennington to Streatham by cable. Doubts were freely expressed as to whether the cable was sufficiently strong to stand the extra strain of the new cars, which are much larger and heavier than the old ones, and these fears have since been justified. Of the 20 electric cars fitted for working on the combined systems about 10 or 15 have been running daily during the past two or three weeks, and observations go to prove that the added strain of a large number of cars would be too much for the cable. It is understood, therefore, that the original scheme for combining the cable and electrical system is to be abandoned, and it may be confidently expected that the conversion of the cable route to electric traction will be pushed on as soon as possible. The improvement of the facilities in South London has given rise to a movement in Streatham and district to induce the County Council to extend its tramways from Streatham to Norbury, so as to connect with the Croydon system at the county boundary, a mile separating the two points. There is rather a steep hill to be negotiated—Streatham Village Hill—but it is not expected that this will present difficulties that cannot be surmounted by electric traction. A petition setting forth these views is being extensively signed by ratepayers in Streatham and the neighbourhood for presentation to the Wandsworth Borough Council and the London County Council.

PROVISIONAL PATENTS, 1903.

AUG. 24.

18250. Improvements in thermal cut-outs. Edgar Alfred Carolan, 83, Cannon-street, London. (The General Electric Company, United States.)

18251. Improvements in processes of insulating coils. Edgar Alfred Carolan, 83, Cannon-street, London. (The General Electric Company, United States.)

18252. Improvements in speed-regulating devices. Edgar Alfred Carolan, 83, Cannon-street, London. (The General Electric Company, United States.)

18253. Improvements in magnetic controlling devices. Edgar Alfred Carolan, 83, Cannon-street, London. (The General Electric Company, United States.)

18254. Improvements in a combined socket-shell and shade-holder for incandescent electric lamps. Edgar Alfred Carolan, 83, Cannon-street, London. (The General Electric Company, United States.)

18255. Improvements in methods of sealing metal into glass or other vitreous material. Edgar Alfred Carolan, 83, Cannon-street, London. (The General Electric Company, United States.)

18256. Improvements in time-limit controllers for circuit breakers. Edgar Alfred Carolan, 83, Cannon-street, London. (The General Electric Company, United States.)

18257. Improvements in electric switches. Edgar Alfred Carolan, 83, Cannon-street, London. (The General Electric Company, United States.)

AUG. 25.

18304. A water-wheel for the generation of power for electricity or other purposes. Alfred Phillips, 4, Sussex-street, Hartlepool.

18318. An improved electric incandescent lamp. George Wallace, 68, Victoria-street, London.

18319. Improvements in electric battery jars. Arthur Ford Lloyd, 63, Cavendish-street, Brighton.

18323. Improvements in machine for making battery grids. Thomas John Coster and Smith Storage Battery Company, 62, St. Vincent-street, Glasgow. (Complete specification.)

18334. The electrical treatment of milk for the separation of cream. Hutchinson Hunt, Sydney Aston, Mersey Rose, and Joseph George Howard, 23, Southampton-buildings, Chancery-lane, London.

18336. Improvements in electrical interrupting devices for currents, particularly those of high intensity. Thomas Joseph Murphy, 55, Chancery-lane, London. (Complete specification.)

18343. Improvements in electric vapour lamps. Edgar Alfred Carolan, 83, Cannon-street, London. (The General Electric Company, United States.)

18344. Improvements in electric lamps. Edgar Alfred Carolan, 83, Cannon-street, London. (The General Electric Company, United States.)

18354. Improvements relating to electromagnetic rail brakes. Carl Adolf Wilde, 45, Southampton-buildings, Chancery-lane, London.

18376. An improved connection block for electric conductors applicable also as an insertion contact and ceiling rosette. William Phillips Thompson, 6, Lord-street, Liverpool. (The firm of O. and H. Keller, Germany.) (Complete specification.)

AUG. 26.

18383. Improvements in trolley pulleys for electric tramcars or railways to facilitate the finding of the trolley wire. Walter Rhodes, 22, Bond-street, Leeds.

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18390. Improvements in the construction of electric insulators. Albert Edward Mitton, Richard Whitehouse, and Edward Blakemore, 2, George-street, Parade, Birmingham.

18393. Improvements in electrical indicating instruments. Thomas Albert Briggs Carver, 8, Windsor-quadrant, Kelvinside, Glasgow.

18398. Improvements in and relating to automatic electric signalling. Harold Hawthorne, 16, Montague-street, Russell-square, London.

18411. Improvements in or relating to the steps of electric tramcars and like vehicles. John Farrer Mason, 8, Quality-court, Chancery-lane, London.

AUG. 27.

18453. Improvements in dynamo-electric machines. Cenek Macku, 6, Bank-street, Manchester. (Complete specification.)

18485. Improvements in secondary or storage batteries. Harold Wade, 111, Hatton-garden, London. (Hugh Rodman, United States.) (Complete specification.)

18513. Improvements in apparatus for determining the magnetic properties of metals. The British Thomson-Houston Company, Limited, and Frank Holden, 83, Cannon-street, London.

18536. Improved means and apparatus for controlling electric motors. Oliver Imray, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Bullock Electric Manufacturing Company, United States.)

AUG. 28.

18550. An improved construction of commutator for dynamos and electric motors. John Maclean, 100, Wellington-street, Glasgow.

18551. Improvements in brush-holders for the commutators of dynamos and electric motors. John Maclean, 100, Wellington-street, Glasgow.

18555. Improved section insulator for overhead wire systems of electric traction. John Henry Luby, William Harris, and Joseph John Ballard, Lloyd's Bank-buildings, Bristol.

18556. Improved adjustable crossing for overhead wire systems of electric traction. John Henry Luby, William Harris, and Joseph John Ballard, Lloyd's Bank-buildings, Bristol.

18557. Improvements in and relating to points for overhead wire systems of electric traction. John Henry Luby, William Harris, and Joseph John Ballard, Lloyd's Bank-buildings, Bristol.

18558. Improved clip for clamping or binding the wires to fittings in overhead wire systems of electric traction. John Henry Luby, William Harris, and Joseph John Ballard, Lloyd's Bank-buildings, Bristol.

18581. Improvements in a system for electric lighting of railway trains. Henry Leitner and Richard Norman Lucas, Lynton, Dartnell-park, Byfleet.

18586. Improvements in porcelain and other electric insulators. William Edward Langdon. John Crisp Fuller, and George Fuller, 33, Chancery-lane, London. (Complete specification.)

18598. An improved automatic electro-mechanical cut-out. James Ernest Spagnoletti, 53, Chancery-lane, London.

18602. Improved carrier for an incandescent electric lamp. Ernest Taylor, 22, Southampton-buildings, Chancery-lane, London.

AUG. 29.

18624. Improvements in electric lamps of the character known as vapour lamps or vapour arc lamps. Charles Orme Bastian and Albert Edward Salisbury, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

18625. An improvement to incandescent electric lamps to enable variation of their candle-power. Thomas Woodward Bullock, 13, Cambridge-street, Prescot, Lancs.

18631. Improvements in or relating to trolley heads for electric tramcars. James Eagles and James Eagles, 3, Sagar-street, Hough-lane, Salford.

18653. Improvements in electric switchboards and fuseboards. Herbert James Read, Chalfont, Stanhope-road, St. Albans.

18680. Improvements in means for controlling electrically-operated elevators. Hans Lauritz Eriksen and the Company Koefoed Hauberg, Marstrand, and Helweg, Aktieselskabet Titan, 18, Buckingham-street, Strand, London. (Complete specification.)

COMPLETE SPECIFICATIONS ACCEPTED.

To be published September 17, 1903.

1902.

16205. Dynamo-electric machines. Heyland.

18429. Electric heater for liquids. Briggs.

18872. Electrical switches. Cox.

18925. Rheostats for starting electric motors. Lake. (The General Electric Company.)

18958. Apparatus adapted for indicating or for opening or closing a circuit on change of the direction of flow of electrical energy. Andrews.

19283. Electric transmission and controlling gear. Johnston and Dobbs.

19305. Apparatus or device for use in applying bituminous or similar composition to conduits for electric cables, or to drain pipes, or like goods to form jointing rings thereon. Oates.

21734. Telephone apparatus. Houbigant.

22649. Method of and appliances for operating trolley line and other switches. Dawe.

23257. Flexible metallic tubing for armouring insulated electrical conductors. Bowley.

23421. Rontgen-ray and like apparatus. Cox.

1903.

459. Prepayment attachment for electricity meters. Swan.

5240. Conduits or casings for electric conductors. Knight and Nagel.

7561. Electric current controllers. Bradley and Allen.

7789. Telephone systems. Paul and McDougall.

10190. Commutator contact protector for use on commutator of electrically-ignited internal-combustion engines. McClymont.

12194. Apparatus for the production of electrolytic deposits. Müller.

13061. Fuse head for electric blasting. Render.

13282. Coupling device or clutch for electric motors. Wüst-Kunz.

15506. Armatures for electric induction motors. Thompson. (Electricitäts-Gesellschaft Alioth.)

16138. Electrical signalling systems for railways. Mills and Piddington.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.		Last price
Commercial and Industrial.—	£		£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1	..	½-¾ xd
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1	..	¼-½
British Insulated and Helsby Cables, Ord., 1-100,000	5	..	6⅞-7¼
—— 6 per cent. Cum. Pref., 1-100,000	5	..	5⅛-5⅜
—— 4½ per cent. Mortgage Debentures	100	..	102-106
British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red.	100	..	104-106 xd
British Westinghouse Elec. and Manuf., 6 per cent. Pref., 275,001-375,000	5	..	5⅜-5⅞
—— 4 per cent. Mortgage Debenture Stock	100	..	100-102
Brush Electrical Engineering, Ordinary, Nos. 1-105,731	2	..	⅞-1¼
—— Non. Cum., 6 per cent. Pref.	2	..	1-1¼
—— 4½ per cent. 1st Debenture Stock	100	..	99-102
—— 4½ per cent. 2nd Debenture Stock	100	..	85-90
Callender's Cable, Debentures	100	..	106-110
—— Ordinary	5	..	11½-12½
—— 5 per cent. Pref.	5	..	5⅛-5⅜
Crompton and Co.	3	..	2-2½
—— 5 per cent. Debentures	100	..	100-104
Edison and Swan United, "A" Shares, 1-98,261	5	..	¼
—— "A" Shares, 01-017,139	5	..	1½-2½
—— 5 per cent. Debentures	100	..	75-80
—— 4 per cent. Deb. Stock, Red.	100	..	71-75
Electric Construction, Limited, Nos. 1 to 112,100	2	..	1½-1⅝
—— 7 per cent. Cumulative Pref.	2	..	2½-3
—— 4 per cent. Perp. 1st Mort. Deb.	100	..	99-102
Ferranti Limited, 5 per cent. 1st Mort. Deb. Stock, Red.	100	..	90-95
General Electric Company (1900), 5 per cent. Cum. Pref.	10	..	9½-10
—— 4 per cent. 1st Mort. Deb. Stock	100	..	99-102
W. T. Henley's Telegraph Works, Ordinary	5	..	13½-14½
—— 4½ per cent. Preference	5	..	5-5½
—— 4½ per cent. Debentures	100	..	107-111
India Rubber, Gutta Percha, and Telegraph Works	10	..	18½-19½
—— 4 per cent. Debentures	100	..	100-103
Parker, Thos., Limited, Ordinary	10	..	14½-15½
Telegraph Construction and Maintenance	12	..	34-37
—— 5 per cent. Bonds	100	..	100-103
Electric Lighting and Supply.—			
Blackheath & Greenwich District Ordinary 1,201-101,200	1	..	⅝-¾
—— 4½ per cent. Deb. Stk. Certs., Red. and Conv.	100	..	118-121
Bournemouth and Poole, Ordinary	10	..	12½-13½
—— 4½ per cent. Cum. Pref., 7,501-15,000	10	..	10-11
—— 6 per cent. Cum. Second Pref., 15,001-22,500	10	..	10½-11½
—— 4½ per cent. Debenture Stock, Red.	100	..	103-106
Bromley (Kent) Electric Light and Power Co., 4½ per cent. 1st Debenture Stock, Red.	100	..	102-105
Brompton and Kensington, Ordinary	5	..	10½-11
—— 7 per cent. Preference	5	..	10½-10⅝
Calcutta Electric Supply Corp., Ordinary, Nos. 1-40,000	5	..	6½-7⅛
—— Nos. 20,001-30,000	5	..	7-8
Cambridge Electric Supply Company, Ltd., £10 Ord.	8	..	14½
—— £10 Ord. "	5	..	10⅜
Central Electric Supply, Ltd., 4 per cent. Guar Deb. Stock	100	..	105-109
Charing Cross and Strand, Nos. 1-70,000	5	..	9-9½
—— 4½ per cent. Cum. Pref.	5	..	5½-6
—— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000	5	..	4½-5
—— 4 per cent. Debenture Stock, Red. (Prov. Certs.)	100	..	104-106
Chelsea Electricity Supply	5	..	5⅜-6½
—— 4½ per cent. Debentures	100	..	108-111
City of London, Ordinary	10	..	10⅜-11½
—— 6 per cent. Cumulative Pref.	10	..	13-14
—— 5 per cent. Debenture Stock	100	..	122-127
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100	..	102-105
County of London and Brush Provincial, Ordinary	10	..	8-9
—— 6 per cent. Cum. Pref.	10	..	11½-12½
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	100	..	109-112
Edmundsons' Electricity Corporation, Ordinary, 1-50,000	5	..	6½-7
—— 6 per cent. Cum. Pref.	5	..	6½-6⅝
—— 4½ per cent. First Mort. Deb.	100	..	107-110
Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-30,000	5	..	3½-4½
—— 5 per cent. Debenture Stock, Red.	100	..	95-98
Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000	5	..	6-6½
—— 4½ per cent. First Deb. Stock, Red.	100	..	100-103
Hove Electric Lighting, Limited, Ord., 1-13,000	5	..	7½-8½
Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000	5	..	10½-11½
—— 4 per cent. Debenture Stock Red.	100	..	103-105

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Name.	Amount paid. £	Last price. £
Kensington and Knightsbridge and Notting Hill	100	103-106
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	9¾-10¼
London Electric, Ordinary	5	2-2½
—— 6 per cent. Pref.	5	5½-6 xd
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	100-102
Metropolitan, Ordinary	10	17¼-18½
—— 4½ per cent. First Mortgage Debenture Stock	100	108-112
—— 3½ per cent. Mortgage Debenture, Red.	100	97-100
Newcastle-upon-Tyne Electric Supply, Ordinary	5	98-101
—— Preference	4	100-103
Notting Hill Electric Lighting	10	13-14
—— 4 per cent. First Mort. Debs., Nos. 1-500 (Reg.)	100	99-102
Oxford Electric, Ordinary, 1-96 and 407-14,310	5	4½-5½
—— 4 per cent. Debenture Stock	100	98-101
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100	100-102
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5	3½-3¾
—— 4 per cent. Debenture Stock	100	88-90
South London, Ordinary	5	3¾-4¼
St. James's and Pall Mall, Ordinary, 101-20,080	5	15½-16½
—— 7 per cent. Pref.	5	8-9
—— 3½ per cent. Deb.	100	98-101
Urban Electric Supply Co., Ordinary, 8-30,007	5	5-5½
—— 5 per cent. Cumulative Preference, 50,001-80,000	5	5-5½
Westminster, Ordinary	5	13-14
—— 5 per cent. Cum. Pref., 110,101-138,251	5	6-6½

Electric Railways.—

Central London, Ordinary	100	98-101
—— 4 per cent. Pref.	100	99-102
—— ,, ,, deferred	100	101-104
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100	115-118
City and South London, Consolidated Ordinary	100	59-61
—— 4 per cent. Debenture Stock	100	116-119
—— 5 per cent. Pref. Stock '91	100	127-130
—— ,, ,, ,, '96	100	126-129
—— ,, ,, ,, '01	100	125-128
Liverpool Overhead, 5 per cent. Pref.	—	13-13½
—— Ordinary, 1-50,000	—	7¾-8
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	—	102-104
Waterloo and City, Ordinary	100	95 98

Electric Tramways.—

Anglo-Argentine, 1-260,007	5	4⅝-4¾
—— Permanent 6 per cent. Debenture Stock, 1888	100	125-130
Blackpool and Fleetwood Tramroad	10	13½-14½
Brisbane Tramway Invest., Lim., Ord., 1-75,000	5	2-3
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5	4-4½
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100	101-104
British Columbia Electric Railway Co., Ord., Nos. 1-20,000	100	74-77
—— Non-Cum. 5 per cent. Pref., Nos. 25,001-38,600	100	91-94
—— 4½ per cent. 1st Mt. Debs., Nos. 1-6,250, of £40 each	40	104-106 p.c

Name.	Amount paid. £	Last price £
British Electric Traction, Ord. 1-300,000 & 60,001-90,000	10	12¼-12¾
—— 6 per cent. Cm. Pf., 30,001-60,000	10	11¾-12¼
—— 5 per cent. Perpetual Debenture Stock	100	122-125
Buenos Ayres and Belgrano Tram., Ord., 1-100,000	5	2¾-2⅝
—— "A" 6 per cent. Cm. Pf, 1-40,000	5	5-5¼
—— "B" 6 per cent. Cm. Pf., 1-27,500	5	4¾-5¼
—— 5 per cent. Deb. Stock, Red.	100	107-110
—— Prov. Cert., all paid	100	99-102
Cape Electric Tramways, Nos. 1-480,000	1	2-2¼
City of Birmingham Tramways, 5 per cent. Cum. Pref.	10	5-5¼
—— 4 per cent. 1st Mortgage Deb., 1-3,000 (1917)	100	99-102
Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red.	100	102-105
Cork Electric Tramways and Lighting Co., Ordinary	10	13-14
—— 5 per cent. Cum. Pref.	10	11-12
—— Debentures	100	96-99
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10	12¼-13¼
—— 6 per cent. Pref., Nos. within 1-60,000	10	15-16
—— 3½ per cent. Mort. Debs., 1-3,000, Red.	100	94-97
Imperial Tramways Ordinary	all	22-22¼
—— 6 per cent. Cum. Pref.	all	14¼-15¼
—— 4½ per cent. Deb Stock	100	112-114
Isle of Thanet Electric Tramways and Lighting, 5 per cent. Cum. Pref., Nos. 30,001-60,000	5	3¾-4¼ xd
—— 4 per cent. Debenture Stock	100	92-95
Kidderminster and District Lighting and Traction, Pref.	5	3¾-4
London United Trys. (1901), 5 per cent. Cum. Pref.	10	11¾-12¼
—— 4 per cent. 1st Mt. Db. Stock, Red.	100	105-107
Metropolitan Electric Trams., Deferred, 1,000,001-1,314,016	1	3/16-5/16
—— 5 per cent. Cum. Pref., 500,001-814,016	1	¾-1⅛
New General Traction, Ordinary	5	¼-⅜
—— 6 per cent. Cum. Pref.	5	2-3
—— 5 per cent. Mortgage Debentures, 1-1,713 (Regd.)	100	88-93
Oldham, Aston, and Hyde Tramway, Ordinary	10	10¼-10¾
—— 5 per cent. Cum. Pref.	10	11¾-12¼
Perth Elec. Tramways (W.A.) 5 per cent. 1 Mort. Deb. Stk.	100	99-102
Potteries Electric Traction, Ordinary, 20,001-40,000	10	9-10
—— 5 per cent. Cum. Pref., 1-20,000	10	9¼-10¼
—— 4½ per cent. Debenture Stock	100	102-105
South Lancashire Electric Traction and Power Company—		
—— £250,000 Ordinary	1	1
—— £101,132 6 per cent. Preference	1	1
—— £528,093 4½ per cent. Debenture Stock	100 p.c.	00 p.c.

Telephones.—

National Telephone, Preferred	100	100-102
—— Deferred Stock	100	78-80
—— 6 per cent. Cum. First Pref.	10	13-14
—— 6 per cent. Cum. Second Pref.	10	13-14
—— 5 per cent. Non-Cum. Third Pref.	5	5-5¼
—— 3½ per cent. Deb. Stock, Red.	100	96-98
—— 4 per cent. Deb. Stock, Red.	100	101-103
Oriental Telephone and Electric Company	1	13/16-15/16

TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line	Traffic Returns for week: Ending	1903. £	1902. £	Increase or decrease: Week. £	Current year. £	Miles of single track open: 1903.	1902.	Accounts for past year: Ending	Total receipts £	Passengers carried.	Car miles run.	Receipts per: Pas-s'nger d.	Car mile. d.	Mile of track. £	Cost per car mile. d.
Aberdeen Corporation	Aug. 29	1,469	1,291	+ 178	+ 2,213	19¼	17¼	May 31	37,931	9,099,715	794,641	0·98	13·02	1,970	6·14
Ayr Corporation	—	—	—	—	—	8	6	Sept. 25	12,503	2,979,276	290,099	1·00	10·34	1,560	4·7
Birmingham Tramways	,, 30	5,039	4,998	+ 41	+ 8,182	6½	6½	—	—	—	—	—	—	—	—
Blackburn Corporation	—	—	—	—	—	24	24	March 25[a]	40,964	7,234,106	826,558	1·36	11·87	1,705	7·44
Blackpool Corporation	—	—	—	—	—	17½	16½	,, 31	211,168	6,169,121	784,443	1·52	10·8	—	—
Blackpool-Fleetwood Tramways	,, 31	1,436	1,563	− 127	—	16½	16½	Dec. 31	30,923	2,049,677	584,989	3·62	12·68	1,932	6·99
Bolton Corporation	,, 30	1,734	1,662	+ 72	+ 5,655	38	25	March 31	85,704	17,761,605	1,896,247	1·15	10·75	3,430	5·87
Bournemouth Corporation	,, 12	1,438	—	—	—	10½	—	—	—	—	—	—	—	—	—
Bradford Corporation	,, 30	3,479	3,595	− 16	+10,172	41	—	—	—	—	—	—	—	—	—
Brighton Corporation	,, 30	1,052	1,095	− 3	—	6½	—	,, 31	—	10,432,508	1,031,928	1·00	10·10	—	—
Bristol Tramways Company	,, 28	5,029	5,061	− 32	—	51½	51½	Dec. 31	223,480	41,192,899	5,724,114	1·30	9·38	4,348	—
Burnley Corporation	,, 29	870	753	+ 112	—	—	—	—	—	—	—	—	—	—	—
Burton Corporation	,, 15	495	—	—	—	—	—	—	—	—	—	—	—	—	—
Cardiff Corporation	,, 1	2,133	1,535	+ 598	+12,345	—	—	—	—	—	—	—	—	—	—
Carlisle Tramways Company	—	—	—	—	—	—	—	,, 31	—	2,216,583	320,129[h]	—	—	—	—
Central London Railway	,, 29	5,499	5,632	− 133	− 1,778[h]	6	—	,, 31	367,225	45,305,110	1,276,971[a]	1·87	66·6[a]	59,076	35·6[a]
City and South London Railway	,, 30	2,403	2,537	− 134	− 2,819	6⅝	—	,, 31	165,003[a]	19,069,319[a]	—	—	—	—	—
Cork E. T. and L. Company	,, 27	619	895	− 275	− 1,305	—	—	—	—	—	—	—	—	—	—
Darwen Corporation	July 10	220	243	− 23	− 113	7·23	—	March 31[g]	12,341	2,360,735	254,279	1·25	11·65	1,707	9·36
Dover Corporation	Aug. 29	289	319	− 30	—	3	—	—	—	—	—	—	—	—	—
Dublin & Lucan Electric Railway	,, 30	166	163	+ 3	+ 61[h]	—	—	Dec. 31	5,796	364,796	102,087	3·81	13·62	859	7·68
Dublin U. T., electric cars	,, 28	4,450	4,434	+ 16	—	46	46	March 31	126,121	24,553,133	3,429,356	1·23	8·82	2,741	5·06[h]
Dublin S. District, Electric	,, 28	1,646	1,678	− 32	—										
Dundee City Tramways	July 15	834	718	+ 116	—	22	22	May 15	35,874	9,084,522	752,814	0·93	11·276	1,630	—
East Ham Corporation	Aug. 29	734	557	+ 177	+ 4,836	10·75	7·52	March 31	25,341	9,971,337	650,224	0·61	9·35	2,357	—
Farnworth U.D.C.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Glasgow Corporation	,, 29	13,784	12,505	+1,279	+19,497	124	101	May 31[g]	656,572	177,179,549	14,008,750	0·88	11·25	5,489 *b*	7·40[d]
Halifax Corporation	—	—	—	—	—	30¼	27¾	—	—	—	—	—	—	—	—
Huddersfield Corporation	—	—	—	—	—	34	35	March 31	56,631[h]	9,738,213	1,218,539	1·4	11·14	1,618	6·38
Hull Corporation, E. S.	,, 29	1,814	1,773	+ 41	+ 1,860	19	19	,, 31	87,707[h]	21,065,999	2,218,696	1·00	9·49	5,004	5·07
Ilkeston Corporation	,, 27	184	—	—	—	—	—	—	—	—	—	—	—	—	—
Kirkcaldy Corporation	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Leeds Corporation	,, 22	5,630	5,119	+ 511	+ 7,439	77	—	March 25	262,656	57,239,779	5,773,651	1·11	10·91	3,283	—
Liverpool Corporation	,, 23	10,475	9,870	+ 605	+12,141	101	95	Dec. 31	504,304	108,906,472	11,705,425	1·11	10·34	5,000	6·88
Liverpool Overhead Railway	,, 30	1,625	1,550	+ 76	+ 832	15½	15½	June 30	79,252	10,466,726	986,185[a]	1·82	19·30[a]	5,110	— [e]
Lowestoft Corporation	,, 22	370	—	—	—	—	—	—	—	—	—	—	—	—	—
Metropolitan District Railway	,, 30	6,205	5,819	+ 386	− 2,391	—	—	—	—	—	—	—	—	—	—
Nelson Corporation	,, 29	114	—	—	—	3	—	—	—	—	—	—	—	—	—
Newcastle-on-Tyne Corporation	,, 29	3,505	2,993	+ 512	—	38½	36	March 25[g]	150,334	33,474,122	3,379,119	1·08	10·93	4,175	6·17
Portsmouth Corporation	—	—	—	—	—	29	29	Sept. 30	47,651	9,168,137	868,157	1·24	13·17	1,643	—
Rochdale Corporation	July 20	157	164	− 7	—	4½	..	March 31	5,416	925,281	127,456	1·38	10·27	—	7·66
Rotherham Corporation	Aug. 27	535	—	—	—	—	—	—	—	—	—	—	—	—	—
Salford Corporation	,, 31	3,835	2,743	+1,092	+25,794	—	—	—	—	—	—	—	—	—	—
Sheffield Corporation	,, 30	4,388	—	—	—	53½	46¼	Mar. 25[g]	216,709	56,812,049	4,926,083	0·904	10·428	7,510	7·0
Southampton Corporation	,, 13	1,270	1,270	—	—	11	11	,, 31	35,874	9,084,522	752,814	0·946	11·436	3,760	—
Sunderland Corporation	,, 30	1,234	1,535	− 301	+ 762	18·48	17·18	,, 31	59,930	13,987,121	1,270,957	1·03	11·3	3,243	6·43
Wallasey U.D.C.	,, 29	795	790	+ 5	—	10·5	10·5	,, 31[g]	31,307	5,690,378	654,550	1·32	11·47	2,981	6·97

* Includes maintenance of permanent way and proportion of profits paid to the tramway companies for term of unexpired lease. *a* Train mile. *b* Per mile of single track. *c* Include rail and tram. *d* including depreciation. *f* Including one section of horse traction *g* 1903. *h* Half-year's figures.

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SUMMER MEETING OF THE INSTITUTION OF MECHANICAL ENGINEERS.

After an interval of 21 years the summer meeting of the Institution of Mechanical Engineers has once more been held in Leeds. The first paper dealt with was by Mr. H. Ade Clark, of the Yorkshire College, Leeds, on the "Diesel Engine." The following abstract includes recent records obtained by the author.

The Diesel Engine.

For the purposes of this paper the author visited the works of Messrs. Carels Frères, Ghent, Belgium, where he made four trials on the 80-b.h.p. engine at that time on the erecting bed. The data and results of these trials are given in Table I. As no preparations for a trial had been made, these results are not so complete as for the other two engines. The engine was connected by a belt to an overhead shaft, which was belted to a four-pole dynamo and to a motor running light. The output of the dynamo was absorbed by a water resistance. The petroleum tank supplying the engine was weighed immediately before and after each trial. Indicator cards were taken every five minutes, and the revolutions by a counter attached to the air-pump rocking lever. The oil used on this occasion was a Texas crude petroleum, a sample of which has since been tested at the Yorkshire College, with the following results: specific gravity, 0·922; gross calorific value, 19,300 British thermal units per pound.

TABLE I.—80-b.h.p. Diesel Engine: Test of Single-Cylinder Diesel Engine at Ghent on Feb. 7, 1903,—Summary of Results.

Load	0·25	0·5	0 75	Full
Duration in minutes	30·5	30·1	32	30·75
Total revolutions	4,890	4,863	4,800	4,797
Revolutions per minute	163	161	160	160
Mean effective pressure	48·5	68·4	89·1	109·4
Indicated horse-power	46·8	67·0	82·8	101·5
Effective ,,	24·8	45	60·8	79·5
Electrical ,,	17·3	35·6	52·1	68·8
Mechanical efficiency	53	67·0	73·5	78·3
Total oil in pounds	8·38	10·73	Lost	17·63
Oil per I.H.P. hour	0·352	0·320	—	0·339
,, effective H.P. hour	0·664	0·477	—	0·434
,, electrical ,,	0·952	0·601	—	0·500
B.Th.U.'s per I.H P. minute	114	104	—	111
Thermal efficiency on the I.H.P. (per cent.)	37·2	40·8	—	39·9
Thermal efficiency on the B.H.P. (per cent.)	19·7	27·3	—	31·2

On March 7, 1903, the author made complete trials on a double-cylinder 160-b.h.p. Diesel engine at the works in Ghent. The indicated horse-power was obtained by taking indicator cards from each cylinder every five minutes during one hour, and the load trials were each of one hour's duration and of half an hour when running light. The data and results are given in Table II.

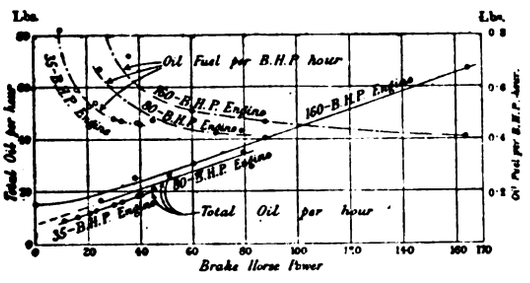

FIG. 1.—Oil Fuel for Diesel Engines.

In Fig. 1 three pairs of curves are shown, one pair for each of the engines tested by the author, the lower curves (straight lines) showing the oil consumption of these engines as the load varied. These curves of total consumption show well the action of the governor in cutting down the oil supply to the requirements of the engine, a result not so nearly approached by other types of oil-engine. They also show that the oil supply is directly proportional to the horse-power, except at very low loads—that is, loads below 25 per cent. of the normal. The upper three curves show the oil consumption per brake-horse-power hour. It will be observed that those curves descend to nearly the same at top loads, and that the rate of increase of consumption is not high, even down to half load, both facts, which point to the economy of this engine when distributed in small units, making it unnecessary to concentrate the power in large units and then use expensive transmission to the points where the power is required.

TABLE II.—160-b.h.p. Diesel Engine: Test of Two-Cylinder Diesel Engine at Ghent on March 7, 1903.—Summary of Results.

Load	Full.	0·53	0·375	0·25	None
Duration in minutes	60	60	61	60	30
Total revolutions	9,258	9,424	9,639	9,476	4,770
Revolutions per minute	154·5	157	158	158	159
Mean effective pressure L	113 4	64·7	51·9	38·2	46·2
,, ,, ,, R	114·5	74·1	60·7	46·2	39·7
I.H.P. cylinder 4 L	101·0	59·1	46·6	34·4	42·6
,, ,, 5 R	103·4	67·1	53·4	40·5	36·7
,, total or mean	204·4	126·8	100·0	74·9	39·64
,, of air pump	3·3	3·25	3·0	2·97	2·98
Net I.H.P. from the oil	201·1	123·6	97·0	71·93	36·66
Effective horse-power	164·8	87·2	60·4	35·4	—
Mechanical efficiency	80·7	68·8	60·4	49·2	—
Total oil in pounds	67·0	40·58	30·45	25·6	7·6
Oil per net I.H.P. hour	0·333	0·329	0·309	0·356	0·415
,, effective H.P. hour	0·408	0·465	0·505	0·724	—
Cooling water per minute pounds, inlet	9·5	9·5	9·5	9·5	10·0
Temperature of water C., outlet	62·0	52·5	60·5	65·5	67·0
Change of temperature	52·5	43·0	51·0	56·0	57 0
Temperature of exhaust, C.	384·0	239·0	197·0	158 0	—
B.Th.U. per net I.H.P. minute	108·0	106·0	102 0	114·0	154·5
,, converted to work	42·4	42·4	42·4	42·4	42·4
,, rejected in cooling water	22·9	26·3	24·3	21·7	—
B.Th.U. rejected in exhaust gases	32·1	28·3	14·4	13·5	—
Thermal efficiency on net I.H.P., per cent.	39·25	40·0	41·5	37·2	—
Thermal efficiency on Eff.H.P., per cent.	32·3	28·3	26·1	18·3	—
Exhaust gas analysis:					
Carbon dioxide vol., per cent.	7·0	4·1	3·1	2·9	—
Carbon monoxide vol., per cent.	—	—	Trace?	0·1?	—
Oxygen, per cent.	11·3	15·0	16·6	17·6	—
Nitrogen, by difference per cent.	81·7	80·9	80·3	80·3	—

The performance of the 160-b.h.p. engine under variation of load was as follows: Load on the dynamo,

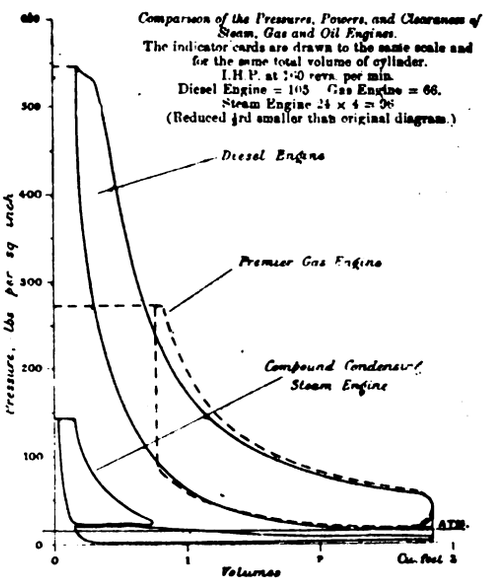

FIG. 2.

700 amperes at 115 volts—that is, 108 h.p.; tachometer reading, 89. The whole load thrown off at once, the tachometer ran up to 96·2, and settled back to 88·7 in about a minute. The engine running light, tachometer 91, a load of 700 amperes at 115 volts was put on at once, when the lowest reading of the tachometer was 87·8, and the engine settled back to 90 in about half a minute. Indicator diagrams were taken during the trial of 160-b.h.p. engine on March 7, 1903. One card shows the starting of the engine under air pressure; then come a series of cards showing the development in the body of the card under various loads, the action of the governor

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in giving more oil for more work being well shown. The whole of the cards taken in a given run are very regular, any single card being very little different from the mean.

In Fig. 2 is shown a comparison of the pressures, powers, and clearances of three types of engine—namely, the compound condensing engine, using high-pressure steam with jacketed cylinders; the scavenging type of gas-engine, using gas of 600 British thermal units per cubic foot; and the Diesel engine, using crude petroleum. The indicator cards there shown are drawn to the same scales and for the same total volume of cylinder. The clearances are as follows: the steam-engine, 3·5 per cent. of the volume of the horse-power cylinder; the gas-engine, 27 per cent. of whole volume; the Diesel engine, 7 per cent. of the whole volume.

Further trials were made in England to confirm those on the makers' testing beds. Table III. gives the results of a trial made on the 35-b.h.p. Diesel engine at Harrogate on May 8, 1903—that is, about 12 months after the trials made in April, 1902. Taking trials at 33 b.h.p, the results are as follows:

Year.	B.H.P.	I.H.P.	Eff.H.P.	Oil per hour—I.H.P.	Oil per hour—B.H.P.
1902	33·1	46·88	70·7	0·336	0·476
1903	33·2	48·80	68·1	0·344	0·505

TABLE III.—35-b.h.p. Diesel Engine: Test at Harrogate after running 16 hours a day for 12 months.—Summary of Results.

Load	0·91	0·82
Duration in minutes	50	29
Revolutions per minute	179·9	179·8
Load on the brake	236	204
Pull on spring balance	12	8·4
Effective load	224	195·6
Brake horse-power	33·2	28 9
Total oil	13·97	6·875
Oil per hour	16·76	14·24
Oil per B.H.P. hour	0·505	0·493
Mean effective pressure	106·5	99·4
Indicated horse-power	48·8	45·5
Oil per I.H.P. hour	0·344	0·313
Temperature of jacket water inlet	50° F.	50° F.
,, ,, ,, outlet	166°	155°
,, ,, ,, rise	116°	105°
Mechanical efficiency (per cent.)	68	63·6

TABLE IV.—80-b.h.p. Diesel Engine: Test made at Messrs. Stafford Allen and Sons, London, May 16, 1903.—Summary of Results.

Load	0	0·50	·75
Duration in minutes	49	145	78
Total revolutions	—	—	—
Revolutions per minute	158	157	156
Mean effective pressure	25·6	69	91 2
Indicated horse-power	23·8	61·9	81·5
Effective horse-power	0	38·1	*57·7
Mechanical efficiency	0	61·6	70 4
Total oil in lbs.	6·52	48·22	35 69
Oil per hour	7·98	19·91	27·48
Oil per I.H.P. hour	0·374	0·322	0·337
Oil per effective H.P. hour	—	0 523	0·479
Cooling water per minute, lbs.	—	24·1	25·7
Temperature of water inlet	—	—	—
,, ,, outlet	66° C.	60° C.	64° C.
Temperature of room	25°	24°	25°
,, oil	21°	21°	18°

* Effective horse-power at full load, 80.

Table IV. gives the results of a trial made in London on May 16, 1903. This engine is of 80 b.h p. at 160 revolutions, and was made by Vereinigte Maschinenfabrik, Augsburg, and there is, therefore, additional interest in comparing it with the trial given in Table I. on the engine of the same size made by Messrs. Carels Frères, Ghent. In the trial at half load the maximum indicated horse-power was 73; the minimum indicated horse-power, 44; the mean being 62 i.h.p., taken from 52 indicator diagrams. In the three-quarter load the highest indicated horse-power was 99, the lowest indicated horse-power being 69·2, and the mean indicated horse-power was 81·5 from 36 diagrams. In the no-load trial the highest indicated horse-power was 31·2, the lowest indicated horse-power 16·35, and the mean from 26 cards, each containing five or six diagrams, was 23·8. The governor "hunted" a little when working without load. This trial was made when the engine was running under load for the first time since its erection at Messrs. Stafford Allen and Sons', and was not then out of the makers' hands; consequently the no-load indicated horse-power is probably a little high, and a month's running of the engine would probably reduce this.

Table V. is condensed from a more detailed statement by the author, and is a comparison of cost for three sizes and types of engine.

TABLE V.—Total Costs in Power Production.

Type of engine.	B.H.P.	Capital cost—Total.	Capital cost—Per B.H.P.	Annual cost—Total.	Annual cost—Per B.H.P.	Cost per B.H.P. hour.
		£	£	£	£	Pence.
Diesel	35	695	19·8	233·05	6·66	0·59
	80	1,075	13·44	348	4·35	0·39
	160	1,916	14·28	582	3·63	0·32
Gas	35	647	18·5	270·5	7·73	0·69
	80	1,142	14·25	466	5 82	0·52
	160	1,836	11·98	726	4·45	0·40
Steam	35	850	24·3	350	10	0 89
	80	1,330	16·7	568·2	7·1	0·63
	160	1,976	12·4	887	5·5	0·49

Initial capital cost includes land, buildings, and plant. Annual charges includes interest on capital, maintenance, and depreciation for buildings, and also for plant, fuel, oil and water, and wages. The gas-engine taken for comparison is the Crossley using a Dowson gas producer. The steam engine compared with is the high-speed compound-condensing engine. The fuels are: for the Diesel, crude petroleum at 45s. per ton; for the gas-producer, anthracite coal at 24s per ton; for the steam-engine, coal at 12s. 6d. per ton. The oil consumption for the Diesel has been taken in each case as the mean between the full and half power rates of consumption. The fuel consumption in the case of the gas-producer has been taken at 1·5lb. to 1·25lb. per brake horse-power hour plus an allowance for stand-by losses. The fuel consumption for the steam-engine has been taken at 4lb. and 3·5lb per brake horse-power for the lowest and highest powers, assuming an evaporation of 8lb. of water per pound of fuel.

Mr. G. WILKINSON (Harrogate) stated his regret that it should be necessary to purchase the Diesel engine abroad, and that there were no firms in England who had taken up its manufacture.

Mr. MICHAEL LONGRIDGE (Manchester) pointed out that improvements were still required, but considered that, even in its existing state of development, the Diesel engine presented very considerable advantages.

Prof. ARNOLD LUPTON (Leeds) said that, admirable as the engine might be, it would never be largely employed as a substitute for the steam-engine, whereas the gas-engine might be so substituted. The chief interest of the Diesel engine, in his opinion, was to be found in the slow combustion.

Prof. GOODMAN (Leeds) thought that the Diesel engine must be regarded as a great triumph for scientific men. The chief reason for the fact that it gave better results than the ordinary gas-engine was to be found in the complete combustion of the fuel. He expressed the wish that English engineers would pay more attention to careful trials of oil-engines. England ought not to be behindhand in this matter, and if Germany could produce an engine such as that under discussion, surely we could do equally well if the effort were made.

Mr. J. MACLAREN (Leeds), Mr. MARK H. ROBINSON (Rugby), and Mr. ALFRED SAXON (Manchester) took exception to various figures relative to the comparative cost of power productions.

Mr. C. DAY (Glasgow) pointed out that the Diesel engine had been made both in England and Scotland, but manufacturers had taken up the invention before it had been completely developed by the patentee. The position, therefore, was that the licensees were placed in an undesirable position. Since the engine had been improved a firm in Scotland had taken up its manufacture, and during the latter part of 1902 had completed an engine for their own use, the results of tests being very similar to those quoted by Mr. Ade Clark.

In replying to the discussion, the AUTHOR said that while the price of the Diesel engine was high, the cost

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would no doubt be reduced, and that the cost of fuel for the ordinary oil-engine would be three times that necessary for the Diesel type.

A New Form of Friction Clutch.

In opening this subject, Prof. H. S. HELE-SHAW said that the importance of the friction justified a very careful consideration of the problem, and as to whether, in view of the modern developments of motive power, particularly in internal-combustion engines and of high-speed machinery of great power, there were not yet improvements possible. The following is a brief abstract of the paper. The four conditions which seem to be involved in the problem of

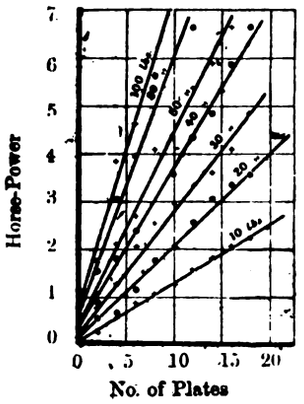

FIG. 1.—Power ransmitted, using various pressures.

the friction clutch are: (1) it must have sufficient gripping power; (2) undue wearing of the surfaces must be avoided; (3) provision must be made for conveying away the heat where there is much slipping contact in the clutch; (4) motion should be imparted to the driven shaft without shock.

The author does not remember seeing in any previous writings on the subject, or in the statement of inventors themselves, the important fact mentioned in condition (3), but it certainly does account for the large number of instances in which friction clutches have failed to give satisfactory results for anything but the smallest powers.

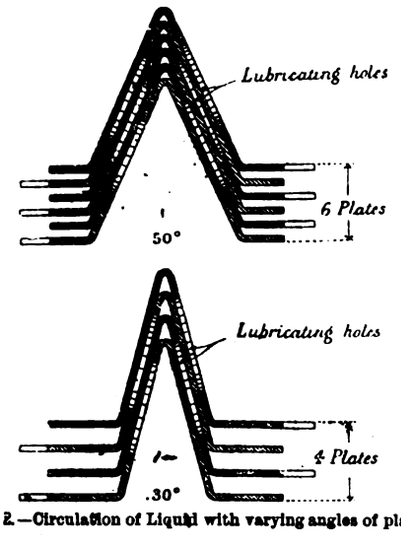

FIG. 2.—Circulation of Liquid with varying angles of plates.

No cluches appear to have been designed for the purpose of allowing slipping to take place to any considerable extent, so as to prevent, at the same time, undue wearing and heating of the friction surfaces. Some devices, such as the coil clutch, the "Weston" clutch, and the expanding ring clutch, may be made to transmit great powers; but it may be safely said that not one of the foregoing clutches has yet been designed so as to be capable of slipping for more than a very short time without being seriously injured, even if the surfaces in contact were not actually destroyed.

There are plenty of illustrations in mechanical science where it has hitherto been impossible to reconcile conflicting conditions, and it is an important question whether the present case forms another example or not. The author believes there is a way out of the difficulty, and this way he indicates in the present paper. Suppose a sheet of metal is pressed into a frustum, the section of the corrugation being the frustum of a cone, and that the disc is placed upon another one similarly corrugated. It will be observed that not only do portions of the frusta not make contact with each other, but there is also a space left between the flat portions of the discs. By placing these discs together, and turning one alternately to the other, an amount of friction is produced which depends on the acuteness of the angle of the frusta. If a number of these plates are now placed in a box of the type of the "Weston" coupling, so that the plates alternately engage with two sleeves, one connected with the driver and the other with the follower, it will be found: first, there is a very considerable gripping power; second, there is a tendency to part rapidly with heat, owing to the

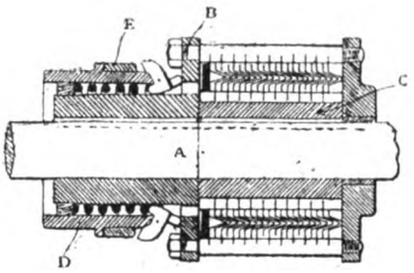

FIG. 3.—Type of Open Clutch, with air cooling.

separation of the discs of metal. By the ordinary theory of friction, the former effect will be found to be much greater, and yet this cannot be accounted for by the ordinary laws of friction, since the increased effect of the wedge action is directly in proportion to the diminution in the number of plates which it is possible to put in a box, which diminution varies according to the same law. There is, however, a still more striking difference between the gripping action of the flat and corrugated plates when a lubricant is introduced.

It may be interesting to give a series of results which have been obtained by actual experiments with a dynamometer attached to an experimental reversing clutch, on the effect of multiplying a number of plates, and gradually increasing the pressure. Fig. 1 shows the results of this series of experiments represented so as to give the horse-power for any number of plates with varying pressures.

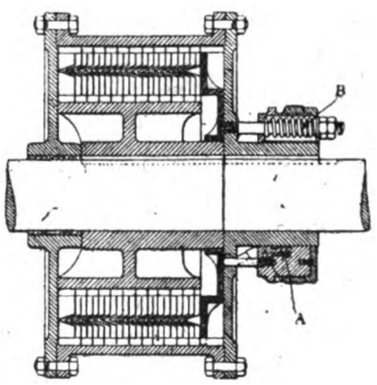

FIG. 4.—Type of Enclosed Clutch.

Efficient lubrication of the surfaces in contact is ensured by drilling the faces of the plates, as indicated in Fig. 2 It will be noticed from this illustration that the number of plates in a given space depends upon the angle of the corrugation, four plates with 30deg. occupying the same space as six plates with 50deg. These four plates give a better grip than the six plates with 50deg., and allow a freer circulation of liquid. The plates are also more rigid with the more acute angle. A standard type of open clutch for shafts up to 2in. diameter is shown in Fig. 3. The shaft is divided at A, the outside case, B, being keyed to the left-hand piece of shafting, and driving the set of plates having external driving teeth, the core, C, keyed to the right-hand shaft, driving the plates with

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internal driving teeth. Pressure is applied to the plates as follows: The sliding sleeve, D, containing a coil spring, is fitted with pins which project through the outside case of the clutch; these pins press against a flat disc, which in turn presses against the plates, causing the clutch to drive. When the operating lever is worked so as to release the plates, the ring, E, encircling the sleeve withdraws the trigger pins from the holes into which they fit; the spring pressing on the opposite end of the trigger pin causes the trigger to fly up, and the clutch is thereby kept out of operation. By moving the lever so as to force the ring, E, against the trigger, the pin end falls into the hole opposite to it, and the coil spring is then allowed to transmit its pressure to the plates. Fig. 4 shows a section of a larger type of closed clutch fitted to a 3in. shaft, the action of this clutch being similar to that described in Fig. 3. The triggers, however, are worked by separate coil springs, A, the pressure being applied to the plates by means of separate springs, B. A considerable amount of lubricant can be contained in this clutch owing to the construction of the casing.

Applied as a dynamometer the corrugated surfaces are quite successful. Fig. 5 shows one fitted to the 150-h.p. triple-expansion engine at the engineering department, University College, Liverpool. This dynamometer, which replaced one of the Froude type previously used, consists of 40 plates, the corrugations including an angle of 35deg. A is the engine shaft on which is keyed a slotted core, this core driving one set of plates; the outer casing, B, is stationary, it is slotted inside its periphery, and carries the stationary plates. Bolted to this casing is a wrought-iron arm, this arm being connected at its free end to a calibrated steelyard, on which the torque is read off in foot-pounds. Above the dynamometer proper a tank, C, is fixed containing the cooling and lubricating solution. Circulation through the dynamometer is maintained by gravity; the cool liquid enters the casing at D, and, becoming heated, returns to the tank above by means of the pipe, E, fixed to the top of the casing. Inside the cooling tank a coil of piping is arranged through which water from the town mains is allowed to flow by pipes; by this means the arrangement is kept cool for tests of any duration. Varying pressures can be applied to the plates by means of the hand-wheel and screw fixed to the end of the lever, F, the fulcrum being at G. The other end of this lever carries a claw, which transmits the pressure to the ring, H, carrying the pins, which press against a flat disc, this disc transmitting its pressure to the corrugated plates. As each pair of plates have flat springs inserted between them the engine is enabled to run quite free when starting. A friction dynamometer of this type of 600 h.p. has been constructed for Messrs. Vickers, Sons, and Maxim, Barrow. It may be pointed out in connection with these dynamometers that the speed can be reduced to a very low number of revolutions under the conditions of pressure at the engine without impairing the accuracy of the observations, while the running remains perfectly steady for very great loads. Although this dynamometer has been at work for many months, the plates have not worn to any appreciable extent.

A number of applications of the clutch have been already made, but the application which really led to its invention was in connection with the motorcar. There are many cases, such as the use of electricity with petrol motors on light railway wagons, and also with what is called the petrol electrical car, where expensive means have hitherto been employed to effect what can be done in a perfectly simple manner by a slipping clutch such as that described.

Prof. Hele-Shaw's paper was followed by a practical demonstration of the working of the new clutch in reversing gear. With the aid of a motor lent by the Leeds Corporation for the purpose of supplying the gearing with motive power, members were able to see the new slipping clutch in actual operation.

Prof. ARNOLD LUPTON (Leeds) remarked that the friction clutch described by Prof. Hele-Shaw seemed to be what the mining world was wanting. Such a beautifully-arranged clutch as that would enable them to vary the speed at difficult turns in an underground road without altering the speed of the electric motor, and would confer great advantages on all connected with mines.

Mr. WILSON HARTNELL (Leeds) said the clutch supplied what was wanted for electric cranes when they wished to lift very slowly at first, and afterwards at a higher rate of speed.

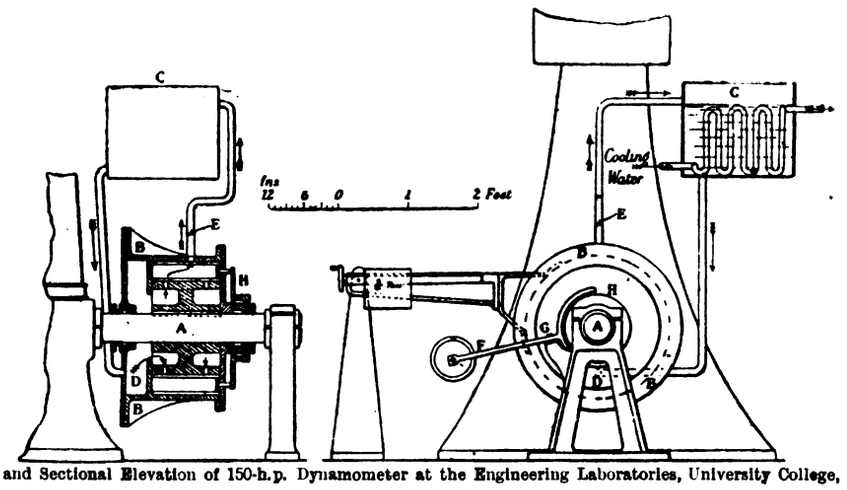

FIG. 5.—Front and Sectional Elevation of 150-h.p. Dynamometer at the Engineering Laboratories, University College, Liverpool.

Mr. BARNES (Liverpool) said the new clutch was one that was bound to have a great effect upon every branch of engineering in which it would be used, and it was hard to say for which branch it would not be suitable.

Prof. HELE-SHAW, replying on the discussion, said the new clutch would doubtless be applied to machine tools in course of time. He had no doubt that this or some other form of slipping clutch was absolutely necessary for the introduction of a chain drive. A chain drive was impossible if you expected a chain to last at all where you had not some "give," when motor and driving machines were put in connection with each other.

Economy of Fuel in Electric Generating Stations.

Mr. HENRY MCLAREN, of Leeds, contributed a paper on this subject, the following being some of his chief points. The first feature that attracts attention in the yearly return of public or municipal lighting authorities is the great difference in cost per unit generated. The generating stations are located in various parts of the country; some are condensing, others partly condensing or non-condensing stations. The price paid for coal varies largely, and different systems of supply are used. All these considerations affect the costs. In the returns for the lighting stations the figures are based on units sold to consumers, and therefore include the large leakage or loss in the mains, which is debited to the generating plant. This may be as much as 20 per cent, and is a very important factor to be kept in mind when comparing purely lighting stations with tramway or railway plants—that "meter" the current as it leaves the station. Engineers would naturally expect that condensing stations would show a better fuel economy than non-condensing stations both for tram and lighting purposes, but so far as lighting only

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is concerned it is just the reverse. The average, both in fuel and works costs, is considerably in favour of non-condensing stations. Where trams are added to lighting, the condensing plants show a better economy than non-condensing, but in all cases the partly condensing station is the most economical both in fuel and works costs. It is manifestly unfair to compare purely lighting stations, which have only a poor load factor, with stations that combine lighting and tramways, and generate large quantities of current all day long, and meter it as it leaves the station. The author has, therefore, sub-divided the stations given in published tables of costs, and arranged them as follows :

Twenty-Two Metropolitan Stations, Lighting only.

	Units sold.
Non-condensing	24,014,141
Partly condensing	11,305,581
Condensing	41,318,891

as compared with the metropolitan stations, and their average cost of producing current is 18 per cent. less. Here, again, the non-condensing and partly condensing stations are more economical than the condensing, the saving in works costs being 14 per cent. and 16 per cent. respectively, and the saving in fuel 12½ per cent. and 20½ per cent.

Thirty-Two Provincial Stations, Supplying Current for both Lighting and Tramways.

	Units sold or generated.
Non-condensing	7,968,426
Partly condensing	30,040,162
Condensing	39,893,928

In these stations the condensing plants are found to be more economical than the non-condensing by about 9 per cent in works costs and 19 per cent. in coal, but the partly condensing stations are still better than the condensing, showing an economy of 23 per cent. in works

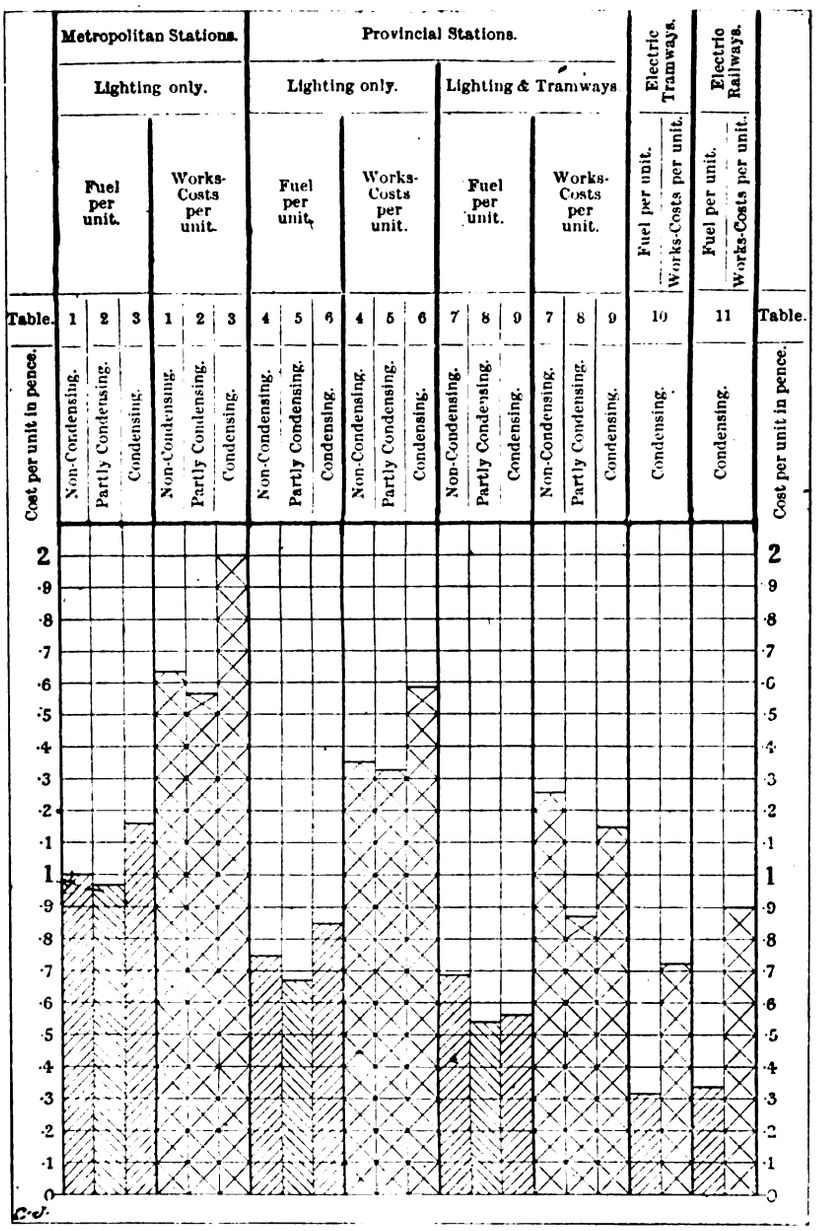

FIG. 1.

In comparing the costs of these three types, it is found that the non-condensing stations produce current at 18 per cent. less cost than the condensing stations. For fuel only, the saving in favour of non-condensing and partly condensing plants is about 14 per cent. and 17 per cent. respectively.

One Hundred and Sixteen Provincial Stations, Lighting only.

	Units sold.
Non-condensing	18,430,119
Partly condensing	20,873,145
Condensing	35,933,215

On the whole these stations have cheap coal and labour costs and nearly 4 per cent. in fuel. It is surprising to find that at least two of the lighting stations, Leeds and Edinburgh, deliver current at the consumers' meters at 9 per cent. lower average cost than averaged at the switchboards of the tramway power stations of Blackpool and Fleetwood, Dublin, Glasgow, and Hull. Glasgow, the most economical of these four power-houses, with an annual output of over 10,000,000 units and a tramway load factor, delivers current at the switchboard at a cost of 0·6d. per unit works costs; whereas the Leeds lighting station, with only 3,000,000 output and a lighting load factor, shows a works costs of 0·62d. per unit, including

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the heavy loss in the mains. Three power-houses, generating current for the Central London Railway, the City and South London Railway, and the Liverpool Overhead Railway, are beaten in economy by the tramway power-houses already mentioned by over 20 per cent. in works costs and 5¾ per cent. in fuel costs. Fig. 1 shows in graphic form the average costs of the various classes of stations or power-houses. From figures quoted by the author it would appear that the metropolitan condensing stations, after allowing 30 per cent. for outside losses and banking fires, etc., were using at least twice the amount of fuel that economical plants ought to require. They generated during the year over 41,000,000 units at a cost for fuel of over £200,000. A very large percentage of this amount could have been saved by the use of well-managed economical generating plant. It must be remembered that most of these stations were pioneers in the electric lighting industry of this country. Each extension was, in a measure, a large experiment. They have had to contend with difficulties too numerous to mention, and, could their engineers start afresh, there is no doubt that these stations, with their enormous output, would take their place amongst the most economical in the country. Taking the average station throughout the country, there is room for great improvement; on the other hand, one finds a few stations that leave nothing to be desired.

Separate condensing plants are used in most lighting stations. The vacuum in the main engine low-pressure cylinder is usually poor owing to the long lengths of exhaust pipe, often overcharged, and having numerous sharp bends. Engines fitted with their own condensers have a great advantage over those exhausting into one main serving several engines. Usually a saving of 5 to 10 per cent., due to the better vacuum, is effected. Add to this the 10 per cent. of steam used by the separate plant, the loss in the auxiliary steam-main with its traps, the loss in starting up separate plants for short runs, the loss at light loads, the loss of vacuum through leaky atmospheric exhaust valves, and it is not so surprising that under these conditions the economy due to condensing reaches the vanishing point, or even falls behind well-equipped non-condensing stations. It is rather remarkable that the partly condensing stations show the best average economy. "Partly condensing" is a very vague term, and no doubt most of them might be classed as condensing stations. Without exact data it is impossible to come to any definite conclusion as to the reason.

Statistics show that in lighting stations the non-condensing engines beat the condensing by 13 per cent. in fuel economy. This is the average over the whole country, 13 + 25 = 38 per cent., to be accounted for to bring matters as they ought to be. Uneconomical three-crank, compound, tandem, condensing engines, largely used in lighting stations, no doubt account for some of this, and, as already shown, separate condensing plants are also steam wasters. All non-condensing stations should be fitted with efficient exhaust steam feed heaters. Feed heaters or economisers fixed in the boiler flues cool the waste gases, and to a certain extent spoil the draught. The best results are to be got by employing both types of heater, the water entering the economiser at nearly boiling point.

The steam losses in electric generating engines are mostly due to valve or piston leakage. Unless engines fitted with piston valves are very carefully looked after, heavy leakage is likely to occur. Many station engineers do not realise how serious this loss may be, and allow their piston valves to run in a very leaky condition. Balanced slide valves and valves of the Corliss type, having some pressure on the back to keep them up to the port faces, require much less attention, and will run for many years practically steamtight.

Two recent tests of condensing engines fitted with piston valves, disclosed the fact that they required over 40lb. and 50lb. of steam per kilowatt-hour respectively. When previously tested the consumption was about 30lb. per kilowatt in each case. Outwardly they appeared to be running as well as ever. It is safe to assume that £100,000 was lost during the year ending March, 1902, in engine leakages alone. There is no doubt it would pay to employ an engineer in each of the larger stations to do nothing else but make tests and report on fuel losses with a view to their remedy.

Engine builders find much less difficulty in getting their guarantee figures from the honest steam of the Lancashire or other cylindrical boiler than they do from the high-pressure "Scotch mist" given off by the now fashionable box of water-pipes. In lighting stations there are great fluctuations in the demand for steam. Only those who really understand the art of firing, can appreciate the difficulty of working mechanical stokers with economy under such conditions. An efficient method of forced draught is a decided advantage in lighting stations, if it is properly used, for it enables steam to be maintained over the peak of the load. The latest system of Halpin's thermal storage is the ideal method of obtaining the same end. At light loads the steam-jet method of forcing draught is often greatly mismanaged. A peep through the small side door at the back of the grates, in a Babcock boiler, fitted with moving grates and forced draught, and carrying, say, half-load, is often a revelation of how not to do it. One third of the grate may be covered by a spouting volcano of fire, the remainder employed in carrying away dead ashes and clinker, allowing large quantities of cold air to pass, all of which has to be heated up to the temperature of the escaping gases. Under these conditions a low flue temperature is no criterion of economy.

Some makers of steam-jet draught producers only require 3 per cent. of the steam generated to supply their blowers; others state that they require 3 per cent., but their fittings are found to be large enough to pass four times that amount, even when the full rating of the boiler is taken. Feed pumps and other boiler house auxiliary engines require a considerable percentage of the steam generated. In condensing stations better economy is obtained by utilising the exhaust of the auxiliary engines in heating the feed than by working them as condensing engines. In lighting stations the losses in the ring steam-main, with its numerous traps, is a serious consideration. It is seldom less than 5 per cent., and may be very much more if the traps are not kept in perfect order and properly regulated. Superheating, especially when piston-valve engines are used, shows a good steam economy, but the saving in fuel is not so marked, and in lighting stations its proper regulation is rather difficult. The extra wear and tear on the main engines and on the superheaters themselves are items that have to be considered. The station engineer should note that the average works costs for the non-condensing lighting stations are 16½ per cent. less than the condensing stations. One explanation of this may be that less plant requires less looking after and less repairs. But a well-managed condensing station with economical engines is certainly the most economical type of station, especially where trams are coupled with lighting.

There are only four stations given in the tables wholly using steam-turbines—Newcastle, Scarborough, Cambridge, and Melton Mowbray. Newcastle station is the lowest both in coal and works costs, yet it is easily beaten by South Shields, a station with vastly less output, situated on the same river, and using triple-expansion condensing engines, which comes out 35 per cent. less in fuel and 25 per cent. lower in works costs than the turbine station. Northwich, using Mond producer gas, has an output of 104,000 units Its fuel cost is 0·48d. per unit; works costs are 1·48d. per unit. This is handsomely beaten by Leigh, a station with a smaller output, using non-condensing steam-engines, which comes out at 28 per cent. less in fuel and 15 per cent. less in works costs. Redditch, the other gas-engine station, using Dowson producer gas, has an output of over 172,000 units; coal costs are 1·3d. per unit, and works costs are 2·61d. per unit. There are over a dozen smaller-sized steam-engine stations that beat these results. It is encouraging to note from recently-published returns that the costs in various stations throughout the country show a decided tendency to improvement. This is partly owing to cheaper coal, but there is also a healthy rivalry between station engineers which should in time bring the electric generating stations into the front rank as regards economy of fuel.

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In the course of the discussion which followed, Mr. GEORGE WILKINSON (Harrogate) said he would like Mr. McLaren to give them the names of the condensing stations which lowered the averages so much that they compared so unfavourably with the non-condensing plant. He himself thought that condensing stations were as efficient as non-condensing plant.

Mr. CHARLES FORGAN, one of the engineers connected with the Central London Railway, spoke of the relative cost of hand and mechanical stoking. Some time ago his company decided to make a change from mechanical to hand stoking, and after six months' running the cost of coal worked out at £4,000 a year less than under the system of mechanical stoking. He could not believe that all this reduction was due to the stoking.

Mr. J. D. BAILIE (Leeds) regretted Mr. McLaren had spoken disparagingly of the steam-turbine stations. He considered that it was unfair to compare the station at Newcastle, which had been in operation many years, with a new station like South Shields.

Mr. T. L. MILLER (Liverpool) regarded the alleged superior economy of non-condensing stations over condensing stations as the most interesting point of Mr. McLaren's paper. His own view was that non-condensing engines were the least economical.

Mr. MARK ROBINSON (Rugby) said that there was no need to wonder that the non-condensing station came out the best with a lighting load. For almost any purpose a partly condensing station was likely to be the best. Referring incidentally to the late Mr. Willans, of Leeds, he remarked that that gentleman nearly 20 years ago made non-condensing engines which used 18½lb. of steam per indicated horse-power, the same engines using about 12½lb. when working condensing.

Mr. MICHAEL LONGRIDGE (Manchester) said: "Electrical engineers have shown us how to measure, how to measure accurately, and how to record results, but I think that in the choice of their plant and steam-engines they have still a good deal to learn." One reason why the non-condensing engine had come out more economically than the condensing engine was that on the whole condensing engines were very badly designed. He urged every engineer to put a condensing plant to his engine.

Mr. A. SAXON (Manchester) remarked that a cotton mill in Lancashire could be run with an engine which developed 1,000 h.p. for £20 worth of coal per week, running 56 hours per week. That included the steaming and heating of the rooms and stand-by losses.

Mr. MCLAREN, in the course of his reply, said that recently his firm put in a new engine and thereby effected a saving of 60 per cent. in fuel. If it had been a motor, the saving would have been credited to electricity, but as it happened, the engine had nothing to do with electricity.

ELECTROLYTIC APPARATUS.*

BY F. MOLLWO PERKIN, PH.D., MEMBER.

Owing to the great expense of platinum and the necessity for its use in electrochemical analysis, members may be interested in the description of a simple form of electrode, which is comparatively inexpensive and is very satisfactory.

In Fig. 1, which shows the electrodes, the cathode is in the form of a flag and is made of platinum gauze, which is held rigid by means of a platino-iridium frame (10 per cent. iridium); the frame, which is roughened by means of the sand blast, has a stout piece of iridio-platinum wire welded on to it. The wire, of course, is for holding the electrode in position during analysis. The loop near the top of the wire is for hanging the electrode on the balance. The anode is made of iridio-platinum wire, and is bent upon itself in such a way that when it is placed into position for electrolysis, as illustrated in Fig. 2, an even current density is obtained on all parts of the cathode. The distance between the two sides of the anode is 2·5cm., therefore, when in position, it is 1·25cm. distant from each side of the cathode.

The cathode is 6cm. high and 4·3cm. wide, and the length of the supporting wire is 7·5cm., the loop being 2·5cm. from the end. As the anode is opposed to both sides of the cathode during electrolysis, it follows from the above measurements that the total cathode surface is 50·4 cm.², that is, practically half a square decimetre, which, as the C.D. for analytical purposes is generally calculated per square decimetre of surface, is a very convenient size. It is not essential for the cathode to be made of gauze—in many cases sheet platinum is quite as useful; but for metallic deposits which are inclined to exfoliate—such as bismuth and antimony—the gauze is more satisfactory; it is also very useful for mercury and for peroxide deposits. The gauze should not be too fine; the finest which I have found satisfactory is about 50 to 60 meshes to the square centimetre.

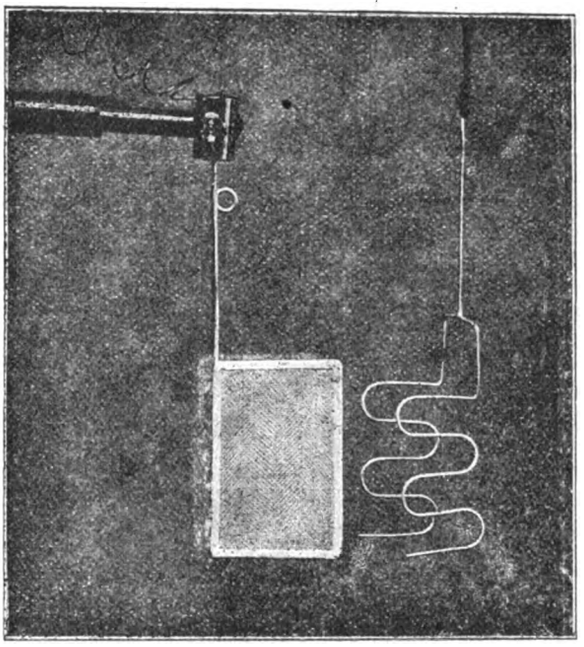

FIG. 1.

When it is too fine there is a tendency for hydrogen to collect upon the surface and thus cause polarisation.

The weight of the cathode, when made of platinum sheet, is about 14·5 grm. If thinner platinum is employed the weight can be reduced to 8 grm., but I have found it better not to make them of very thin platinum, because then they are so fragile and there is a tendency for the deposits not to adhere well at the edges. The weight of the gauze electrode is about

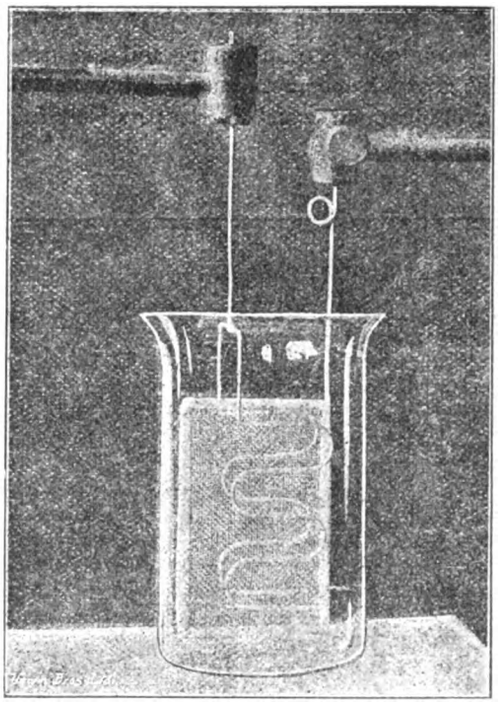

FIG. 2.

15 grm. It follows that, as these electrodes weigh much less than the basin or cylinder ones, they are much cheaper. A basin usually weighs from 40 grm. to 60 grm., and a cylinder from 26 grm. to 28 grm.

These electrodes are also more satisfactory for carrying out electrolytic separations, the manipulation being much easier than with the basin. Suppose, *e.g.*, that one is electrolysing a mixture of copper and iron salts. In the first place, the copper

* Paper read before the Faraday Society.

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would be deposited out from an acid solution; then, after neutralising, the iron would be electrolysed out. Now, when a basin is used, the solution has to be transferred to a beaker, and as the manipulation has to be rapid there is a danger of loss through spilling; further, the acid solution must not be left in contact with the copper deposit. The dish, therefore, must be washed at once, and the solution which is clinging to its sides, and which contains iron, is lost. In the case of the

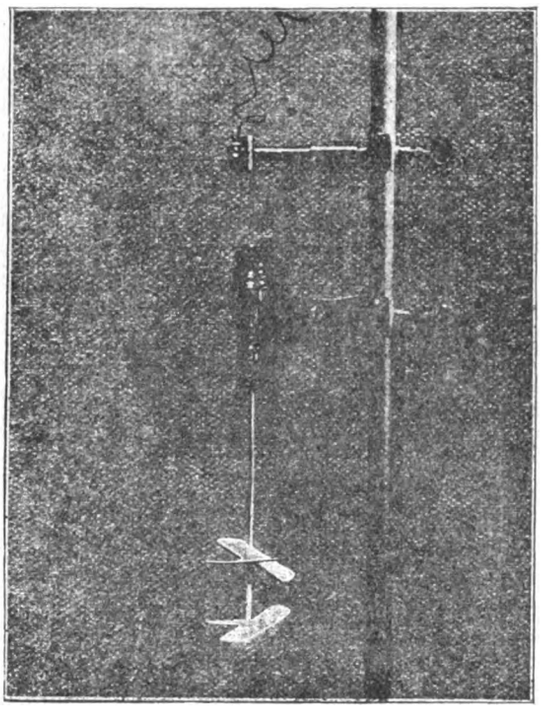

FIG. 3

flag electrode the cathode is rapidly raised out of the beaker and the solution at once washed off its sides while it is hanging over the top of the beaker by means of a wash bottle. The solution in the beaker can then be neutralised without being transferred to another vessel; multiplication of manipulation is thus avoided.

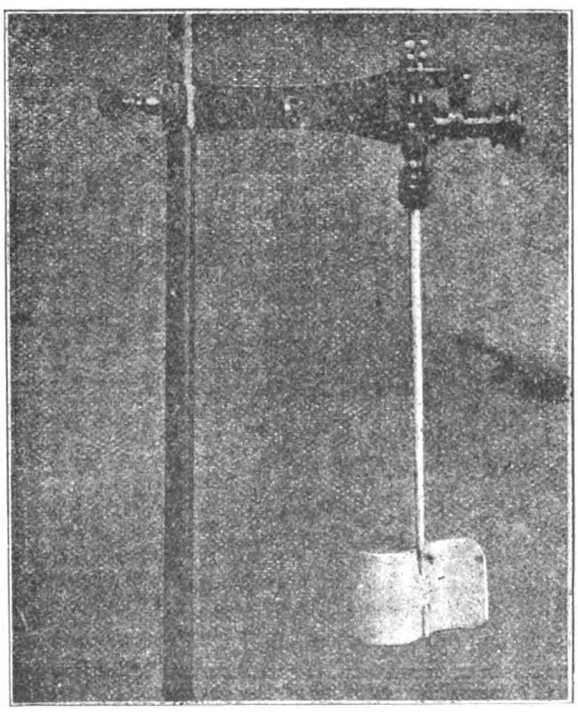

FIG. 4.

Apparatus for Rotating Electrodes.—It is often necessary in electrolysis to keep the electrolyte agitated. This is generally done by means of an agitator, entirely separated from the electrodes and rotated by means of a water turbine or motor. In many cases, however, much better results are obtained if one of the electrodes is itself caused to rotate. In most of the descriptions of rotating electrodes, there seems to have been considerable difficulty in obtaining good electrical contact, and the methods employed have often been rather complicated. Fig. 3 shows an arrangement which has been found to work extremely well. It consists of a supporting arm, made of gun-metal, the end of which is drilled to allow a spindle to pass. This spindle carries a small chuck (such as is used for fixing small drills on a lathe), which is used for fixing the rotator. The grooved pulley, which is fastened on to the upper end of the spindle, bears on the top of the arm, which is ground smooth. The whole arrangement is driven by means of a belt from a water turbine or electrical motor. This arrangement is found to give very perfect contact and to work with very little friction. The parts should only be slightly lubricated, the best lubricant being a mixture of graphite and vaseline. The water turbine, which has proved very useful, and has been working for a long time, has ball bearings—an unusual nicety—and was obtained from Messrs. Baird and Tatlock, Glasgow.

Fig. 4 shows another form of the rotator, which can be driven either from a horizontal or vertical pulley, and is also convenient for working several apparatus in series. The electrode shown in Fig. 3 is of iridio-platinum, and has been used with very satisfactory results in the electrical oxidation of organic substances. The electrode in Fig. 4 is of aluminium.

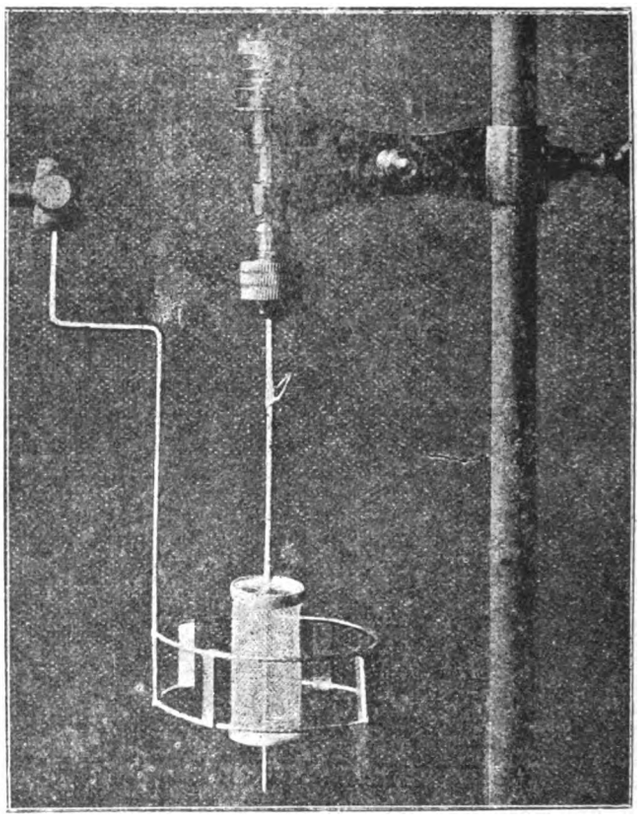

FIG. 5.

I have found the following method work very well for making rotating lead electrodes. Thin lead pipe, to which the vanes for mixing the liquid are burned, is drawn over a steel rod of the same diameter as the bore of the pipe. The steel rod protrudes about 1in. above the top of the pipe, in order that it may be fastened in the chuck. The pipe is burned at the bottom and the top to prevent the solution from running in between it and the steel core. If a central core such as this is not used, lead electrodes are not sufficiently rigid to use for rotating purposes.

Rotating Cathode for Analysis.—In Fig. 5 is shown a rotating cathode and a stationary anode for electrolytic depositions. It is found that the rate of deposition of a metal from its solutions is very much accelerated, and that a higher C.D. can be employed when the cathode is kept in rapid motion. The cathode is a small cylinder of platinum gauze, which has a combined surface of about 25cm.^{2} The anode, B, is in the form of a double circle of stout platinum wire, and has four little baffles placed at intervals round it, to prevent the liquid from rotating with the cathode. Of course, for peroxide deposits the rotating electrode would be the anode. A cylinder of sheet platinum also gives very good results, but in this case very little metal is deposited upon the inner surface. Longitudinal slits, however, partially get over this difficulty, but with gauze, as shown in the figure, the deposition is practically equal inside and outside.

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NOTES.

Books Received.—"Electrical Engineering" (Crosby Lockwood and Son), by Tyson Sewell, A.I.E.E., 7s. 6d.; "The Engineer in South Africa" (Archibald Constable and Co., Limited), by Stafford Ransome, M.I.C.E., 7s. 6d.; "The Art of Illumination" (McGraw Publishing Company), by Louis Bell, Ph.D., 10s. 6d.

German Electrical Industry.—There seems to have been a revival of the electrical manufacturing industry in Germany within the last six months or so. Official returns show a noticeable falling off in the importation of foreign electrical machinery into Germany, the figures for the five months ended May 31 last giving a total of only 322 tons, as contrasted with 634 tons in the corresponding period of last year. Also, there has been an increase in the exports of electrical machinery from Germany. The total for the first five months of the present year was 5,158 tons, while that for the same period of 1902 amounted to 4,899 tons.

Electricity as a Disinfector.—An Italian scientist claims to have established that electric tramways are great mediums in the disinfection of towns. He points out that the electric spark, which is so frequent an occurrence to the overhead trolley, and the emission of light from the car wheel when the rail is used for the return current, transform the oxygen of the air into ozone, which has a purifying and disinfecting influence. The high discharges, he says, are frequent enough to influence greatly the atmospheric constituents, especially where the line passes through narrow thoroughfares. They become antiseptic agents.

Long-Distance Tramways.—Last month there was put in operation for the first time in the States an electric tramway or street railway which has a length of 188 miles. It runs between Indianapolis and Columbus, the capitals of two contiguous States. Originally the line was worked in sections—that is to say, the through route has been obtained by completing the gaps in the chain of interurban lines between the two cities in the same way as the various electric tramway systems in Lancashire in this country are being joined up by the South Lancashire Tramways Company. A line is soon to be completed from Newark to Lanesville, which will carry the through route on another 100 miles or so to Wheeling.

Electrolytic Reduction of Unsaturated Acids.—When a solution of aconitic acid, to which half the quantity of sodium hydroxide necessary for complete neutralisation has been added, is electrolytically reduced, using a cathode of mercury and an anode of platinum, and an apparatus designed to prevent as far as possible oxidation at the anode, a yield of 60 per cent. of the theoretical quantity of tricarballylic acid be obtained. Such is the conclusion drawn by Mr. Ch. Maril from a series of experiments on the subject. The acids were separated by conversion into their copper salts, that of aconitic acid being soluble in dilute acetic acid. Cinnamic acid can by this method be converted quantitatively into phenylpropionic acid.

Smoke Helmets for Tube Railways.—One lesson of the recent disaster on the Paris Metropolitan Railway is to emphasise the importance of a special fire helmet for irrespirable atmospheres. It seems that a helmet of the kind has been designed, and the Paris Municipal Council have voted £120 for the manufacture and experimental use of a number of helmets in the principal stations. The helmet consists of a glazed circular headpiece surmounted by a small chamber containing an air pump, a vizor to protect the face, and with the air pump are connected two tubes—one for inspiration and the other for expiration, and merging in an indiarubber pipe connected with an air compressor near the spot to be explored. Three men are necessary, one to penetrate into the choke area, the other to hold a safety lamp, and the other to work the air compressor.

Brazil Rubber.—There is a good prospect that the yield of rubber in Brazil for the current year will be bigger than ever, despite the fears that have been entertained that the rubber supply is becoming exhausted. An American consular report from Para assures us that the greatest enthusiasm is being shown in the trade there. The rubber crop for the year 1902-3 closed very satisfactorily, the yield being 29,890 tons. Although this is a decrease of 108 tons on the previous year's produce, it should be remembered that the 1901-2 crop was the largest ever produced. "Never before," says the consul, "have so many men been employed in the business; thousands of labourers are pouring into the forests of the interior, and thousands more are expected to follow. New rubber fields will, it is said, be opened, and old ones worked with improved methods and larger forces." As an example of this, the consul adds that one of the largest producers on the Madeira informed him that he would take out this year four times as much rubber as ever before.

Indian Telegraph Department.—In the last two or three decades the expansion of the superior establishment of the Telegraph Department of India has been on a large scale. This is shown by the following figures. In 1877 there were 423 telegraph offices, and in 1900 this figure had increased to 5,420. In the same way the mileage of telegraph posts increased from 17,232 to 52,909, and that of telegraph wire from 39,113 to 170,776. This expansion has chiefly been in the divisions of the Punjab, Bengal, Bombay, Madras, Assam, and Eastern Bengal, and changes have necessarily had to be made from time to time to meet the growing requirements. Now, however, the Indian Government has taken in hand a scheme of reorganisation, by which five new divisions will be created. The proposals include an all-round increase of staff, and among the appointments will be two under the designation of deputy director of traffic and deputy director of construction. The salaries will be at the rate of Rs.1,600 a month, or, converted into English money, nearly £1,100 a year each.

Hertzian Waves.—It will be remembered that Prof. Fleming in his recent Cantor lectures on wireless telegraphy, emphasised the importance of research in the direction of finding some means of directing the Hertzian waves or of detecting the direction from which they are sent. Mr. R. Blochmann has put forward a possible solution of the problem in a paper before the German congress at Carlsbad. Instead of sending out the electric impulses from tall rods or antennæ, whence they burst out like explosions, or like stones flung into an electric pond and causing electric ripples, he suggests that the waves should be sent out through lenses. A lens of glass or of paraffin wax, or any other substitute of high dielectric constant, will serve the purpose, and that purpose will be the concentration and orientation of the waves in a certain direction. The effect of trains of waves which have thus been directed and concentrated is further enforced by making them traverse a lens at the receiving station similar to that at the sending station, the detector of the waves being placed at the focus of the receiving lens. Mr. Blochmann intends to pursue his researches into the possibilities of this method, which, of course, is as yet only in the experimental stage.

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Electrical Fire Rules.—About the present is the time when the various insurance companies are wont to issue revised lists of rules and regulations for electrical installations. This week we have received copies of those issued by the Royal Insurance Company and the Liverpool and London and Globe Insurance Company respectively, and it is with no uncertain pleasure that we find ourselves able to congratulate both companies on following the course laid out for all fire insurance offices by the Institution of Electrical Engineers. Thus, the Royal Insurance Company adopts the Institution rules *in toto*, with the addition of a few special conditions of its own coining; and the same may be said of the Liverpool and London and Globe list, embodying as it does the latest general rules issued by the Institution. We believe this is the first time that the rules drawn up by the Institution have been officially recognised and adopted by the insurance companies, and the course cannot be too highly commended as tending towards complete uniformity in the rules governing electrical installations all over the country. In addition to the general rules, each company attaches a "special risks supplement," which relates to the special conditions to be met with in warehouses, mills, central stations, car-sheds, factories, trolley wires, etc. These are identical in both cases, and the recommendations embodied therein must prove of the greatest value to those responsible for carrying out electrical installations on premises to which they apply.

Abyssinian Telegraphs.—The Emperor Menelik is ranking his country very closely with many European States in the provision of telegraphic and telephonic facilities. For some years both the telegraph and the telephone have been in operation between the towns of Harar and Addis Abeda, and recently the seat of the Government of Abyssinia has been connected by telegraph with Jibuti. An estimate places the total length of the telegraphs in the empire at 500 miles. Acoording to a statement made by the director of the telegraph line from Massowah to Addis Abeda, Eritrea and the capital of the country will shortly be in communication. This will increase the total length of the line in use to 1,060 miles. A telephone system now connects Asmara with Barromeida by way of Adowa, and Addis Abeda with Ankober. The Emperor has given permission to the Italians to construct the line from Massowah on condition that it passes by Ankober, where the political prisoners of Abyssinia are detained. Menelik more and more realises the necessity of being quickly informed of what is passing in all parts of his empire. He receives daily reports by telephone. The southern frontier is at present not included in the system, but Menelik has given orders that a telephone line 500 miles long shall be constructed by way of Kaffa. The necessary material has already arrived in the country. A telegraphic line from Wallaga, proceeding in a westerly direction parallel to the Blue Nile, is also contemplated. In a few years Abyssinia will have a complete telegraphic system.

New Theory for Auroras.—Mr. Charles Nordmann has presented a paper before the Academy of Sciences at Paris, in which he suggests that auroras may be due to Hertzian waves emitted by the sun. Experiment proves that, owing to the diffraction of the atmosphere, Hertzian waves, especially of great wave-length, "turn corners," or, in other words, pass around intervening obstacles. The waves of the space telegraph, for example, surmount the intervening convexity of the earth between two distant stations. It is not surprising, therefore, that auroras should be visible in the polar regions during winter, although the ordinary rays of the sun do not reach them. Mr. Nordmann, seeing that Hertzian waves have passed between Newfoundland and England, a distance of about 30deg. on a great circle of the earth, argues that at the equinox polar auroras should be most frequent within 30deg. from the pole, and that has been found the case. It would follow from the above that auroras would be most frequent in the early hours of the night and morning, but another factor comes in. It has been proved that the luminescence of a rarefied gas is brighter the more free ions exist in it. In a small tube the free ions disappear mainly by diffusion, but in the atmosphere by recombination of positive and negative ions. The upper atmosphere is, he thinks, ionised during the day by the violet and ultra-violet rays of the sun, but through the night toward morning there are fewer free ions in the atmosphere, and so the Hertzian waves of the sun do not readily excite luminescence in the atmosphere at that time. The number and intensity of auroras ought, therefore, to be greatest in the early hours of the evening and decrease toward morning.

Wireless Telegraphy in Japan.—Advances in the use of wireless telegraphy in Japan, and particularly in the Japanese navy, cannot, it seems, be laid directly to the credit of Mr. Marconi. That inventor's application for letters patent in Japan some time ago was refused, and the system now in use has been developed by a Japanese scientist. An American consular report from Kobe gives some interesting information with regard to the progress space telegraphy is making in the East. The Japanese warships equipped with wireless telegraph apparatus have sent and received messages to and from Japan at a distance of about 50 miles, and the system is to be further extended at an early date by the Japanese Navy Department. The necessary plant is now being erected for the establishment of communication by wireless telegraphy between Miesaki, in Nagasaki prefecture, and Sharyo Island, off Kelung, Formosa, a distance of about 850 miles. The installation was commenced in January last, and the expenditure on the enterprise is estimated at about £4,000. Mr. Saiki, an engineer in the department of communications, is in charge of operations at Miesaki, and the instruments are now well on the road to completion. The station at Sharyo was commenced in March last, and is in charge of Mr. Ichimura, an engineer in the same department. Experiments with wireless telegraphy, it seems, have been continuously made by the department of communications and by the navy since 1896. The experiments were first made with satisfactory results over a distance of 11 miles, and afterwards between the shore and ships in Tokyo Bay, a distance of over 20 miles. The system of wireless telegraphy employed in Japan is stated to differ materially from the Marconi system.

Electrolysis of Aqueous Solutions.—There is published in the current number of the Chemical Society's *Journal* an abstract of a paper by C. Frenzel, who states that when solutions of ammonia or of the hydroxides of the alkalies or alkaline earths are electrolysed with an unpolarisable cathode and a small anode, a gradually increasing E.M.F. being employed, the curves representing the connection between the current passing and the applied E.M.F. exhibit a change of direction corresponding with the discharge of hydroxyl ions; after this, the current increases with increasing E.M.F., it then remains constant or diminishes, and finally increases again. The E.M.F. at which the second increase begins, varies with the concentration of the hydroxyl ions in the solution; when the latter is divided by 10, the E.M.F. rises by 0·06 volt. The form of curve described above is only obtained when the anode is a platinum wire freshly heated to redness; when the same wire is used repeatedly, the successive curves become more and more continuous,

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finally exhibiting a steady rise of current with rising E.M.F. The change is much more marked in solutions of ammonia than it is in the other solutions. It is shown that the impurities in the salts used have no effect on the form of the curves, and also that the assumption of a transition resistance at the anode due to a layer of gas does not account for it. The assumption of some chemical change at the anode is therefore necessary. The most probable is the formation of ozone by interaction of discharged hydroxyl ions and molecular oxygen occluded by the electrode. This is capable of explaining the effect of heating the anode to redness, and also the dependence of the position of the change of direction on the concentration of the hydroxyl ions in the solution.

Electrical Schemes in South Africa.—Manufacturers of electrical machinery and appliances in this country should keep a watchful eye on what is doing in South Africa at the present time, especially on those parts which have only lately ranked among the dominions of the Empire. In the Transvaal one of the biggest electrical undertakings South Africa has yet seen is making favourable progress at Johannesburg, but it is only the forerunner of what is to come in the near future. In the past 12 months or so innumerable schemes for supplying electric light and power have been launched, and soon any town in British South Africa which is unable to boast the electric light will be looked upon as behind the times. To mention a few of the schemes that are now going forward, Mafeking—that gallant little town in Bechuanaland of historic memory—has adopted a proposal in favour of the electric light, but beyond the fact that it has been decided to generate by oil-engines, nothing has yet been definitely settled. Manufacturers may also be interested to hear that the Transvaal Tender Board are now calling for tenders for the electric lighting of Potchefstroom, which will be received up to Oct. 30. The specifications and other details will be furnished on application to the Assistant Colonial Secretary for Urban Affairs, Pretoria. As Potchefstroom is a fairly large and growing town, it is likely that the orders for plant will be very considerable. In Natal, the municipality of Harrismith are progressing with their electric lighting scheme as prepared by Messrs. Mordey and Dawbarn, who have been empowered to carry out the necessary work to completion. The tenders will be out shortly, and our readers may expect the orders to be of a fairly extensive character. We gather from the *British and South African Export Gazette* that these are but a few of the electrical schemes which are going forward in South Africa, and there is little doubt but that the field which is now opening to British manufacturers in that country offers vast opportunities, which every day are becoming more extensive.

Australian Patent Law.—Those of our readers who are concerned in Australian patents will be interested in the following information, which has been furnished us by Messrs. W. P. Thompson and Co., of Liverpool, with regard to the provisions of the Australian Federation Patent Bill, which was introduced into the Australian Senate and received its first reading in June. The subject of a single patent to cover the whole Australian Commonwealth has been one of lively interest ever since the Commonwealth became an accomplished fact. The Bill follows in general the British Act, while modifications are numerous and important. The principal provisions may be summed up as follows: patents to be granted for 14 years to cover the six States comprising the Commonwealth; examination as to novelty is to be made to a limited extent; actual working of the invention within the Commonwealth must be begun within five years, and must be continuous thereafter; patent attorneys must be registered; applications for patents may be filed by the inventor or his assignee, by representative of deceased inventor or assignee, or by a communicatee; additional patents are provided for at half fees; compulsory licenses are provided for; existing State or Colonial patents remain without change in their scope. An important and valuable feature is found in Article 57, according to which a patent is valid as to all good claims, notwithstanding it may contain one or more invalid claims. The working requirements cannot fail to appear to an Englishman to be a retrograde step, and it is to be hoped that those requirements will be eliminated. The cost of a patent under this new Bill to cover the six States comprising the Commonwealth will be about one-sixth the cost of taking out patents at the present time to cover the same area. There is, however, a fee of £8 payable before the actual issue of the patent, and a renewal fee of £5 before the expiration of the seventh year. If enacted this session of Parliament, the Act may take effect as early as next January, but it is more probable that it will not come into force earlier than January, 1905.

Wireless Telegraph Conference.—We briefly noted in last week's issue the main conclusion arrived at by the conference which recently considered the question of wireless telegraphy in Berlin, to the effect that it was advisable that all coast stations should be obliged to receive and to forward all telegrams from vessels at sea irrespective of the system employed. We are now able to give several of the other recommendations which were adopted in a general way, which, without binding the Governments represented, will serve as a basis for future discussion. In order to facilitate communication between vessels and coast stations, it is proposed that all technical explanations referring to the working of the apparatus shall be published. Telegrams referring to wrecks and attempts to render assistance to vessels at sea should be forwarded before all others. The rates for telegrams forwarded into the interior from a coast station will be those of the ordinary telegraph service plus a special charge for the use of the wireless apparatus, and will be paid for on receipt. Telegrams sent to a vessel will be paid for on board the vessel at the rates usually charged by the nation under whose flag the vessel sails. Stations are to be arranged so as to interfere with one another as little as possible, and arrangements will be made to ensure correspondence in a number of technical details. Provision is made for other states besides those which sent representatives to the preliminary conference to be parties to any arrangements which may finally be made for the regulation of wireless telegraphy. It will be remembered that the representatives of this country and Italy did not agree to the main conclusion. The reason for Italy's action in this matter is that the Government is bound by a 14 years' contract with the Marconi Company to employ no other system, and can only promise to suggest to the company that alterations should be made in the contract so as to bring it within the terms of the proposed convention. This country's representatives promised to lay the resolutions of the conference before their Government, but refused at the present time to be a party to an international agreement on the lines indicated.

α-Rays of Radium.—Henri Becquerel has published an account of some experiments conducted by him concerning the α-rays of radium. From an abstract in the current number of the *Journal* of the Chemical Society, it seems that a radium salt was placed in a lead tube, and this was closed by an aluminium plate to arrest the light emitted. Above this a screen was placed, and over it a photographic plate lying horizontally, the whole system

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being oriented parallel to a strong magnetic field. Provided the exposure is not too long, no appreciable impression is produced by the γ-rays. If in the middle of the exposure the direction of the magnetic field is reversed, an impression of two parallel tracks is produced on the plate. If the plate be placed at an angle instead of horizontally, the tracks are curved and meet at the point of contact of the plate and the screen. It might be that these curves were segments of circles in accordance with the ballistic theory. In this case it was to be expected that the relationship $R H = m v/e$ would hold good as it does for the β-rays, where R is the radius of the circular trajectory, H is the intensity of the magnetic field, m is the mass carrying charge e, and v is the velocity. The results obtained for R H when the distance of the plate from the screen is varied are not constant, but vary from $1{\cdot}9$ to $2{\cdot}9 \times 10^5$. This inconsistency may well be explained by variation of the mass, m. It is certain, however, that the curvature of the trajectory of the α-rays increases with the length of the trajectory, and the disturbance is no doubt due to the presence of the air. In a vacuum, R H would probably be constant. If we assume m to be a material mass positively charged, then on passing through the air it attracts the negative ions of the air and the charge, e, diminishes. If m be assumed to be merely an electromagnetic magnitude dependent on e and v, it may likewise be admitted that the charge, e, attracts the negative ions of the air and thus alters the trajectory. This suggested explanation is supported by the fact that the α-rays of radium are absorbed when they pass through air, and they become less and less penetrating as they pass through increasing thicknesses of aluminium.

Junior Institution of Engineers.—The summer meeting of this institution, which has recently taken place, was exceptionally well attended, a circumstance no doubt due to the particularly attractive character of the programme provided. The proceedings opened at the Town Hall, Sheffield, where the Lord Mayor welcomed the institution. The members then visited the works of Messrs. Davy Bros. at Attercliffe, where they had the opportunity of seeing in course of erection the most powerful armour-plate mill yet constructed. It is for the Imperial Japanese Government, and will be capable of rolling a 40 or 50 ton hard chrome steel ingot into a plate in about 15 minutes. The next visit was to Messrs. Hadfield's Steelfoundry Company's works at Tinsley. A most interesting afternoon was spent in the inspection of the splendid foundry, where steel castings for hydraulic, marine, and other machinery, track work, points and crossings, and mining machinery of all kinds were being turned out. The works of Messrs. Charles Cammell and Co. were also opened to the members, an armour-plate for H.M.S. "Hinduston" being specially rolled on their arrival. The various other processes incidental to armour-plate manufacture were shown. In the foundry marine, locomotive, dynamo, and other castings were in hand. The Toledo Steelworks of Messrs. John Henry Andrew and Co. were visited. Springs, wire, Siemens and Bessemer steel, and specialities in casting steel, rolling mills, mining tools, etc., afforded ample food for a morning's reflection, and in the afternoon the Master Cutler's works (Messrs. Thomas Turner and Co.) were seen. The series of visits was brought to a close by inspecting the works of Messrs. Mellowes, where the well-known "Eclipse" roof glazing is produced, and in the evening the institution summer dinner was held at the Royal Victoria Hotel, the chairman, Mr. Kenneth Gray, presiding. The Master Cutler, the Deputy Lord Mayor, representatives of the different works visited throughout the week, and other guests were present. Same capital speeches were heard in the course of the evening, and an illuminated vote of thanks was presented to Mr. King in recognition of his valuable service as honorary local secretary of the meeting.

Police Telephones.—If the police authorities in this country are still tardy in recognising the full value of the telephone as a means of rapid communication, their *confrères* on the other side of the Atlantic are by no means of the same temperament. In America they have not been slow to accept the great advantages which the telephone has to offer them in their responsible duties of keeping the peace. Thus we find that in practically every city in the States the police have the best telephone facilities at their disposal, but only in some comparatively few cases could the same be said of this country. Now the police authorities in New York are organising a complete independent street telephone system in the borough of Manhattan, which is very soon to be put in operation. An arrangement has been made with a company to carry out the scheme, and the company will maintain the system when completed at fixed rates. The present equipment consists of 660 telephones, which are to be placed in iron boxes, and as far as possible it is intended to place the boxes on the walls of buildings The boxes measure about 15in. by 18in., and will be painted a greyish colour. In each police station a switchboard will be installed, at which will terminate the lines from all the telephones in that particular precinct. The system is to be entirely independent of the existing telephone plant operated by the department, and at first only the police will be put in possession of keys to the various telephone boxes in the streets. The proposition, however, of entrusting keys to drug store proprietors and other responsible parties who could be reached at odd hours is under consideration. The advantages of such a system are obvious. The policemen on duty will be able to quickly get assistance from the stations, and a record of their movements will necessarily be kept, as the men will be required to report at regular intervals during their patrol to their particular station. It is intended later to devise a means of communication from the station house to the men on duty, and ultimately other parts of New York will be similarly equipped. For the information of the police authorities in this country we may say that the annual rental for the 660 telephones to be installed in Manhattan will be £4,171, a really small outlay in comparison with the valuable facilities gained.

New York Subway Cars.—Illustrations are given in the *Street Railway Journal* showing the principal features of the electric cars which are being constructed for service in the new subway in New York. From a view of the interior of one of these cars one concludes that they are very similar in design to those on the Central London Railway, but in construction there are several valuable features noticeable which represent an advance on the older type of car The length over platforms of the new cars is about 50ft., and over car body 42ft. 7in., with a width of between 8ft. and 9ft. The chief point about the construction of the car bodies is the means adopted for protection against fire. For example, the floors are double, with asbestos roll felt sandwiched between, and the floor sheathing is of white pine, completely covered on the underside with $\frac{1}{4}$in. asbestos transite board. Also, all parts of the car framing, flooring, and sheathing are covered with fireproof compound. These precautions to secure safety from fire extend to the arrangement and installation of the electrical apparatus and electrical wiring For the lighting circuits a flexible steel conduit is used, and a special junction box has been designed. On the side and upper roofs over these con-

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duits for the lighting circuits a strip of sheet iron is securely nailed to the roof boards before the canvas is applied. The entire under portion of the car flooring is covered with electrobestos, and the wires are carried in ducts moulded into suitable forms made from the same material. The pump box under the car is lined with steel. Special precautions have been taken with the installation of the wires, the specifications calling for—first, a layer of paper, next, a layer of rubber, then a layer of cotton saturated with a weatherproof compound, and outside of this a layer of asbestos. The hangers supporting the rheostats under the car body are insulated with wooden blocks, which are subjected to a special process, being dried out in an oven and then soaked in an insulating compound and covered with ¼in. transite board. The rheostat boxes themselves are also insulated from the angle iron supporting them. Where the wires pass through the flooring they are hermetically sealed, to prevent the admission of dust and dirt. In many of these particulars the new cars show a valuable advance on previous practice, and with so many precautions against the dangers of fire the chances of a disaster such as recently occurred in Paris may be regarded as practically nil.

Electric Lighting of Paris.—Now that the public excitement in connection with the recent disaster on the Paris underground railway has more or less subsided, the energetic Parisian has found time to once again turn his attention to a subject which at least is as important as the question of possible reforms in the working and management of the Metropolitan Railway. The lighting of Paris is a problem of which the Municipal Council may well fight shy, for it is beset with difficulties and complications which have more than once been alluded to in this journal. True, the final question will not require to be definitely decided for some two or three years, but the important question as to whether the municipality will take the responsibility for the lighting of the city streets on its own shoulders when the private concessions fall in, is one which calls for early consideration. It is common knowledge that in the French capital the electric light companies, as well as those supplying electric power only, have no monopoly, and almost without exception the concessions expire between 1907 and 1910. There are two courses open to the municipality—either to renew the contracts, or to combine the several undertakings and place them under municipal control. In the city itself there is a strong feeling that the latter course should be adopted, but the Prefect of the Seine, who, to a certain degree, has a right of veto, is said to be examining other proposals. The question assumes greater importance in the light of the fact that during the last few years the electric light has been making steady progress in Paris. The correspondent of the *Financial Times* in that city sends his paper some information with regard to this progress, in the course of which he says that there are six companies in existence, as well as a municipal plant for supplying the central markets, and in 1897 these seven installations furnished current for 11,800 arc lamps and 416,000 incandescent lamps. On Jan. 1 last the number had increased to 17,830 arc lamps and 1,250,700 incandescent lamps, irrespective of those in the railway stations and private factories. Of the 17,830 arc lamps, only 1,910 are used for street-lighting and municipal buildings, together with 6,470 of the 1,250,700 incandescent lamps. There is little doubt that the increase is likely to continue on a progressive scale, but a difficulty in the way lies in the fact that owners of flats have to run to considerable expense when they wish to have the electric light in a house not connected with the mains.

Electrical Progress in Russia.—It is only within the last few years that Russia has shown any great desire to advance in matters electrical, but one notable feature of the progress which has been made is the extensive use of electricity for motive power in factories and works. A consular report from Odessa throws an interesting light on what has been done in this direction and what is going forward at the present time. Thus we find it stated that the use of electricity for the distribution of motive power is spreading, and to-day practically all the machine works of Russia have adopted this method. Enormous central stations have been erected at places where such factories exist, but up to the present electricity has scarcely been used at all for the transmission of energy over great distances. Mention is again made of projects which are under way to utilise the waterfalls of Marva and Imatra for this purpose. In reviewing the position of the electrical industry in Russia some 12 months ago we referred to these schemes, but it does not seem that much progress has been made since. However, the Government has granted a concession to a company to supply power to St. Petersburg from the Volhoy rapids, and the scheme is estimated to involve a cost of nearly three millions sterling. It is proposed to transmit energy over a distance of 188 miles. Another scheme is to use the colossal force of the Dnieper cataracts for the generation and transmission of electrical energy. Electrotechnical appliances will have a great future in Russia, and the home factories are unable to supply the demand. There are many Russian factories, however, which produce cables and insulated conductors at St. Petersburg and Moscow. Chief among these is the Siemens and the Riben establishments, both of which produce cables which compare favourably with the foreign articles. Accumulators are also manufactured in various towns in Russia. There are a number of large establish ments in St. Petersburg which produce accumulators of original design, or after the best known foreign models, such as the Julien, the Tudor, and other types, and the importation is small. Such appliances as circuit breakers, commutators, and rheostats, as well as fittings for lamps, are also manufactured in Russia, but not nearly enough to supply the demand. Measuring and counting instruments are scarcely manufactured at all in Russia, although the demand for them is enormous, especially of late, since central stations have been constructed in a number of towns. These instruments are imported from France and Germany. The manufacture of porcelain insulators and of porcelain appurtenances in general is so largely developed in Russia as to completely satisfy the home demand, and no insulators are imported. Incandescent lamps are not manufactured in Russia at present, owing to the strong foreign competition. Most of the arc lamps also are imported, principally from Germany. One branch of the electrotechnical industry is fully supplied by the home manufacturers, and that is the signalling and telegraphic apparatus in use on the railways, to indicate whether the line is open or closed. As regards telegraphic appliances proper, some are manufactured in Russia and some come from abroad, chiefly from Sweden and Germany. It will thus be seen that the demand for electrotechnical apparatus and machines in Russia is relatively but little satisfied by the home manufacturers, and the progress in the application of electricity for transportation, manufacturing, and domestic economy will undoubtedly enormously increase the market for foreign appliances. The above information will, no doubt, prove of considerable value to manufacturers of electrical apparatus in this country, and should serve as a useful guide to the demands of Russia in their business relation with that country.

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NOTES ON THE THEORY AND WORKING OF ROTARY CONVERTERS.

BY W. ROGERS.

In the following short article the writer has attempted to bring together a few notes on the rotary converter, a machine which has done much towards making it possible to combine the advantages of alternating-current transmission and continuous-current working. The rotary converter may be used for converting alternating currents of one, two, or three phases into continuous currents, or *vice versâ*. Its armature has but one set of windings, connected to a commutator at one end, and at the other end tappings from the windings are taken to two, three, or four slip-rings, according to the nature of the alternating current. This one set of windings receives the incoming primary current, at the same time generating the secondary current. Converters in a simple form have been known for some years. One of the earliest types took the form of a two-pole Gramme machine, the armature windings being connected up at one end to an ordinary commutator, and at the other end to two slip-rings, these rings being connected to two points on the winding at opposite ends of a diameter, the machine acting as a single-phase converter. If there had been three slip-rings connected to three symmetrical points on the winding, the machine would have acted as a three-phase converter. Fig. 1 is a table showing the relation between the number of slip-rings, the nature of the alternating current to be put in or taken out of the converter, the angles between the points on the windings which are connected to the slip-rings, and the voltage ratio.

No. of rings.	Angle between connections to slip-rings.	Nature of current.	Voltage ratio.
2	180deg.	Single-phase.	$\frac{1}{\sqrt{2}}$
4	90deg.	Two-phase.	$\frac{1}{\sqrt{2}}$
3	120deg.	Three-phase.	$\frac{1}{2}\frac{\sqrt{3}}{\sqrt{2}}$

FIG. 1.

We will now consider the relation between the currents and voltages on the continuous and alternating current sides respectively. The actual effective voltage of the alternating side of a converter, supplied on the continuous-current side at a constant pressure of 100 volts, equals $\frac{100}{\sqrt{2}} = 70{\cdot}7 = {\cdot}707$ times the continuous-current E.M.F., this being the case with a single-phase converter.

The voltage on the alternating side with a three-phase converter = continuous E.M.F. × ·707 sin 60deg. $= \frac{{\cdot}707 \times \sqrt{3}}{2}$

i.e., single-phase voltage $= \frac{\text{V (cont.)}}{\sqrt{2}}$,

and three-phase voltage $= \frac{\text{V (cont.)}}{\sqrt{2}} \times \frac{\sqrt{3}}{2}$

Nature of current.	Volts.		Amperes		Amperes in line	
	Max.	Eff.	Arm.	Rings.	Max.	Eff.
Continuous	100	100	50	50	100	100
Mono-phase	100	70·7	100	70·7	200	141·4
Two-phase	100	70·7	70·7	50	100	70·7
Three-phase	86·6	61·23	77	54·5	133	94·3

FIG. 2.

Fig. 2 is a table showing the respective values of the maximum and effective voltages, also the relative values of the currents in the armature and line during the conversion of a continuous current into an alternating current of one, two, or three phases. The currents in this table are obtained when the circuit is non-inductive. In the case of an inductive circuit there will be a phase difference in the currents, consequently there will be wattless as well as working currents, and for an equal output of power, the values in columns 4 to 7 in the table must be increased by dividing them by the cosine of the angle of lag. If the continuous current supplied = 100 amperes, the effective value of the alternating current $= \frac{100 \times 100}{70{\cdot}7} = 141{\cdot}4$ amperes, if the current follows a sine curve. If the effective value of the current = 141·4 amperes, its maximum value = $141 \times \sqrt{2} = 200$.

Although, as already stated, it is possible to obtain converters for single, two, or three phase currents, as the two former types are not often met with, it will only be necessary to pass a few remarks on them. In the case of the single-phase converter, it has several disadvantages when compared with the two or three phase type—firstly, it has considerable variations of armature reaction, which is a most important point in the running of converters; secondly, a greater and more unequal heating; thirdly, it is not self-starting from the alternating-current side; and fourthly, it causes a periodic fluctuation in continuous current. In the two-phase converter the heating is more equally distributed through the armature, and there is not so great a tendency to cause fluctuations in the continuous current; also it has a great advantage over the single-phase converter in being self-starting. On account of these distinct advantages it is more often met with in power transmission schemes than the single-phase type, but both types are a long way behind the three-phase type, which we shall now consider at some length, although some of the following remarks apply to all three types of converter.

There are three different E.M.F.'s to be taken into account in a converter: (1) the impressed E.M.F. on the slip-rings; (2) the counter E.M.F. induced in the converter by the armature revolving in the magnetic field, which is proportional to the field excitation; (3) the E.M.F. consumed by impedance, representing the lost volts due to the reactance and resistance of the armature. The impressed E.M.F. depends upon the voltage at the terminals of the generator. The counter E.M.F. depends upon the field excitation, and is constant at all loads. The E.M.F. of impedance is proportional to the current, and varies with the load. Work done by a converter is equal to the product of the current taken by it, and the projection of the counter E.M.F. on this current. At no load this current is at right angles to the counter E.M.F.

The input of a converter equals the product of the impressed E.M.F. and the projection of the current on it, and if we assume no energy is consumed the current is in quadrature with the impressed E.M.F. Now, at any moment we have three separate E.M.F.'s in the system, their sum being always zero; also at any instant we have impressed E.M.F. = counter E.M.F. + E.M.F. of reactance. As the counter E.M.F. is less than the impressed E.M.F. when the converter is under-excited, the E.M.F. of reactance must be in phase with it, and since the current is always 90deg. ahead of the E.M.F. of self-induction, it must be 90deg. behind the impressed E.M.F., and consequently be lagging. Should the field excitation be increased, so that the counter E.M.F. is higher than the impressed E.M.F., the E.M.F. of reactance must be in phase with the impressed voltage. In this case the current becomes a leading current.

As regards the excitation of "converters," they may be either shunt or compound wound. The shunt type is chiefly used for lighting work. It does not admit of phase control, but maintains a constant wattless current at all loads, with constant adjustment of the field. Its power factor is the same for all loads, but changes with various loads when there is any variation in the reactance of the supply circuit. As the pressure on the continuous-current side falls with the load owing to the C R loss, it is necessary to use converters having compound excitation when running on widely varying loads, such as are met with in tramway practice. With this type of converter the pressure on the continuous-current side may be maintained constant, or made to increase with load, as with an over-compounded continuous-current machine. The compound field is so proportioned that at no load it is under-excited. When this is the case the E.M.F. of the converter is less than the impressed E.M.F., and the current in the line is made lagging. This increases the E.M.F. of self-induction, cutting down the voltage of the system. Excitation increases

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with the load, and the counter E.M.F. is also increased, thus bringing the impressed E.M.F. and current into phase. This is followed by a rise in the voltage at the receiving end and also on the continuous-current side. At full load the counter E.M.F. is greater than the impressed E.M.F., consequently the current leads and the voltage reaches a maximum. From this is derived the fact that a leading current raises while a lagging current lowers the pressure at the terminals of a converter. The power factor of a compound-wound converter, excited for a factor of unity at full load, is not so good when running light. To obtain 10 per cent. over-compounding, the fields must be excited to give a factor of unity at about three-quarter load. The current for compounding in a converter must lag on light

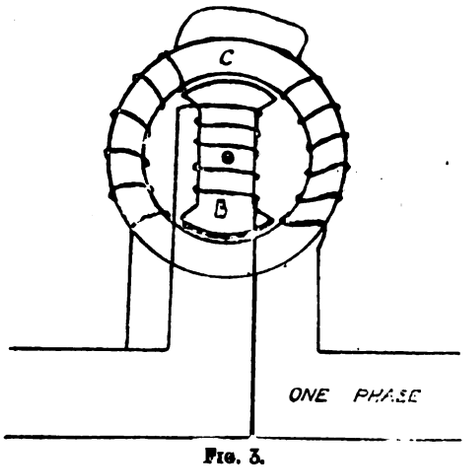

Fig. 3.

loads and lead on heavy loads. This requires a large amount of reactance, and it will, therefore, be seen that self-induction, which is supposed to be the bugbear of alternate-current working, owing to the drop in volts it causes in the system, is absolutely necessary for the satisfactory running of converters, as it raises the pressure with increase of load. A converter may be made to take a leading or lagging current by altering its excitation, and therefore its counter E.M.F. By altering the shunt field and putting choking coils in the alternating supply circuit, the machine may be made to take a lagging current on light load. As the load increases, the compound winding increases the excitation, and this diminishes the lag of the current, thus increasing the pressure on the slip-rings, which is followed by a rise in pressure on the continuous-current side. When full load is reached, the alternating current is leading, and the continuous-current pressure will have increased in proportion to the increased pressure on the slip-rings.

Although the rotary converter possesses similar characteristics to those of the synchronous motor and the continuous-current generator, these facts do not tend to simplify the complications met with in its working. As the pressure between the slip-rings is always a definite percentage of the pressure on the continuous-current side, being about 61 per cent., it is necessary to insert step-down transformers between the slip-rings and the high-pressure bus bars. Whatever the voltage of transmission may be, it is transformed down to about 330 volts by means of three separate transformers having a mesh connection on both high and low tension sides. The advantage of this mesh connection is that in the event of one of the transformers developing a fault and blowing its fuse, the other two will continue to supply three-phase currents to the converter, which will enable it to be kept loaded (although under its full power) until the faulty transformer has been replaced. As the two transformers will be overloaded during the period of emergency, the increase of heating must be carefully watched. Owing to the fact that the ratio of the continuous-current E.M.F. to the alternating impressed E.M.F. is constant, there is a difficulty in regulating the continuous-current side of a converter. As the pressure on either side is independent of the field strength, regulation cannot be effected by varying the excitation. There are several ways of varying the continuous-current E.M.F., but they all work on the same principle—namely, that of altering the pressure applied to the slip-rings. When the load is fairly steady a shunt-wound converter is used, and hand regulation is resorted to, but in the case of a varying load hand regulation is not effective, and must give way to automatic regulation. There are several ways in which hand regulation may be effected: (1) By inserting a choking coil in each phase, which method has the disadvantage of lowering the power factor of the supply. (2) Altering the ratio of transformation of the transformers supplying the converter, by means of a special switch. This method is expensive, inasmuch as it requires a special winding of the transformers.

Another method is that due to the Allgemeine Company, and consists of a small alternator mounted on the converter shaft, its armature windings being connected in series with those of the converter. The small alternator acts as a booster, and may be made to add or subtract volts to or from the supply mains by adjusting and reversing its excitation. This method is also expensive, and is only used when heavy currents are dealt with.

The best method of hand regulation, and that most commonly used, employs a small boosting transformer, known as an induction regulator, in each phase. Fig. 3 shows one form of this apparatus, which consists of a stationary iron core, C, connected in series with one phase. Inside this is placed a moving core, B, carrying a primary winding connected across one phase of the supply mains; this core is capable of being turned through 180deg. The secondary voltage is at its maximum when the core is in a vertical position, and falls gradually as the core is turned round, finally becoming zero when the core is horizontal. When the core is in this position, the fields due to the two windings neutralise one another. If the core is still turned further round, the secondary voltage rises again in the opposite direction, consequently the regulator may be made to add or subtract volts In the case of a three-phase converter, one of these regulators is required in each phase, the handles of each being interlocked, so that the voltage may be equally adjusted in each phase at the same time. On account of difficulties connected with

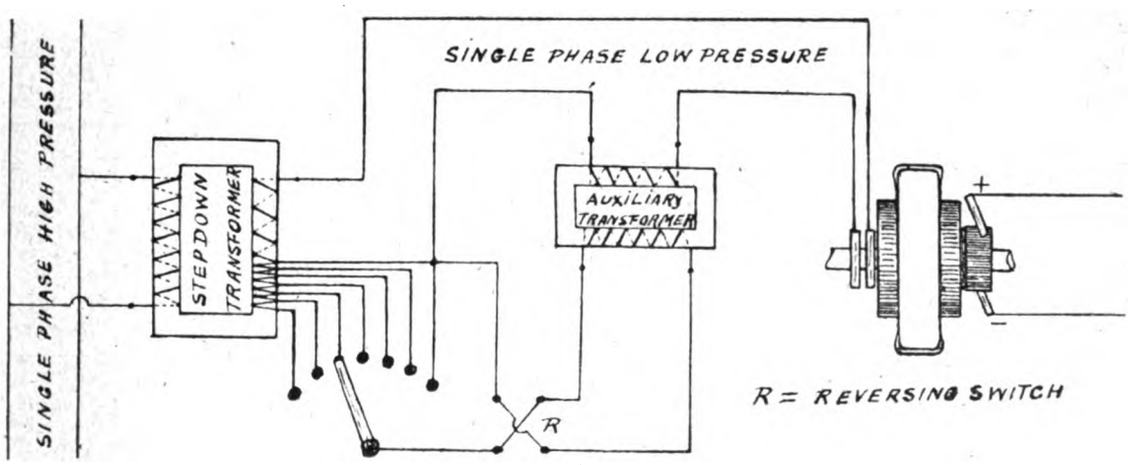

Fig. 4.

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insulation, inductor regulators are always connected in the secondary circuits of the step-down transformers. Such an apparatus is inexpensive, and is very effective, giving a range of about 5 per cent. both ways, at the same time being unlikely to get out of order, having no contacts. A more efficient form of regulator, due to Mr. M. B. Field, is shown in Fig. 4. The secondary of each transformer carries a few extra turns, which are connected through a small regulating switch to the windings of a small auxiliary transformer whose secondary winding is in series with the low-tension circuit, adding or subtracting a small voltage to this circuit as desired. We shall now consider a method of automatic regulation which is used in connection with the compound-wound converter. It consists of introducing a certain amount of self-induction between the secondaries of the step-down transformers and the slip-rings by means of choking coils. The action depends on the fact that the excitation controls the phase relation existing between the alternating current flowing into the converter and the voltage at its terminals. We have already seen that the excitation necessary for a power factor of unity varies with the load, the current being in phase with the voltage. Should the excitation be too small to give a power factor of unity at any particular load, the supply current lags behind the voltage; if the excitation is too great the current leads the volts, and the power factor is again less than unity. The effect of this is to cause the voltage across any self-induction in the circuit to vary in phase with the voltage of the supply, which in turn varies the voltage supplied to the slip-rings.

Comparing the methods explained above for regulating the pressure on the continuous-current side, it will be seen that in the case of the shunt-wound converter running on a lighting circuit very good regulation can be obtained by employing induction regulators worked by hand in accordance with the varying load. For traction work the employment of the compound converter in which regulation is effected by means of lagging and leading currents, is to be preferred on account of the wide variations of the load. As the running of converters presents some difficulty, owing to the special character of the machines and regulating devices, it might be well to say a few words on their starting. A converter may be started up by applying an alternating current to the slip-rings or a continuous current to the commutator. When it is started up on the alternating side, it must first be run up to speed in the same way as a synchronous motor-generator. In some cases a small induction motor is coupled to the converter shaft, the high pressure being simply switched on to it when starting up. They are also sometimes started up by synchronous motors. A converter may be started on the continuous-current side in the same way as a shunt motor. The fields should be fully excited, and a resistance placed in the armature circuit at starting. When the machine is running at full speed it is synchronised with the alternating supply; then the field switch supplying the excitation for starting is opened, and the switch supplying its own field closed. In starting up from the alternating side there is some difficulty in finding out the polarity on the continuous-current side. This is because the converter depends for its excitation upon the polarity that its commutator has at the moment it is synchronised. If the station plant includes two or more converters, and the first machine comes up with a wrong polarity, it may be allowed to run until the second one is synchronised. The second machine can then be given any desired polarity by using the first machine as a source of continuous current. Then from the second one the polarity of the first machine may be reversed, the second machine being then shut down. When the machines have heavy armatures, it is best to control the polarity of the first machine when it is started from the alternating side. As the machine approaches synchronism, the needle of the continuous-current voltmeter will vibrate rapidly about the zero mark with a short swing. These will be followed by a few slow long swings in opposite directions from the zero mark. Near the maximum point of whichever of these swings is in the direction of the desired polarity, the field switch should be closed, when the machine should excite itself, if the terminals have the correct polarity. If the field is put on when the needle is on the wrong side of the scale, the polarity of the converter is reversed, which means that it must be synchronised again. To ensure the machine being synchronised at the right pole it is well to have an indicator on each continuous-current panel, so that the polarity may be checked before the machine is connected to the continuous-current 'bus bars. These remarks only apply to a self-exciting converter. If the machine is excited off the 'bus bars, which is seldom the case, it will pull itself round to the correct polarity if it has been synchronised at the wrong pole. When a converter is driven from the continuous-current side it runs as a shunt motor, consequently its speed depends on the field strength and also upon armature reaction. When a lagging current flows from the alternating side the armature reaction reduces the field strength, consequently the speed rises. As this armature reaction is always considerable when the converter delivers an alternating current, the armature is liable to wide variations of speed as the load varies, and may easily reach an excessive speed unless special means are taken to prevent it. With the Westinghouse type of converter for delivering an alternating current is provided a small exciter having an unsaturated field, so that any slight increase in its speed causes a marked increase in the voltage it generates. Should the speed of the converter increase, its field is greatly strengthened, thus preventing any further rise in the speed. When a converter is supplied with power on the alternating side, it runs as a synchronous motor, keeping step with the main alternators. Any change in speed of the latter will similarly affect the converter. Sometimes these variations in the supply circuit are so rapid that the converter cannot follow them, and the result is a pulsation in speed known as "hunting" is set up. This has the effect of causing a fluctuation in the pressure on both sides of the converter, making it impossible to obtain constant pressure on the continuous-current side, at the same time causing sparking and flashing over on the commutator, besides throwing the converter out of synchronism if steps are not taken to check the "hunting." There are several conditions of working which tend to cause "hunting," and they may be briefly enumerated as follows: (1) a difference in the E.M.F. waves of the generators and converters; (2) employing machines having a strong armature reaction and working with under-excited fields, or machines having a high momentum; (3) employing engines having an unequal turning moment. In checking this tendency to "hunt," some means must be devised for damping the oscillations or speed variations set up in the armatures through the above-mentioned causes. This may be brought about by (1) working with over-excited fields; (2) lessening the amount of distortion of the fields by means of damping coils. As used in Westinghouse converters, the damping coils consist of copper strips bridging the poles from horn to horn. Eddy currents are induced in these strips (by the action of the leading and lagging armature currents), and these have the effect of preventing the distortion of the main field. At the same time they tend to steady the speed of the generating machines.

A very important question in connection with converters is that of parallel running. Although their tendency to "hunt" has something to do with this question, there are other points which must be considered. Although parallel running of these machines is possible, it will be readily understood that the best results are obtained when they are running on independent circuits. Converters may be run in parallel on the continuous or alternating current sides, but when they are required to be operated in parallel on both sides they must be provided with a separate group of step-down transformers for each machine, the low-tension leads being kept quite separate. This is to prevent what are known as parasitical currents being exchanged between the two machines, as a result of a difference in the wave-forms of their counter E.M.F.'s, and which would be the cause of one machine giving a larger current from its positive brush than that going in at its negative brush, and *vice versâ* in the case of the other machine. In practice the necessity for using another group of three transformers is done away with by winding each unit forming the group of three step-down transformers

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with an additional secondary winding. The connections are similar to those on the alternating side of the diagram shown in Fig. 5, which represents the arrangement of connections for the parallel running of two converters on the alternating side, the continuous-current sides supplying current to a three-wire network. Under these circumstances it is impossible to run a number of converters in parallel on the alternating side, because the slip-rings cannot be paralleled, as the connection already exists on the continuous-current sides. We shall now consider the question of the frequency at which it is

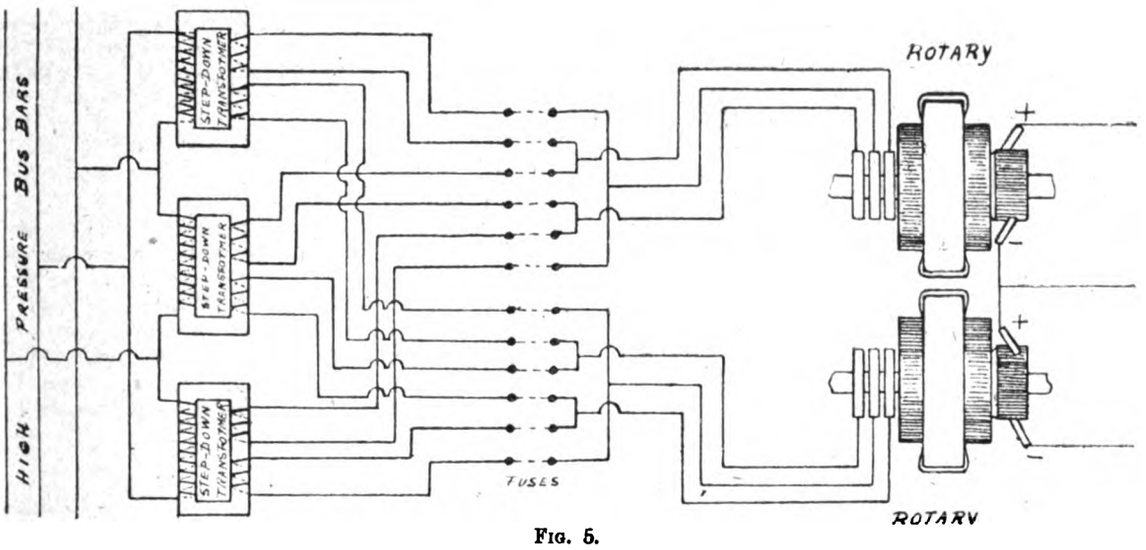

FIG. 5.

desirable to run converters. The limit of successful operation is about 40 cycles. With a higher frequency good parallel running becomes impossible, as the machines have a great tendency towards "hunting." Parallel running is always more satisfactory when the machines are operated at a low frequency, because the phase difference between the E.M.F. waves of the machines is not so large, also a high frequency requires a large number of poles on the converter. For the reasons mentioned above a frequency of 25 cycles has been fixed as a standard for converters, but they are generally operated at about 30 to 35 cycles when the whole output of the station is not absorbed by converters, as such a low frequency as 25 cycles is undesirable for the working of motors and transformers, lighting work being quite out of the question. There are a few special points in converters which should not be overlooked. As the motor and generator currents overlap in

and V a voltmeter on the continuous-current side. Another ammeter not shown in the figure must be put in the field circuit, so that the exciting watts may be found. A^1 is an ammeter and V^1 a voltmeter on the alternating side. R is an adjustable resistance, and Q a three-phase rheostat used as a load. W^1 and W^2 are wattmeters, and S a three-pole switch. Readings of the instruments are taken for several different values of speed and load, the efficiency being calculated in the following manner:

Total watts put in $= A\,V + C^2\,r$, where $C^2\,r$ = exciting watts.

Total watts given out $= W^1 + W^2$.

$\therefore$ Watts lost in converter $= (A\,V + C^2\,r) - (W^1 + W^2)$.

$\therefore$ Efficiency of converter $= \dfrac{W^1 + W^2}{A\,V + C^2\,r} \times 100$.

The ratio of conversion $= \dfrac{V^1}{V} \times 100$.

In this test the machine is run as an inverted rotary—*i.e.*, it is converting from continuous to alternating current. From the results of the test an efficiency curve may be plotted having values of $(W^1 + W^2)$ as abscissæ and the corresponding values of efficiencies as ordinates.

In conclusion, it might be well to consider the advantages and disadvantages of the rotary converter as a transformer for alternating and continuous currents. Among its advantages may be mentioned: (1) a large overload capacity; (2) high

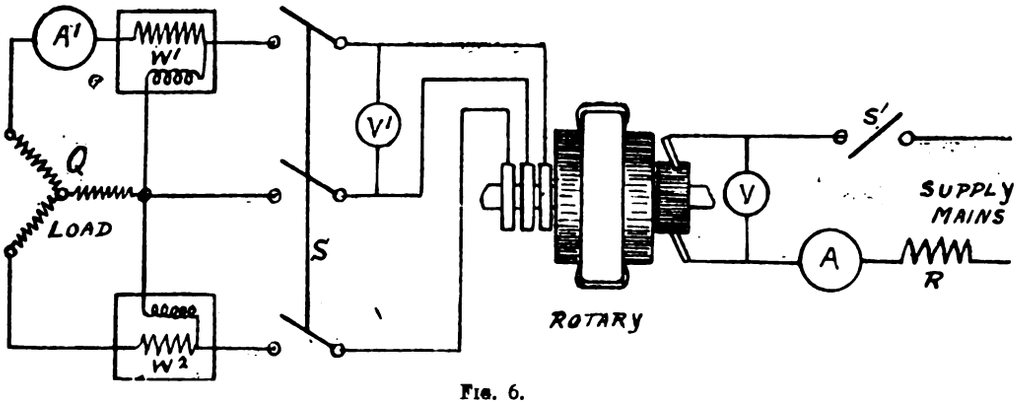

FIG. 6.

the armature conductors, the latter may be of small section for a given output. In consequence of the armature reaction being neutralised, it is possible to use a large number of conductors on the armature; for the same reason it is unnecessary to shift the brushes during variations of load. The efficiency of a converter is practically the same as that of a continuous-current machine of similar type and capacity, and depends to some extent on the frequency of the supply alternating current. In large machines it varies from about 90 per cent. half load to about 94 per cent. full load. An example of an efficiency test of a converter might be of interest, Fig. 6 being a diagram of the connections necessary for such a test. A is an ammeter

efficiency; (3) relatively low cost and high power factor. In comparing the cost of rotary converters with other forms of transforming machinery, it must not be forgotten that step-down transformers must be provided, which increase the cost and lower the efficiency of transformation. The disadvantages of the converter are: (1) sensitiveness in parallel running; (2) necessity of using complicated regulating apparatus and switchgear; (3) requires skilled attendance; (4) to obtain satisfactory working it must be operated by currents of low frequency, which are undesirable for use in other forms of transforming apparatus, so far as economy in copper is concerned. Notwithstanding these disadvantages, the rotary converter will continue to

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play a very important part in the working of the large power schemes which are springing up all over the country in connection with electric traction and the supply of electrical energy in bulk.

SOME NOTES ON THE DESIGN OF MAGNET SYSTEMS FOR CONTINUOUS-CURRENT MACHINES.

BY T. SQUARE.

Before we can begin designing the magnet system for a continuous-current dynamo or motor we must first decide upon the number of poles which we propose to use, the effective polar embrace, and the maximum flux which will be required per pole. These questions are almost entirely dependent on the design of the armature, so we will only dwell shortly upon them here. The best *number of poles* is determined mostly from three considerations:

1. *Good Commutation.*—In order to satisfy this, or, rather, to get the best result possible, the number of turns per armature coil should be kept as low as possible, preferably one. This means where the number of turns per coil exceeds this figure the number of poles should be reduced. Of course, if the commutation constants are already sufficiently good, we need not give so much weight to this consideration.

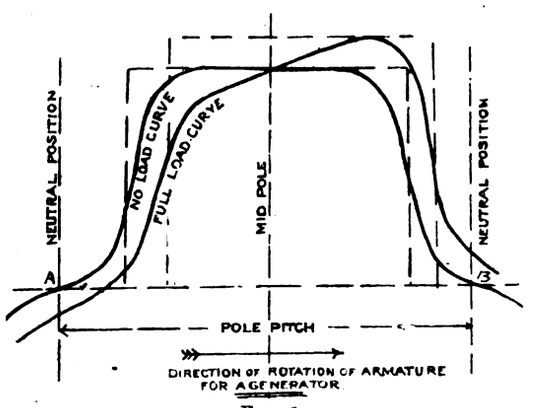

FIG. 1

2. *Cost.*—The cost price of a machine may be roughly divided into two parts—cost of materials and wages. In large machines the former is by far the greater proportion of the total; in small machines the reverse is the case. Now, a large number of poles increases the work required to construct the machine and hence the wages, and decreases the cost of materials. A small number of poles works in exactly the opposite way, hence we should use a large number of poles on a large machine and *vice versâ*. The best number from this point of view can only be found by working out a number of cases and seeing how the cost varies.

3. *Weight.*—For some purposes weight is of great importance. To get a light weight we must obviously go for a large number of poles, thus reducing the weight of both armature and magnet system.

In order to determine the *effective polar embrace*, we must plot the flux densities in the air-gap at various points along the pole-pitch when running at no load and full load, and we shall probably get curves something like those shown in Fig. 1. These curves can be obtained experimentally from similar machines already made, by measuring the volts between each two adjacent commutator bars all along a pole-pitch by means of two exploring brushes fixed just one commutator bar pitch apart. This voltage can best be read by balancing it against a potentiometer; in this case no current flows through the exploring brushes, so there is no voltage drop due to chattering and sparking, and very steady readings can be obtained. These voltages should be expressed as flux densities and the results plotted. The distortion of the full-load flux distribution curve is, of course, due to the armature reaction. In order now to find the effective polar embrace, find the area of these curves and divide by the maximum height. The ratio of the dividend to the pole-pitch (A B) gives us the effective polar embrace required. In other words, it is the amount which the line A B has to be squeezed up to give a perfectly square wave, with a height equal to the maximum height of the wave, and area equal to its area, as shown dotted in Fig. 1. The effective polar embrace does not vary very much between no load and full load, and for all loads with average machines it lies between ·65 and ·75, according to the design of the pole tips and shoes. This value may also be calculated from the drawings of the machine, but the operation is rather long and will not be gone through here. In alternators with a sine wave of flux the calculation is easy. We have, as in Fig. 2,

$$\text{Area of sine wave} = 2\int_0^{\frac{\pi}{2}} y\,dx = 2\int_0^{\frac{\pi}{2}} \sin x\,dx$$

$$= -2\left(\cos\frac{\pi}{2} - \cos 0\right) = -2(0-1)$$

$$= 2$$

and maximum height = 1. ∴ Effective polar embrace $= \frac{2}{\pi} = ·636$.

If we work out the net area of the teeth under each pole and multiply it by the effective polar embrace, we shall get the effective tooth area. If we take any flux per pole and divide it by this area, we shall get the maximum density the teeth reach. This determines the iron loss of the armature, and also the excitation ampere-turns required to drive this flux through, since they also are determined by the maximum density reached.

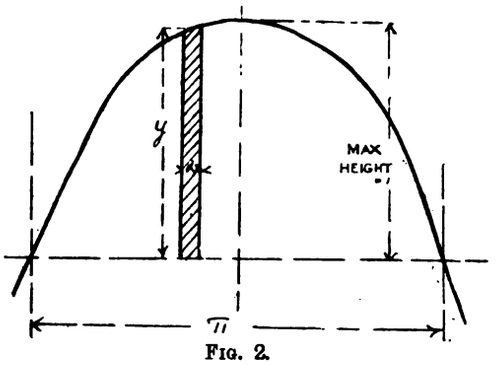

FIG. 2.

The normal working flux per pole is determined from a great many considerations, but with average modern designs the densities in the teeth come out very closely to those given in the table below. These figures, therefore, form a very good basis for design. Having determined the flux per pole from the product "effective tooth area" times "density in teeth per unit area," we proceed to calculate the sections of poles and yoke required in order to give densities there also in agreement with the table below.

I.—TABLE OF FLUX DENSITIES IN MAGNET SYSTEMS IN LINES PER SQUARE CENTIMETRE.

Diameter of armature Inches.	Maximum tooth density per sq. cm.	Pole density.	Yoke density. Cast steel.	Yoke density. Cast iron.
4 to 8	16,000	13,000	13,000	6,000
8 to 16	16,000 to 19,000	13,000 to 14,000	13,000 to 14,000	6,500
16 to 24	19,000 to 21,000	14,000 to 14,500	14,000 to 14,500	7,000
24 to 40	21,000 to 22,000	14,500 to 15,000	14,500	7,500
40 and above	22,000 to 23,000	15,000	14,500	7,500

The tooth density given above is the "apparent"; the "real" density is slightly less, owing to some of the flux passing through the slots, instead of it all, as we have assumed, passing through the teeth. This correction is, however, not of very great importance in determining the normal working flux per pole, so we will neglect it here.

Before we finally work out the sections of pole and yoke required, we must remember that all the flux generated by the field coils does not cut the armature conductors. This is due to leakage, principally between the pole-tips, the pole-flanks, and a little, perhaps, through the air-gap and along the tops of the teeth. For ease of calculation, however, it is assumed that all the leakage takes place between the pole-tips, which is approximately true. Under this assumption, the flux traversing the poles and yoke is the same at all points of the path. The ratio

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$$\frac{\text{Total flux in pole}}{\text{Total flux cutting armature conductors}}$$

is known as the *leakage coefficient* of the machine.

The normal working flux per pole which we have found above is the flux cutting the armature conductors, so that we must multiply this value by the leakage coefficient before dividing it by the permissible flux density in order to determine the required section of poles and yoke.

We can easily find the leakage coefficient of a machine by a simple experiment on one which is similar in design. Two search coils, x and y, are wound as in Fig. 3, one

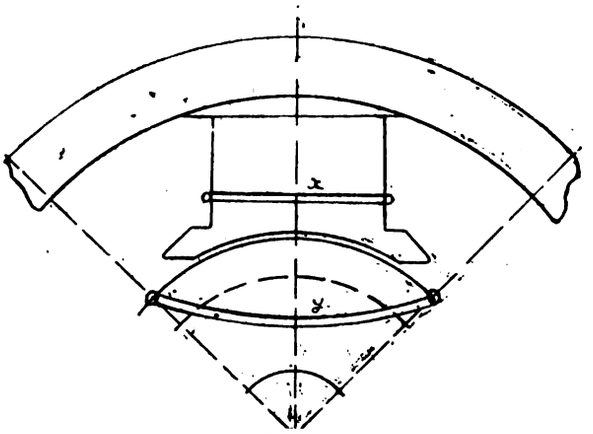
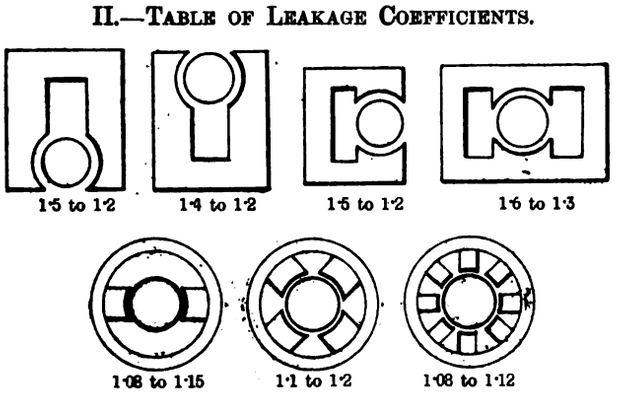


FIG. 3.

about one-third the way up the pole, where the maximum number of lines is linked, and the other on the armature, just spanning a pole-pitch. These two search coils are each connected to a ballistic galvanometer. The field current of the machine is then reversed, and the ballistics are deflected by an amount proportional to the number of lines linking the two search coils. The ratio of these two deflections will evidently give us the leakage coefficient required. The two ballistic galvanometers must have very long time constants—*i.e.*, be heavily weighted—as the complete reversal of flux in a large magnet system may take some seconds. The following table gives the average results found from practice for the leakage coefficients of several common types of magnet systems.

II.—TABLE OF LEAKAGE COEFFICIENTS.



Type of Magnet System and Leakage Coefficients.

E. Arnold has given the following formula for calculating the leakage coefficients knowing the dimensions of the magnet system, and the writer has found them to give results which are in close agreement with those found subsequently on the same machines by experiment, as shown above.

We have $H = \frac{4\pi}{10\,l} \times$ total ampere-turns.

Since practically all the leakage paths are in air, H = density of flux $= \frac{\text{flux}}{\text{area}}$.

Let M = total ampere-turns per pole. Then

$$M = \frac{\text{flux}}{\text{area}} \times \frac{10}{4\pi} \times l. \quad \therefore \frac{\text{flux}}{4\pi\,M} = \frac{\text{area}}{\text{length}} \text{ for any path.}$$

If we neglect the magnetic resistance of the poles and yoke in comparison to that of the air-gap and armature teeth, we have that the ampere-turns acting across the pole-tips are = 2 M.

We can now split up the leakage flux as follows:

1. *Leakage Between Poles in a Circumferential Direction.*—(*a*) Between the pole-tips: If we look at Fig. 4, noting the symbols given to the various dimensions, we shall see that the length of this path is a_0, and that its area, since there are two tips to each pole, will be $2\,L\,h$

$$\therefore \frac{\text{flux}}{\cdot 4\pi \times 2\,M} = \frac{2\,L\,h}{a_0}, \quad \text{or} \quad \frac{\text{flux}}{\cdot 4\pi\,M} = \frac{4\,L\,h}{a_0}.$$

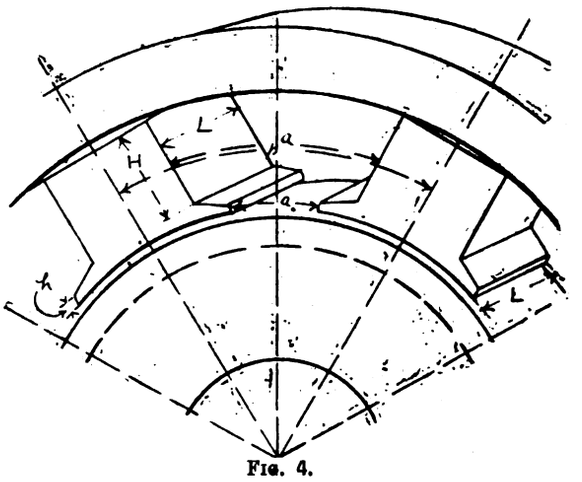


FIG. 4.

(*b*) Between the two flanks in a circumferential direction: In the same way

$$\frac{\text{flux}}{\cdot 4\pi\,M} = \frac{2\,L\,H}{a}.$$

The length of mean path a should be taken half-way up the pole, and the ampere-turns acting across the flanks vary from zero at the yoke to 2 M at the pole-tips. The mean value, M, is, therefore, taken in the above formula.

2. *Leakage Between the Ends of the Poles, as in Fig.* 5.—(*a*) Between the pole-tips: Take any strip dy. Its area is equal to $dy \times h$. The length, assuming the path to be composed of two quadrants of a circle with centre at corner of the pole, as in Fig. 5, and the straight line joining them, will be

$$= a_0 \times \pi\,y.$$

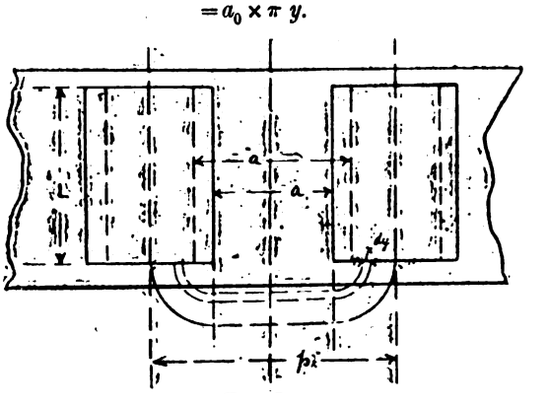


FIG. 5.

Now, the ampere-turns acting are 2 M, and there are four branches to this leakage path, one from each corner of the pole-face. Hence we have

$$\frac{\text{flux}}{\cdot 4\pi\,2\,M} = 4 \times \frac{\text{area}}{\text{length}}$$

or,

$$\frac{\text{flux}}{\cdot 4\pi\,M} = 8\,h \int_{y=0.}^{y=\frac{p-a_0}{2}} \frac{dy}{a_0 + \pi\,y}$$

$$= \frac{8\,h}{\pi} \log_e \left\{ 1 + \frac{\pi}{2} \frac{p - a_0}{a_0} \right\}.$$

(*b*) Between the pole ends: Here, again, we have four branches, but the ampere-turns acting vary from 0 to 2 M, the mean value being, therefore, M. We have, therefore,

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$$\frac{\text{flux}}{\cdot 4\pi M} = \frac{4H}{\pi}\log_e\left\{1+\frac{\pi}{2}\frac{p-a}{a}\right\}.$$

Hence $\dfrac{\text{total leakage flux}}{\cdot 4\pi M}$

$$= \frac{4Lh}{a_0} + \frac{2LH}{a} + \frac{\cdot 8h}{\pi}\log_e\left\{1+\frac{\pi}{2}\frac{p-a_0}{a_0}\right\} + \frac{4H}{\pi}\log_e\left\{1+\frac{\pi}{2}\frac{p-a}{a}\right\}$$

or, $\dfrac{\text{total leakage flux}}{\cdot 4\pi M} = \dfrac{4Lh}{a_0} + \dfrac{2LH}{a}$

$$+6h\log\left\{1+\frac{\pi}{2}\frac{p-a_0}{a_0}\right\} + 3H\log\left\{1+\frac{\pi}{2}\frac{p-a}{a}\right\}$$

From this we find the total leakage flux, and

$$\text{Leakage coefficient} = \frac{\text{armature flux + leakage flux.}}{\text{armature flux.}}$$

We can now, therefore, determine exactly the section of pole and yoke we require. We will consider now a few points in connection with the

MECHANICAL DESIGN OF THE MAGNET SYSTEM.

First consider the *poles* themselves. These are always made of wrought iron or mild steel (very often of the same quality as the armature core plates) in order to keep the length of the mean turn of the field winding as small as possible. Wrought iron, mild steel, or cast steel being, roughly, of twice the permeability of cast iron, we can for a given ampere-turns run at twice the density, and so have $\frac{1}{\sqrt{2}} = \frac{1}{1\cdot 414} = \cdot 707$ of the length of mean turn with round poles. Poles can be either solid or laminated. If the latter, the poles are rectangular in section, and pole and pole "shoe"

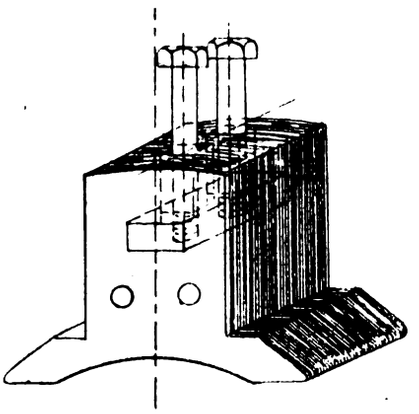

FIG. 6

are all punched out of one plate. The object of lamination is to reduce the hysteresis and eddy-current losses in the pole-face. As each tooth passes in front of a pole it carries a bunch of lines or wave of flux with it across the pole-face. This sets up a variation of flux density in the pole-shoe, which, although its amplitude is small, has a very high periodicity, and hence the resulting loss may amount to something appreciable unless reduced by lamination, as in the armature core. The effect probably does not extend very far into the pole, but as it makes a simple construction many makers laminate the whole pole. In order to secure these poles to the yoke, it used to be thought necessary to tap the thread into which the bolts were to be screwed in a key on to which the plates were threaded, as shown in Fig. 6. It is, however, quite strong enough if the holes are drilled and tapped straight into the laminations.

The best construction is, however, the writer considers, to have a solid round pole cast into the yoke, or cast with it, and having a laminated pole-shoe screwed to its face with counter-sunk screws (Fig. 7). By this arrangement we get even a smaller length of mean turn, being the perimeter of a circle against that of a square at best, thus reducing the weight of field copper required in the same ratio. We also avoid fastening the whole pole to the yoke by bolts, and have only to screw on the comparatively light pole-shoes. Again, only so much of the pole is laminated as is affected by the variation of flux density. The round bar iron which is used for the poles can always be obtained up to fairly large diameters, and needs no further machining except to be bored out when cast in place. This "casting-in" process has been universally adopted by the English Electric Company, of Preston, and many other large firms. The

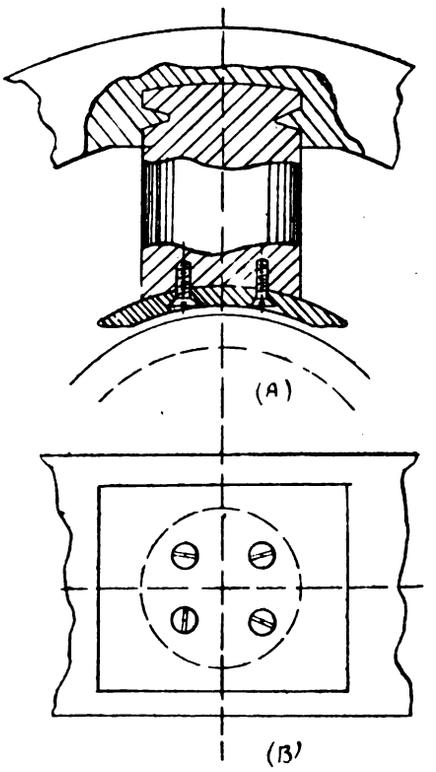

FIG. 7.

poles when ready are built into the mould, and the yoke is run in around them. Of course, this construction only applies to cast-iron yokes. If the yokes are of cast steel, the poles should be cast with them.

(To be continued.)

QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any questions should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

617. In an alternating-current system generating at 2,000 volts, with the outer earthed at the works, where the area of supply is a scattered one and house transformers are used connected to the high-pressure mains, what is the best way of testing the insulation of these mains without disconnecting the transformers, so as to keep ahead and get warning of any faults which may be developing?—C. M. R.

618. A 1-h.p. continuous-current motor, running at 1,200 revolutions per minute, drives a machine by means of gearing at the rate of 100 revolutions per minute. This machine requires to have its direction of rotation reversed every two minutes. Describe some automatic arrangement controlling the motor by means of which these reversals can be obtained.—W. F. S.

ANSWERS.

Question No. 609.—Can anyone tell me which is the best contact breaker to use on a medical induction coil, giving their reasons for thinking so

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Best Answer to No. 609 (*awarded* 10*s.*).—The question asked by "J. S." is extremely vague. Of the induction coils now made, 60 per cent. are for medical purposes of one kind or another. The factors determining the choice of contact breaker are: (1) The specific purpose in view. (This may be either (*a*) application of weak currents for nerve stimulation; (*b*) production of high-frequency oscillations; (*c*) X-ray work. (2) The voltage of supply.

Where batteries are employed, and a small medical coil for nerve stimulation is used, nothing can beat the ordinary hammer make and break, though certain points should be looked to in designing one. The hammer should be near the end of the core, the spring should be short and moderately stiff; it should have a piece checked out near the support; the platinum should be near the centre of gravity of hammer. The platinum contacts should be not less than 16 S.W.G., the one on the hammer being larger than that on contact screw. The contact screw should be of fine pitch with a locking screw—without this the contact breaker will be most erratic (see Fig. 1). A contact breaker

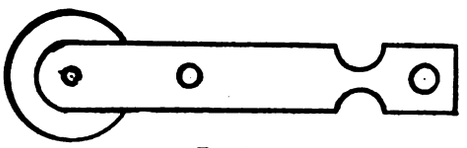

Fig. 1.

of this kind with pure platinum contacts (not silver or nickel as *very commonly sold*) will require adjustment, but seldom provided condenser is suitable. For very rapid

Fig. 2

break Fig. 2 does well. It requires practically no adjustment, but is rather sore on the battery. A is a stiff steel strip, B is a lighter strip, both with platinum contacts. Both are in tension. This combination vibrates at a very high speed, and with small coils is not so painful or jerky as the ordinary contact breaker.

(*b*) For the production of high-frequency currents, the contact breaker should have high speed and yet permit heavy currents to be used. The most satisfactory type for this is the mercury dipper. After years of experience I have found no other that can be used so long at a time with consistent results. If the design of this it should be noted that armature of motor should be light; all moving parts should be as light as possible; contact to dipper should be positive, and not through oily crank or slipper; a powerful spring should aid in lifting dipper; there should be plenty of mercury covered with 2in. to 3in. methylated spirit. Fig. 3 shows one such found most reliable by the writer.

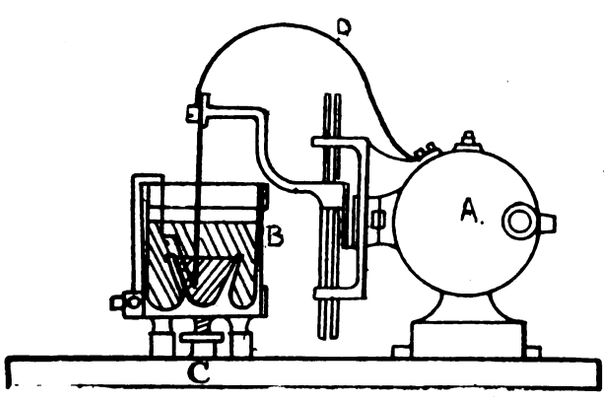

Fig. 3.—Part in Section. A, Motor; B, Glass Vessel with Mercury and Methylated Spirit; C, Reg. Screw; D, Flat Spring.

Many types, such as the McKenzie-Davidson interrupter, use a segment or segments, as in Fig. 4. All these, however, churn up the mercury, cannot be used long at a time, and require very frequent cleaning, besides being wasteful in mercury.

(*c*) For X-ray work there are two cases to consider—screen work and photography. For screen work the high-speed segment dipper, such as the McKenzie-Davidson, is very suitable, as the screen is seldom required for lengthy periods and the illumination with the segment dipper is perfect. For photography, where penetration is most required, the slow but simple dipper is far and away the best. Fig. 3 with the motor slowed down is very suitable. For instantaneous work, however, nothing can equal the Wehnelt electrolytic break. Many of those on the market are very erratic and unreliable. The requirements are: (1) correct strength of acid; (2) plenty of acid; (3) parts of massive size and non-corroding. The Wehnelt, however, is apt to smash tubes, and cannot be used more than a few seconds at a time. The writer has got over the difficulty by connecting an ordinary dipper break in series with the Wehnelt. The dipper then acts as a switch to the

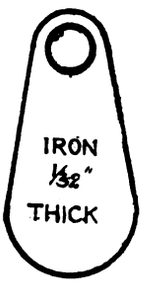

Fig. 4.

Wehnelt, and the tube is at least as long off as on, and therefore has time to cool. This arrangement has given excellent results, especially in cases where the supply voltage is 200 to 250. It is then economical, safe, and reliable. A special condenser on the dipper circuit is, however, advisable.

In a busy practice with coils working four or five hours per day the great difficulty is to keep the contact breakers cool. All kinds of breakers have been designed to get over this trouble, but with little success. The writer has designed and is experimenting with a break for continuous use. The first model consists of a glass tube about ¼in. bore, with a bunch of platinum wires inserted at each side. To the branch shown is a small pump filled with mercury, while the end is connected to the high-pressure water-main. A jerk of the pump sends in some mercury, which is shot through with great violence, making and breaking contact. A grand spark is given, while no spark to speak of is seen at the break in the tube. Any one is at liberty to make and use this. Contact breakers using jets of mercury are very unsatisfactory, as they churn up the mercury into minute globules, which do not conduct, and later get choked up with oxide and carbonised oil.

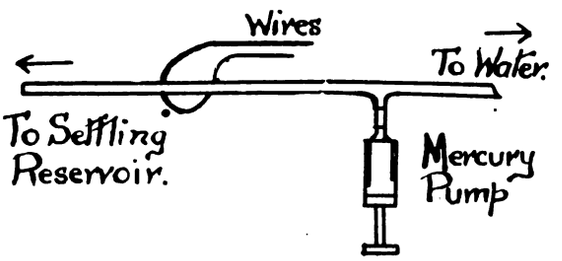

Fig. 5.

Finally, a word on contact-breaker motors. Most of them are simply toys. They should have well-insulated windings, not less than eight-section built-up commutators, carbon brushes not less than ⅜in. square, or round composite brushes ⅜in. diameter. Bearings should be phosphor bronze and renewable, with means for oiling; parts requiring adjusting should be accessible, and lastly, but very important to be noted, the motor, if driven off the same circuit as the coil uses, should be thoroughly insulated from the dipping circuit.—POLYPHASE.

Answer to No. 609 (*awarded* 5*s.*).—Premising that the induction coil is to be employed for physiological effects, such as the application of "shocks" to various parts of the body, there would appear little doubt but that the ordinary make and break at platinum contacts is the most suitable, all things being considered. The two methods in general use are making and breaking at platinum contact pieces,

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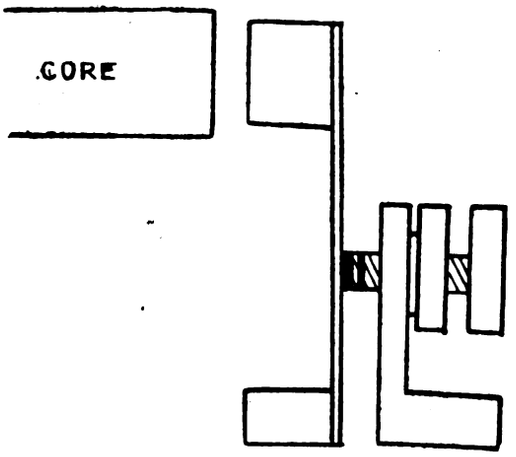
or dipping a platinum wire in and out of mercury. When a comparatively large current flows in the primary circuit, as in coils used for radiography, where the current may be several amperes, some form of mercury make and break is desirable. With such a current, platinum contacts are very liable to fuse together and give trouble. In a medical coil, however, the current to be dealt with would be but a fraction of an ampere, and with well-made platinum contacts and ordinary care there should be little difficulty in keeping the contact breaker in a satisfactory condition. Objections to the mercury form are that it is larger, and is not so conveniently portable as the ordinary spring and screw with platinum contacts. Although the mercury may be rendered more viscous if some silver is dissolved in it, to obtain the best results it is necessary to have a layer of alcohol on the surface of the mercury. Unless the mercury is covered with alcohol, the sparking soon sets up oxidation. In favour of the mercury form, it is claimed that the presence of the alcohol causes the interruption to be more sudden, owing to the arc being extinguished so quickly, and that by having an adjustable weight on the rocking lever carrying the platinum wire, the rapidity of making and breaking the circuit is under control of the operator. These advantages, however, may easily be obtained with the other arrangement, as by placing the platinum rather low down the spring, as shown



in figure, so that the spring takes a bend before actually breaking contact with the screw, break is very quick, and by adjustment of screw considerable variation may be obtained in the rapidity of the interruptions. If the form of spring is horizontal instead of vertical, as shown, the same result would follow by having contact nearer fixed end of spring. It would appear, therefore, that for a medical coil the ordinary spring with platinum contacts is better for the purpose than a mercury arrangement, on the grounds of being more compact, more portable, and at least as efficient.—M. M.

Answer to No. 609 (*awarded* 5*s.*).—One of the most simplest yet rapid type of contact breaker for large induction coils is the Wehnelt interrupter, which is based on electrolytic action. In Fig. 1, *h* is a vessel containing a

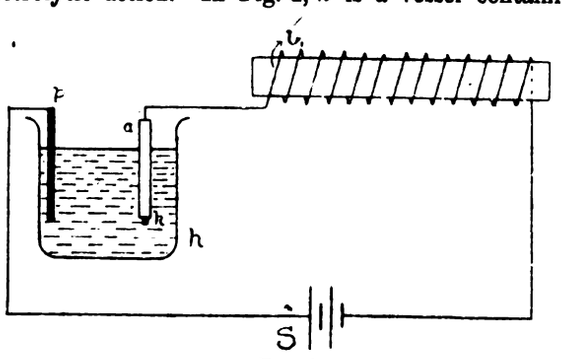


Fig. 1.

dilute solution of sulphuric acid, generally about one part of strong acid to ten of distilled water; *p* and *a* are two electrodes, which convey the current from the battery, S, through the electrolyte. The electrode, *a*, is a glass or porcelain tube through which runs a wire which is provided with a platinum point, *k*. The current from S flows through the primary coil, *b*, to the electrode *a*, and through the electrolyte, from *k*, to the electrode *p* (which is merely a lead plate), and back to S. In this illustration *k* forms the anode and *p* the cathode. The current in flowing through causes an evaporation of the electrolyte to take place at *k*, by reason of the heat generated (Joule's law), thus causing an accumulation of steam and gas around the point, *k*. The steam and gas being bad conductors break the circuit; at the same instant the interruption spark explodes the small quantity of mixed steam and gas, and it flows upwards along the tube, *a*. The electrolyte then further surrounds the point, *k*, and the action is repeated. The heat necessary for the production of the steam and gas bubble arises partly by the heating of the particles conveying the current, but is especially due to the Peltier effect, which in electrolytic action on the anode causes an active development of heat to take place in certain circumstances, a cooling effect taking place at the cathode. For this reason the tube, *a*, with its platinum point, *k*, must always be the anode in the Wehnelt interrupter. This type of interrupter is also made with two, three, or four anodes, held in a common arm, and these can be connected up together, or singly, and thus obtaining a different frequency varying from 260 to 2,000 makes and breaks per second, which has a considerable advantage over the ordinary hammer contact breaker.

Another consideration, owing to the high price of

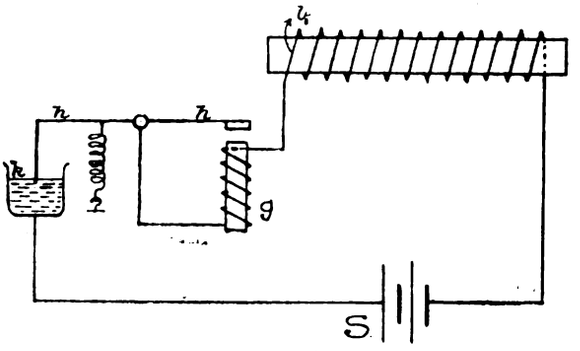


Fig. 2.

platinum, is the rate at which it wears away, due to the sparking when the current is broken in the primary coil. This wearing is very much diminished in the case of a Wehnelt interrupter compared with that of the hammer type. On the other hand, the Wehnelt interrupter must not be overloaded or used too long without a rest, or the platinum points will become overheated and may melt.

A modification of the hammer contact breaker is shown in Fig. 2, and is called the mercury interrupter, but is only suitable for smaller induction coils (not more than 5in. spark). In this case the alternate switching in and out of the primary current circuit is effected by the dip of a metal point in mercury. With this device the current flows from the battery, S, to the primary coil, b_1, the electromagnet, *g*, the dip, *h*, the mercury contact, *k*, and back to S. The armature of the dip, *h*, is attracted, the metal point (generally of platinum) is raised out of the mercury, and thus the circuit is broken. When this occurs the magnet, *g*, releases the armature, and the point, *k*, drops either by its own weight or generally by the action of a spring attached to *h*, and thus the circuit is made again by the point, *k*, dipping in the mercury, thereby causing a fresh impulse to be effected. This device is not found much more suitable in current practice than the hammer type, and will only allow, even under the most favourable conditions, about 40 makes and breaks per second. It is not adapted for rapid movement with very large currents, and could not be used for long-distance spark telegraphy.

Under these circumstances a suitable interrupter would be one in which the reciprocating is replaced by a rotating action, and the mercury contact still taking part in this. A suitable type of such a mechanism has been designed by the Allgemeine Elektricitäts-Gesellschaft, of Germany, which they call a "turbine interrupter," a section of which

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is shown in Fig. 4. It is rather complicated in construction, yet simple in its action, and admirably meets the requirements. Referring to Fig. 3, the metal tube, *t*, is bent at a right angle, the lower part of the vertical arm dipping in mercury, and the mercury being covered with a layer of alcohol in a sufficient quantity so that the horizontal arm is surrounded with it. The lower part of the tube, *t* (see Fig. 4), is in the shape of a turbine wheel, and if the tube be made to turn rapidly about the axis of its vertical arm suction takes place, and the mercury is drawn up the tube, and is, owing to centrifugal force, discharged at the end of the horizontal arm in the form of a heavy jet. A

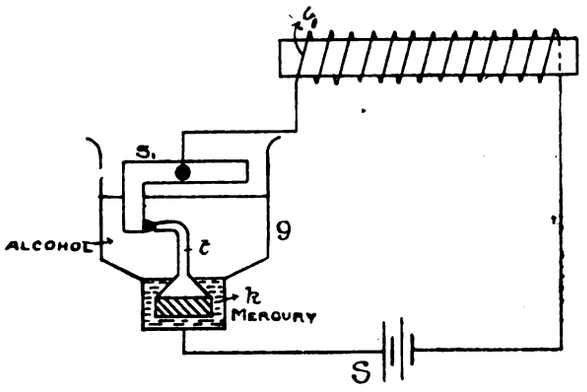


FIG. 3

metal ring, s_1, made with a segment, is placed concentrically to the shaft of the turbine. The segment projects downwards, and is under the surface of the alcohol, but not touching the surface of the mercury, so that the primary circuit is made as soon as the jet of mercury during its rotary motion comes in contact with this segment, and the duration of the contact is a very small interval of time, and decreases with the speed of the turbine; thus the make and break of the primary circuit is effected. The current passing from the battery, S, to the primary, *b*, the metal ring, s_1, the mercury, *k*, and metal tube, *t*, back to S. The idea of the layer of alcohol is to prevent any arcing, which would otherwise take place between the mercury jet and the metal segment. The number of makes and breaks can easily be made to vary between 1,000 and 10,000 per second, according to the speed of the turbine, and also the number of segments the ring, s_1, may have, which may be from one to four, according to the diameter of the ring. The whole of the body and cover of the apparatus is of cast iron, owing to the mercury not amalgamating to this metal.

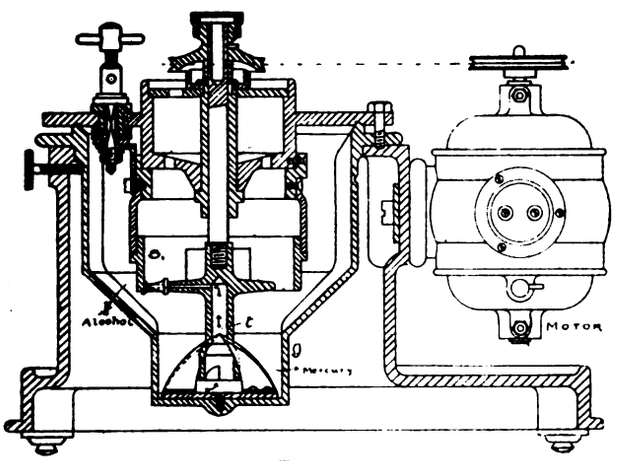
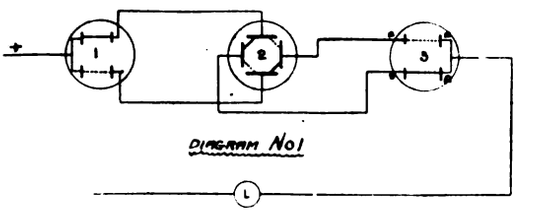


FIG 4.

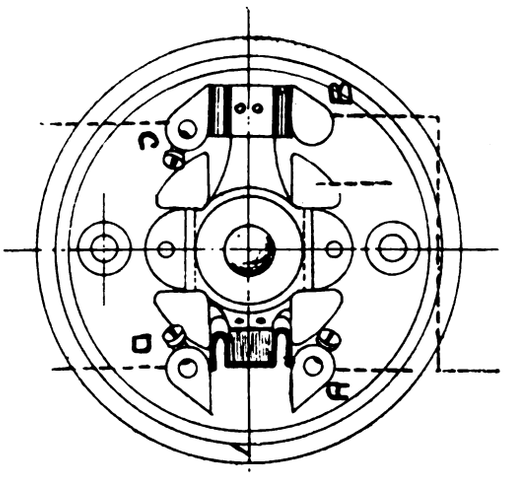
This turbine interrupter is driven by a cord transmission from a small electric motor fitted on the body of the interrupter. In the writer's opinion, this type of make and break for coils of large capacity is one of the best which has been invented, owing to the simplicity of its action and the absence of the expensive metal, platinum, and the great range of periodicity. The only disadvantage which is worth considering is the prime cost, and even this might be reduced if the apparatus were made less elaborate. However, this type of interrupter would save the cost of buying new platinum heads for the ordinary hammer type.—H. R. GREENYER.

Question No. 610.—Show diagrammatically the simplest method of controlling a single incandescent lamp from three places independently. Also give a sketch of the switches used for the purpose.

Answer to No. 610 (*awarded* 7*s.* 6*d.*).—I think the diagram below (No. 1) explains a good method of controlling a single incandescent lamp from three independent points. Nos. 1, 2, and 3 are the separate switches or

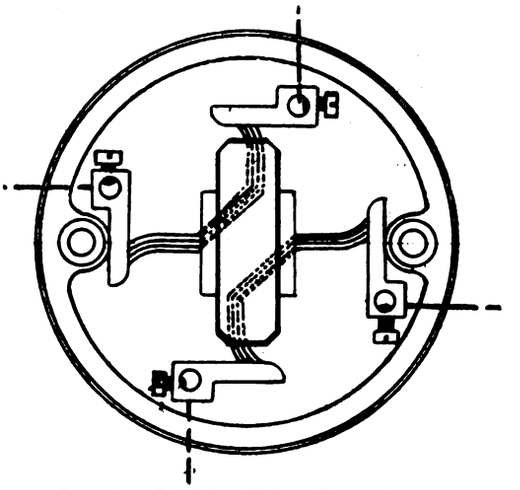


controlling points, and the dotted lines show the passage of current when in the other position. The switches 1 and 3 are of the two-way tumbler type, having no "off" position, as shown in plan herewith, and the intermediate



No. 1 AND 3.—Plan of Switch with Cover Removed. Terminals A and B Connected Together.

switch (No. 2) is of a different type, being a turn switch, although it is like a tumbler switch in the external appearance except for the ebonite handle. This switch also has no "off" position, as shown in plan herewith. A good switch for this purpose (No. 2) is made by the General Elec-



Plan of No. 2 Switch with Cover Removed.

tric Company, who call it the "Hydra" switch. If these "Hydra" switches cannot be readily obtained, another way out of the difficulty would be to use for the intermediate point two two-way switches, same as Nos. 1 and 3, coupled together by a fibre bar, and mounted on a two-way block and connected as shown in No. 2 diagram, thus keeping the switches all of the same type. The General Electric Company also list a "Hydra" two-way switch of the same pattern, which, if desired, could be used for Nos. 1 and 3 points instead of the switches shown. As all the

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switches are on one pole, there is no danger of a short-circuit occurring. One or a group of lamps may be easily

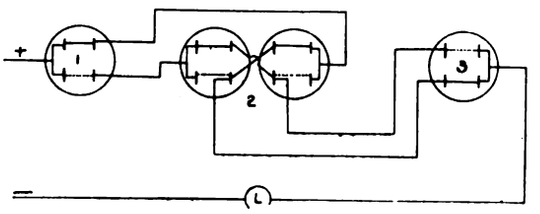

DIAGRAM No. 2.—Connections Show Lamp Alight.

controlled from any number of points by the use of extra intermediate switches.—PETER P. DEAN.

Answer to No. 610 (*awarded 7s. 6d.*).—In order to control an incandescent lamp from three points independently, two types of switch must be used. Those at the extreme points of the system, to which the leads from the main and lamp are connected, must be two-way switches; whilst the third

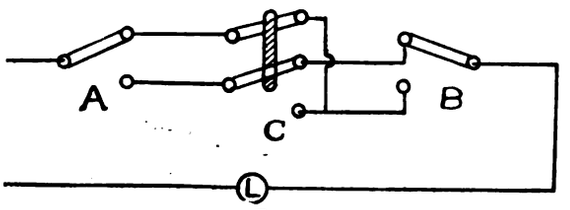

FIG. 1.

switch, connected between the above, must be of the change-over type. The connections necessary for carrying out this control are given in Fig. 1. By tracing out these connections it will be seen that the lamp, L, or a group, if necessary, can be switched on or off from either of the switches A, B, or C. A and B are ordinary two-way

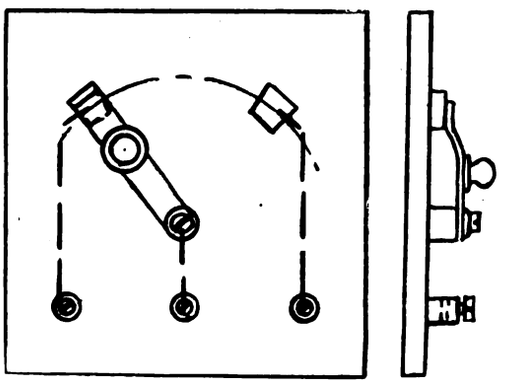

FIG. 2.

switches, whilst C has two contact arms, coupled mechanically, working on three contacts, two of which are connected together. The two-way switches may be of the simple lever pattern, as Fig. 2. They can also be obtained with either a "tumbler" or rotary action, both types being provided with a quick break. The change-over switch may also be of the lever form, as Fig. 3, this being similar to

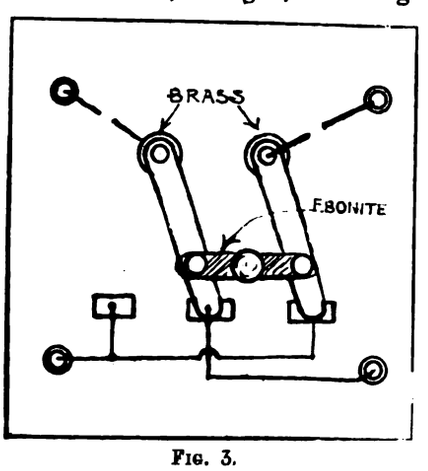

FIG. 3.

the type of switch supplied with small Rhumkorff coils for current reversal. The switch can be obtained with a rotary action, as Fig. 4, this type being provided with a quick break, not shown in sketch. Messrs. Verity's, I

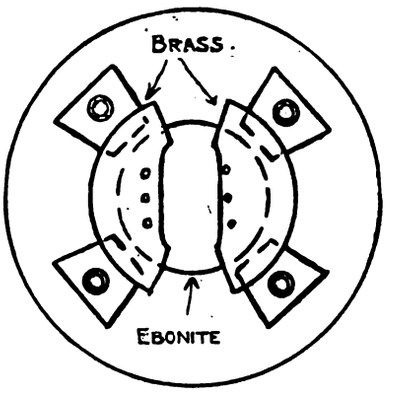

FIG. 4.

believe, manufacture a switch which enables a lamp to be controlled from any number of points independently. In this case, also, simple two-way switches are used at each end of the system.—F. T. C.

Answer to No. 610 (*awarded 7s. 6d.*).—The simplest way for "R. H. G." to control a single incandescent from three places independently is first to obtain two two-way switches

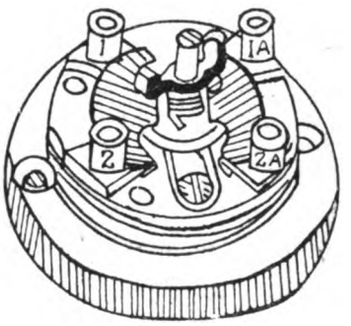

FIG. 1

and one variable-circuit switch. The types of switches required would be as described in sketches Figs. 1 and 2 The system here described has been carried out in dozens

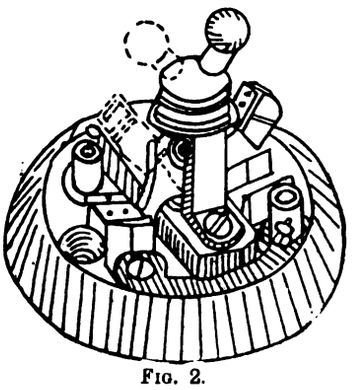

FIG. 2.

of cases by the writer, which is both practical and simple. In many cases, what is simple to one might appear the most complicated to another. As will be seen from Fig. 1,

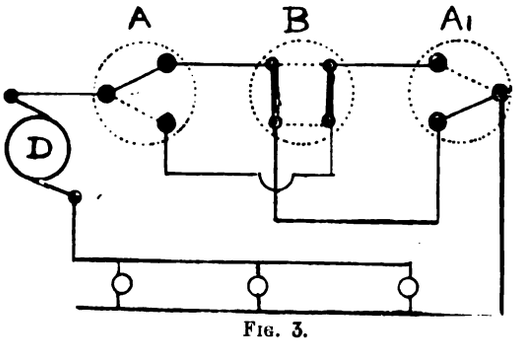

FIG. 3.

there are four terminal plates held in position by four binding terminals. This switch has both right and left

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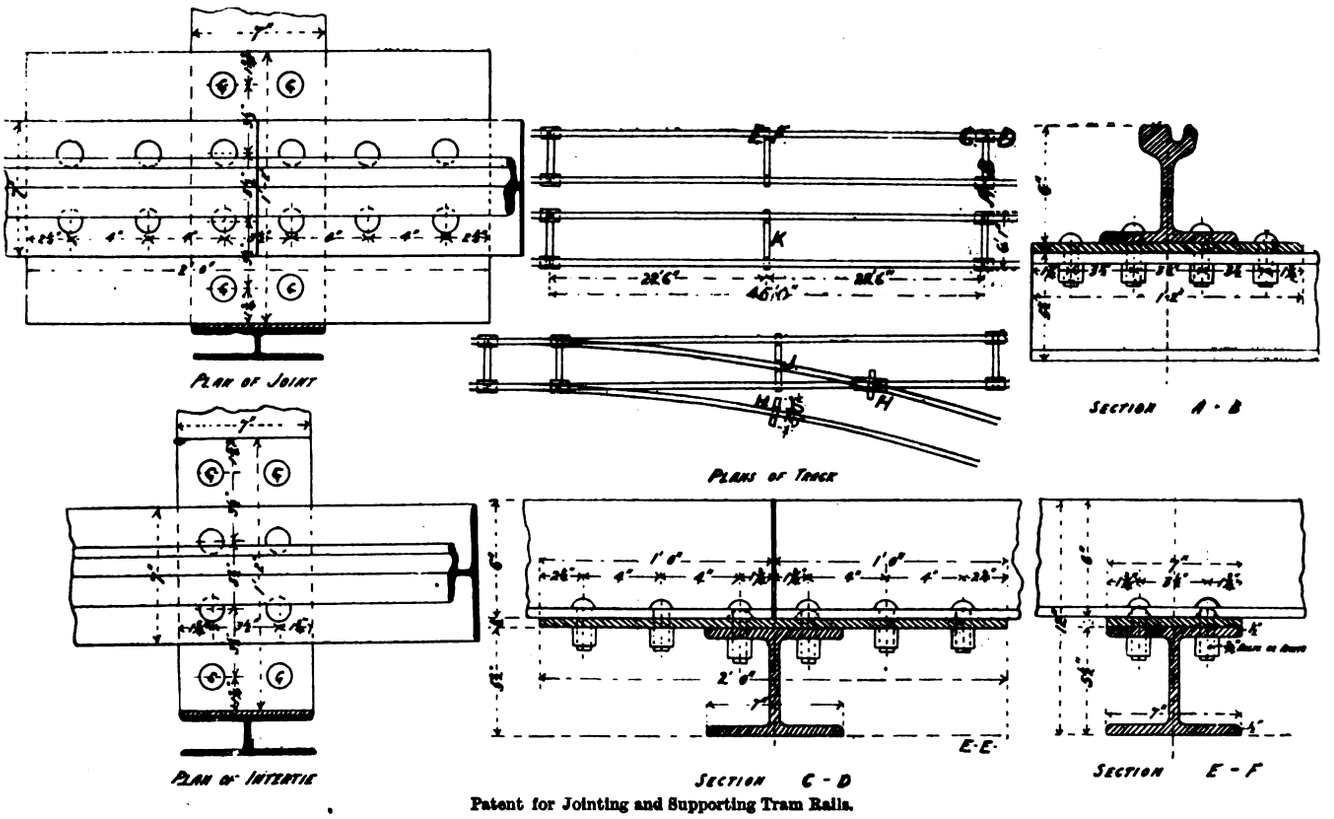
handed movements. The object of this is to short-circuit any two terminal plates. As in Fig. 1, contact is made at the points 1 and 2, also 1A and 2A, with a left-handed movement the positions taken up on the terminal plates would be 1 and 1A, also 2 and 2A. These consecutive movements switch the lamp on or off. Fig. 2 is an ordinary two-way tumbler switch, which is too well known to require description here. Diagram 3 illustrates all necessary connections; A and A_1 are the two-way switches, and B the variable-circuit switch. The connections show the lamps as being switched on, but a reversal of any switch will extinguish them. By using the variable-circuit switch for the intermediate positions and the two-way for the outer positions, a light or lights can be controlled from an indefinite number of points.—H J. G.

PATENT FOR JOINTING AND SUPPORTING TRAMRAILS.

We are indebted to Mr. W. C. Sample, a member of the city surveyor's staff, Sheffield, for the following particulars of a patent method of jointing and supporting tramrails for which provisional protection has been obtained.

It is claimed by the patentees that the adoption of their method will render the use of fishplates and tie-bars unnecessary, and will prevent the vibration so common in tramrails laid according to present methods, which is so detrimental to the wear of the rails, and cause the displacement and consequent expense in the maintenance and repair of the paving. It will also secure greater uniformity of track than is possible under present conditions, as the transverse girder embedded in concrete will secure the one rail firmly to the other.



Patent for Jointing and Supporting Tram Rails.

The patent consists of a transverse girder passing between and under the tramrails, and carrying two plates. The plates in turn support and are secured to the tramrails at the joints and also at the centre of the rails, which may be of any length and laid to any gauge. The plates on the transverse girder will be bolted or riveted to same at the points marked G on plan, and will be so fixed before arrival on the site of the works. The necessary bolt or rivet holes will be drilled or punched in the plates, girders, and tramrails in their correct positions at the works, so that the drilling of further holes on the site of the works will be rendered unnecessary. In double junctions and on curves where the joints of the tramrails do not come opposite one another the transverse girders can, if necessary, be shortened (as shown at H on plan), though this will be avoided as much as possible, and the transverse girder carried from rail to rail. Cases will occur in which the plates to carry points and rails will vary in shape and size, and in which the transverse girder will have to carry more than two plates and rails (as shown at J on plan), but the patent will be equally applicable to these and similar cases.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

REPULSION MOTOR.

SIR,—In his article on a "New Single-Phase Motor" in your current issue, Herr L. Schüler describes as the subject of a recent English patent a type of machine which is started as a repulsion motor and converted during running into an induction motor by three slip-rings with resistances between them, which are gradually cut out. It will interest your readers to learn that nearly three years ago I introduced this very device for the same purpose on an experimental motor at the Central Technical College.—

Yours, etc. WILLIAM CRAMP, A.M.I.E.E.,
Lecturer on Electrical Design.

Central Technical College, S.W., Sept. 8, 1903.

APPOINTMENTS VACANT.

Engineer-in-Charge, Darlington Corporation, £78 per annum, 14th inst.

Designer, well up in both alternating and continuous currents. See advertisement in last issue.

Resident Engineer, Morecambe Borough Council, £150, rising to £200, Sept. 14.

Second Engineer-in-Charge, Bermondsey Borough Council, £125, Sept. 15. See advertisement in last issue.

Switchboard Attendant, Aston Manor Urban District Council. Sept. 18. See advertisement.

Assistant Instructor, City and Guilds of London Institute, salary commencing at £150. See advertisement.

Electrical Engineer for mine work abroad. See advertisement.

Draughtsman or Teacher, South-Western Polytechnic, Manresa road, Chelsea, S.W., 12s. 6d. per evening. See advertisement.

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THE

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All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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Bound Volumes of "THE ELECTRICAL ENGINEER," containing half-year's copies, bound in Dark-Blue Cloth, Gold Lettered, price 8s. 6d. New Volume, January to July, 1903, now ready.

THE BRITISH ASSOCIATION.

The annual meeting of the British Association for the Promotion of Science is again with us, and this year Southport is the favoured town to be invaded by scientific experts. It is to be hoped that the benefits conferred by this choice of a meeting place will be mutual, and that Southport will give in health a fair return for what it receives in enlightenment. The meeting was opened on Wednesday last with a most able address by Sir Norman Lockyer, in which a strong appeal is made for organising national scientific effort. The president attributes to the lack of scientific knowledge in this country our present backward position as compared with our neighbours in industrial progress. With the increased stress of competition with other manufacturing nations, he claims that it is only by organising on a national scale our scientific efforts that we can maintain our position and be amongst the countries to survive. His advocacy of a practical step to be taken is in the direction of increasing the number of our universities and their equipment. As will be seen from a condensation of the address in this issue, he treats the matter in the same way that our navy was treated in 1888 in order that we might maintain our supremacy on the high seas. Sir Norman Lockyer asks from the Government the modest sum of twenty-four millions sterling to build, equip, and endow eight new universities in the United Kingdom, but we are afraid that in the present state of politics there is little hope that the influence of the members of the British Association will be able to abstract such a sum from the custodians of the national exchequer. The arguments as to our relative position with Germany and the United States as regards means of education, deal with the subject in a more general way than was done in the presidential address delivered by Dr. John Perry before the Mechanical Section last year. The addresses in the individual sections this year are highly interesting. The one which mostly concerns our readers is that delivered by Mr. Charles Hawkesley before Section G. In this a good *résumé* is given of progress made in various departments of applied engineering. An interesting fact which may not be generally known is that Sir Frederick Bramwell has organised a paper to be read on prime movers at the meeting of the British Association in 1931. It was in 1881 that Sir Frederick predicted at York that the steam-engine as known at the present day would become a thing of the past, and that fifty years from then he doubted whether those who would gather together at the 1931 meeting would speak of the steam-engine except as in the nature of a curiosity to be found in the museum. This opinion is to form the text of the paper in 1931, and Sir Frederick left fifty pounds for investment in 2½ per cent. cumulative consols, the resultant sum to be paid to the author of the paper. In the same address a full description is given of progress in the electrical equipment of railways and of the good work which the railways operated by electricity are doing at the present time. The last part of the address deals with the question of water supply, of which its author is one of our greatest experts. For originality, however, the address before the Mathematical and Physical Section, read by Prof. Chas. Vernon Boys, takes, perhaps, the leading position this year. In it he speaks in the following way of the discovery of radium and its properties: "Of the events of the last year one stands out beyond all others, not only for its intrinsic importance and revolutionary possibilities, but for the excitement that it has raised among the general public. The discovery by Prof. and Madame Curie of what seems to be the everlasting production of heat in easily measurable quantity by a minute amount of a radium compound is so amazing, that

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even now that many of us have had the opportunity of seeing with our own eyes the heated thermometer, we hardly are able to believe what we see. This, which can barely be distinguished from the discovery of perpetual motion, which it is an axiom of science to call impossible, has left every chemist and physicist in a state of bewilderment. Added to this, Sir William Crookes has an experiment, characteristic of him, if I may say so, in which a particle of radium keeps a screen bombarded for ever, so it seems, each collision producing a microscopic flash of light, the dancing and multitude of which forcibly compel the imagination to follow the reasoning faculties, and realise the existence of atomic tumult. Thanks to the industry and genius of J. J. Thomson, Rutherford, and Soddy, Sir William and Lady Huggins, Dewar, and Ramsay, and others in this country, besides Prof. and Madame Curie and a host of others abroad, this mystery is being attacked, and theories are being invented to account for the marvellous results of observation; but the theories themselves would a few years ago have seemed more wonderful and incredible than the facts, as we believe them to be, do to-day. An atom of radium can constantly produce an emanation. That is something like a gas, which escapes and carries with it wonderful properties; but the atom, the thing which cannot be divided, remains, and retains its weight. The emanation is truly wonderful. It is self-luminous, it is condensed by extreme cold and vaporises again, it can be watched as it oozes through stop-cocks or hurries through tubes, but in amount it is so small that it has not yet been weighed. Sir William Ramsay has treated it with a chemical cruelty that would well nigh have annihilated the most refractory or permanent known element, but this evanescent emanation comes out of an ordeal undimmed and undiminished." In the conclusion of this address Prof. Boys speaks favourably of the change which is being brought about in our public school life by the introduction of scientific instruction. From these addresses and from the programme which appears elsewhere in this issue, it will be gathered that the 1903 meeting of the British Association is likely to be a remarkable one in an already brilliant record.

THE BRITISH ASSOCIATION.

Under favourable auspices the seventy-third session of the British Association for the Promotion of Science was opened at Southport on Wednesday night, under the presidency of Sir Norman Lockyer, K.C.B., LL.D., F.R.S. Prior to the evening assembly, at which the president's inaugural address was delivered, the General Committee held a meeting, when Prof. Dewar, the retiring president, announced that the council of the association are in favour of accepting the invitation to hold the 1905 convention in South Africa. He stated that the Governments of the South African Colonies have undertaken to make a grant of £6,000 towards the expenses, and that the directors of the Union Castle Line have been equally generous in agreeing to a reduction of 30 per cent. in the fares to South Africa for officials and 25 per cent. for other members of the association. Prof. Dewar also announced that Mr. Balfour, the Prime Minister, has consented to his nomination as president for 1904, when the association meets at Cambridge.

Following we are able to give a *résumé* of the principal arrangements in several of the sections as provisionally fixed.

SECTION G (ENGINEERING).

THURSDAY, SEPT. 10, 11.30.—President's Address; C. A. Brereton, "King Edward VII. Bridge over the River Thames between Brentford and Kew"; J. Harrison, "Illustration of Graphical Analysis."

FRIDAY, SEPT. 11, 10 A.M.—J. H. Reynolds, "The Equipment of the Manchester Municipal Technical Institute"; "Report of the Committee on the Resistance of Road Vehicles to Traction"; T. Clarkson, "Steam Traction on Common Roads"; Lieut.-Colonel Crompton, "The Problem of Modern Street Traffic — opening a General Discussion on the Subject."

SATURDAY, SEPT. 12.—The section will not sit. Excursions to the Manchester Institute of Technology, the Westinghouse Company's works at Trafford Park.

MONDAY, SEPT. 14, 10 A.M.—"The Report of Committee on Small Screw Gauges"; J. Campbell Brown, "On the Nature and Quality of some Potable Waters in South-West Lancashire"; W. B. Woodhouse, "Protective Devices for High-Tension Electric Systems"; J. B. C. Kershaw, "Aluminium as an Electrical Conductor"; E. Wilson, "The Electrical Conductivity of certain Aluminium Alloys as affected by Exposure to London Atmosphere"; E. Wilson, "A Method for Finding the Efficiency of Series Motors"; B. Hopkinson, "The Parallel Running of Alternators"; W. Cramp, "The Single-Phase Repulsion Motor"; J. N. Shoolbred, "Electric Traction"; W. J. Goodrich, "Twenty-five Years' Progress in Final and Sanitary Refuse Disposal."

TUESDAY, SEPT. 15, 10 A.M.—F. B. Behr, "High-Speed Express Monorails and the Manchester and Liverpool Express Railway"; A. M. Bell, "Liquid Fuel"; J. Parry, "Water Supply of South-West Lancashire"; H. R Mill, "Rate of Fall of Rain at Seathwaite"; J. M. Shoolbred, "Tidal Regimé in the Mersey"; R. Pearson, "History of the Discovery of Natural Gas in Sussex"; G Forbes, "Further Experiences with the Infantry Range Finder."

WEDNESDAY, SEPT. 16, 10 A.M.—J. Aitken, "A Few Remarks on the Effect of Traffic and Weather on Macadamised Roads"; E. J. Izod, "Pendulum Apparatus for Testing Steel as regards Brittleness"; C. H. Wingfield, "Permanent Set in Cast Iron as bearing on the Design of Piston-Ring Springs"; H. E Wimperis, "A Further Note on Gas-Engine Explosion"; J. W. Thomas, "Ventilation of Tube Railways"; W. Odell, "Preliminary Experiments of Air Friction"; L. Bairstow and A. D. Alexander, "Experiments in Gas Explosions"; J. Morroco, "A New Form of Mirror Extensometer"; W. G. Popplewell, "Smoke Abatement."

SECTION A (MATHEMATICAL AND PHYSICAL SCIENCE).

THURSDAY, SEPT. 10, 10 A.M.—Address of Mr. C. V. Boys, F.R.S., president of the section; Lord Kelvin, "On Electrotherial Theory of the Velocity of Light in Gases, Liquids, and Solids"; 11 a.m., Prof. J. Rutherford, "On the Nature of the Emanations from Radioactive Substances" (discussion, in which Lord Kelvin, Principal Sir Oliver Lodge, Drs. Elster and Geitel, Prof. Schuster, Prof. J. J. Thomson, Prof. Dewar, Mr. Soddy, Prof. Armstrong, and C. T. R. Wilson will take part.)

FRIDAY, SEPT. 11, 10.30 A.M.—Address of Dr. W. N. Shaw, chairman of the department for astronomy and meteorology, "Methods of Meteorological Investigation"; Sir N. Lockyer, "On Simultaneous Solar and Terrestrial Changes"; Prof. A. Schuster, "Cosmical Rodioactivity" (discussion of two preceding papers); Dr. A. Buchan, "On the Relation of the Rainfall of Scotland to the Sunspot Periods, 1855-98"; Prof. J. M. Pernter, "Observations sur la Radiation aux Observatoires principaux"; Prof. Hildebrandsson, "On the General Circulation of the Atmosphere"; Prof. H. L. Callendar, "On Self-Recording Instruments"; Dr. K. Grossman and J. Lomas, "On the Origin and Forms of Hoar Frost, with Lantern Illustrations"; J. Swinburne, "On the Treatment of the Thermodynamics of Irreversible Processes" (discussion in which Prof. J. Perry will take part); J. E. Petavel, "On the Explosive Pressure and Rate of Combustion of Cordite"; R. T. Glazebrook, "Report of Committee on Electrical Standards"; G. Beilby, "On Granular Structure in Solids."

MONDAY, SEPT. 14, 10.30 A.M.—The section will meet in two departments.

Department of Pure Mathematics.

Harold Hilton, "On Spherical Curves"; W. H. Young, "On the Classification of Discontinuous Functions and the

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Distribution of their Points of Continuity"; Lieutenant-Colonel A. Cunningham and H. J. Woodall, "On Primes."

Department of Astronomy and Meteorology.

Prof. H. H. Turner, "Was the New Star in Gemini shining previously as a very faint star?" J. Milne, "Report of the Seismological Committee"; D. Burns, "Phenomena accompanying the Volcanic Eruptions in the West Indies"; J. Milne, "The Inside of the Earth"; A. R. Hinks, "Exhibition of Photographs from Yerkes Observatory"; Dr. W. J. S. Lockyer, "Relation between Prominences, Sunspots, and Coronæ"; "Report of the Kite Committee"; A. L. Rotch, "Kite Observations at Blue Hill, 1900 2," with discussion; Prof. A. Schuster, "Radiation from a Foggy Atmosphere"; Dr. A. Buchan, "Diurnal Variation of Temperature in the Levant and its Relation to Radiation"; Dr. W. J. S. Lockyer, "Spectra of Lightning."

TUESDAY, SEPT. 15, 10.30 A.M.—"Report of the Committee on Underground Temperature"; "Report of the Committee on Solar Radiation"; R. S. Hutton and J. E. Petavel, "Note on Carbon and Iron Arc Spectra at High Gaseous Pressures"; Prof. R. A. Sampson, "Eclipse Observations of Jupiter's Satellites: A Study of the Ordinary Observations in Comparison with the Photometric Observations of Harvard"; Rev. A. L. Cortie, "Solar Prominences and Terrestrial Magnetism"; Dr. A. Schuster, "Wave Propagation in a Dispersive Medium." 12.30 p.m.—Prof Henrici, "On the Use of Vectorial Methods in Physics, Vector Algebra being the Natural Form of Mathematics for Expressing Relations between Physical Quantities" (discussion). There will be an open meeting of the International Meteorological Committee to discuss hours of observation and international telegraphy.

WEDNESDAY, SEPT. 16, 10.30.—"Report of Falmouth Observatory Committee"; Prof. J. M. Pernter, "Emploie de l'Hygrometre à cheveu au lieu du Psychrometre"; Dr. A. Buchan, "Report of the Ben Nevis Committee"; A. L. Rotch, "A Study of Audibility as affected by the Meteorological Conditions at Blue Hill during 1901"; H. R. Mill, "Mean Rainfall"; Prof. E. W. Marchant and G. W. Worrall, "On the Use of Capacities as Multipliers for Electrolytic Voltmeters in Alternating-Current Circuits"; P. H. Powell, "Considerations of Some Points in the Design and Working of Ballistic Galvanometers."

SECTION F (ECONOMIC SCIENCE AND STATISTICS).

THURSDAY, SEPT. 10.—Presidential address of E. W. Brabrook, chief registrar of friendly societies.

FRIDAY, SEPT. 11.—Discussion on "The Wealth of the Country and what should be done with it," opened by Sir Robert Giffen.

MONDAY, SEPT. 14.—Papers and discussion on the economic aspects of the fiscal controversy as follows: Dr. E. Cannan, "Modern Economics and Free Trade"; Prof. W. Cunningham, "Failures to Attain the Ideals of Free Traders"; A. L. Bowley, "Statistical Methods and the Fiscal Controversy,"; B. Etlinger, "Comparative Statistics of our Trade with our Colonies, U.S.A., and the Protected Countries of Europe"; and probably papers on "History of Retaliation," "History of Commercial Relations with Canada," and "Statistics on Production."

THURSDAY.—Final report of committee on "The Economic Effect of Legislation Regulating Women's Labour"; Mrs. Bosanquet, "Physical Deterioration and the Poverty Line."

The following other papers will probably also be read before this section: S. H. Turner, "Depreciation and Sinking Funds in Municipal Undertakings"; Dr. Ginsburg, "The Growth of Rates"; also a paper on "Garden Cities."

SECTION L (EDUCATIONAL SCIENCE).

THURSDAY AND FRIDAY, SEPT. 10 AND 11.—Discussion on "School Curricula," based on a series of short papers. Introductory papers have been promised by Miss Burstall and M. E. Sadler, J. L. Paton, W. L. Fletcher (Liverpool Institute), John Adams, T. E. Page, and others. A joint meeting with the Geographical Section will be held to discuss the "Teaching of Geography." In addition to the above subjects, there will also be discussions on the reports of committees on the conditions of health essential to the carrying on of the work of instruction in schools; the teaching of natural science in elementary schools; the influence exercised by universities and examining bodies on secondary school curricula, and also of the schools on university requirements; the teaching of botany in schools.

On Saturday, the 12th, at 8 p.m., Dr. J. S. Flett, London, will deliver a lecture to working-men on the subject of "Martinique and St. Vincent: The Eruptions of 1902," with lantern slides.

Among the many diverting and instructive excursions which have been arranged in connection with the meeting are the following, which we think will particularly appeal to members of the engineering profession: On Saturday, the 12th, the place of visit is Manchester, where, among others, the works of the British Westinghouse Company will be open to inspection. The members of the party, which, by the way, is limited to 250, will have an opportunity of expressing an opinion on the electric tramway system of the city, as the arrangements provide for two car rides in the direction of Trafford Park. Lunch will be partaken of at the Westinghouse works, and the excursion will occupy the whole day. On Wednesday, the 16th, a visit to Port Sunlight to inspect Messrs. Lever Bros.' soap works and model village, and to Liverpool for the Diamond Match Works should prove of interest, but in each case the number of the party is limited. The British Insulated and Helsby Cables, Limited, have invited a party not exceeding 100 to visit their works at Prescot for Thursday, the 17th, and on the same day an opportunity will be given to visit a couple of coal pits—the Hulton Park coal pit at Atherton and the Abram coal pit, near Wigan. Among other places of engineering interest which will be opened to inspection during the week are the Blowick Electricity Works; the works of Messrs. Dobson and Barlow, Limited, machine makers and engineers, Bolton; the Manchester Municipal School of Technology; the ss. "Lucania," Liverpool; and the L. and Y. Railway Company's works, Horwich.

RADIUM AND OTHER RADIOACTIVE SUBSTANCES WITH A CONSIDERATION OF PHOSPHORESCENT AND FLUORESCENT SUBSTANCES. THE PROPERTIES AND APPLICATIONS OF SELENIUM AND THE TREATMENT OF DISEASE BY THE ULTRA-VIOLET LIGHT.*

BY WILLIAM J. HAMMER.

(Continued from page 357.)

It is well known that in the case of the radiophone, if a beam of sunlight be thus intercepted by a blackened perforated revolving disc, a musical note, varying in pitch with the speed of the disc, will be produced in a rubber tube held at the opposite side of the disc. I have here one of the original forms of radiophones. A piece of apparatus has been devised consisting of a disc with slits near the edge, which is placed near an incandescent lamp and a selenium cell. If the selenium cell is connected to a telephone and battery, and the disc is rapidly revolved, a musical note will be produced in the telephone, the pitch of which will correspond to the speed of the revolving disc. Mr. Giltay has recently written me suggesting a very pretty experiment in this line, in which a double-vaned Crookes radiometer is placed between a selenium cell and an arc light shielded by an alum cell. The light from the arc lamp causes the radiometer to revolve intermittently screening the selenium cell and producing a musical note in the telephone attached thereto, the pitch of which is in accordance with the speed of revolution of the radiometer. I have here to-night two forms of flame telephone transmitters, one of which was presented to me by Mr. Ruhmer, and the other I have purchased from Mr. Giltray, which I have mounted as you see it here and as illus-

* A lecture delivered at a meeting of the American Institute of Electrical Engineers and the American Electrochemical Society, New York, April 17, 1903.

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trated in Fig. 20 (about 24 volts are required, depending upon the selenium cell). In each case you will note that I have an acetylene generator, which conveys gas to the interior of an otherwise empty telephone transmitter. The diaphragm of these transmitters is made of pigskin or a similar material. A tiny pipe runs from the back of the transmitter, and ends in one case to a single acetylene jet, and in the other case to three acetylene jets. By talking against the pigskin diaphragm the gas inside is made to vibrate, and produces a manometric flame. This flame throws its light upon a selenium cell, to which is connected a battery and a pair of very sensitive telephones between 100 and 200 ohms for each cell of battery, in which the sounds spoken into the transmitter are most perfectly reproduced. A thin sheet of paper inserted between the flame and the selenium cell serves to cut off all sound. It is self-evident that these telephone receivers might be at any distant point. I have worked them over considerable distances.

In Fig. 21 are shown a number of most interesting applications of the selenium cell in conjunction with a battery and relay, used for starting a motor, ringing a bell,

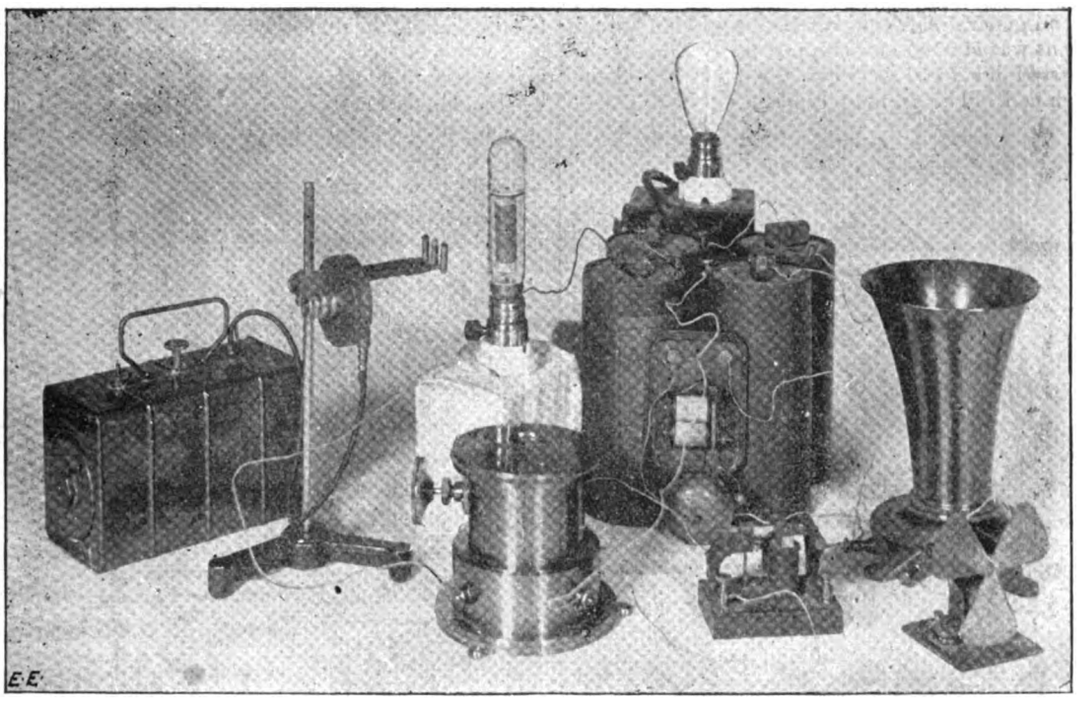

FIG. 21.—Acetylene Flame Apparatus, Ruhmer Selenium Cell, Relays and Battery for Operating, Electric Lamp, Bell, Motor, and Horn. (A 3-h.p. Motor and Generator were also similarly operated and a cannon fired).

firing a cannon, blowing a horn, and lighting incandescent lamps, all of which experiments I shall hope to show you in actual operation, as I have had them working most successfully in my laboratory; and you will see that by merely passing my hand before the selenium cell I can start and stop the motor, turn the light on and off, and ring the bell and blow the horn, or I can fire this cannon, start my phonograph talking, etc. I am indebted to the courtesy of the Marconi Company for the large relay used in certain of these experiments. I have here also a 3-h.p. motor driving a 1½-kw. generator and supplying these lamps which have been courteously supplied by the General

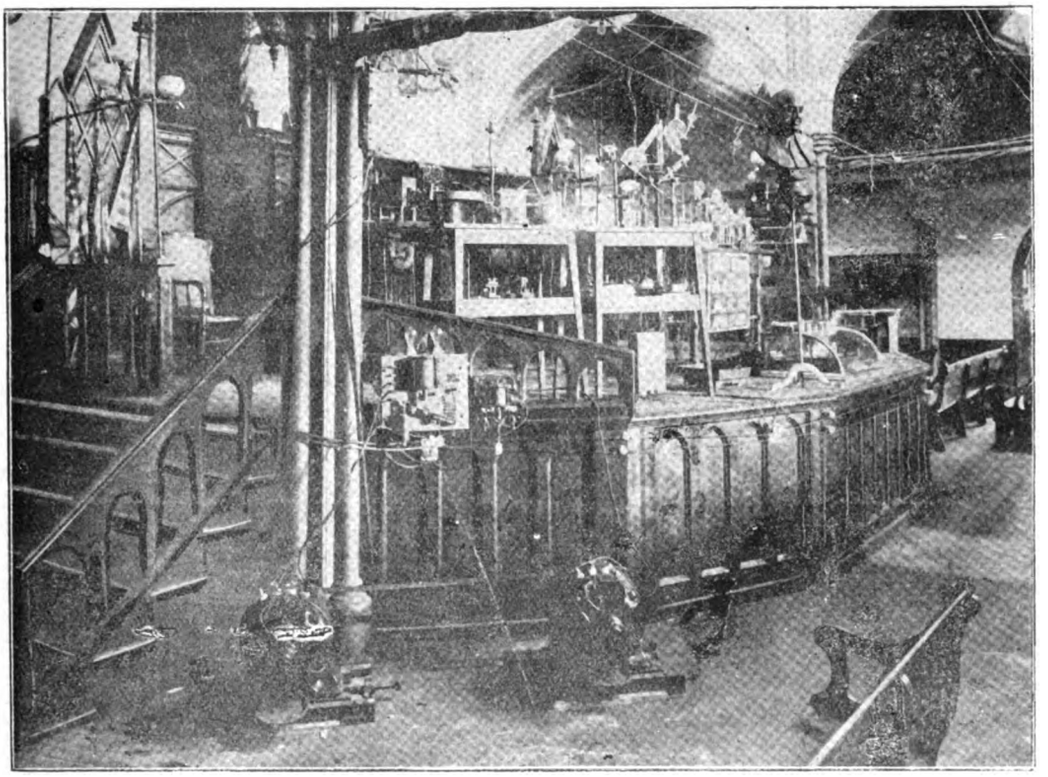

FIG. 22.—3-h.p. Motor and Generator supplying Bank of Lamps and operated by shielding with the hand a Selenium Cell from an Acetylene Flame.

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Electric Company; and by means of this selenium cell, relay, battery, and a motor starter, for which I am indebted to the Cutler-Hammer Company, I hope to be enabled to start and stop the motor by merely passing my hand before the selenium cell. In Fig. 22 is shown a portion of the stage setting at the lecture, and shows in the foreground the 3-h.p. motor and generator which supplied a bank of lamps, and which plant was started and stopped many times when the author passed his hand between the acetylene flame and a selenium cell. The frontispiece is a general view of

FIG. 23.—Pintsch Gas Buoy controlled by a Ruhmer Selenium Cell, Battery, and Switch Mechanism.

the stage setting in the College of the City of New York, and was taken shortly before Mr. Hammer's lecture.

In 1886 the writer attended a convention of the Edison Association of Illuminating Companies at Rochester, New York, and during a discussion of contract systems *versus* meter systems, he gave his experience as chief inspector of central stations of the Edison Company in dealing with the difficulties met with in supplying light by contract; and he then described a practical method of utilising selenium cells to control relays and magnets which would

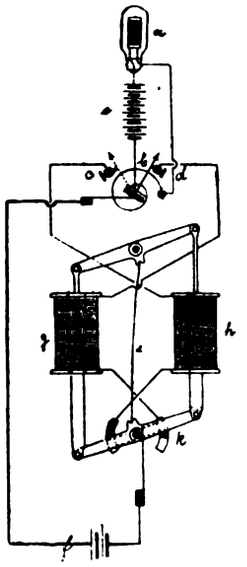

FIG. 24.—Diagram of Circuits of "Selenium" Buoy.

throw off the electric light on the approach of day and on again at night, thus solving the difficulty of street-lighting and other circuits intended to operate only at night. On Feb. 12, 1890, in a paper on some experiments with selenium cells, Mr. Shelford Bidwell showed a relay operated by a selenium cell, which threw on an electric lamp and rang a bell, and he suggested the protection of safes and strong rooms by selenium cells, which would be affected by the light from a burglar's lantern, thus giving an alarm. He also spoke of their being used to give notice of the extinction of railway signal lamps and ship lights, and stated the following: "But I do not at present attach any serious importance to such practical applications of these devices. I regard them simply as offering somewhat attractive illustrations of the effect of light upon the resistance of selenium." This is an important statement from the greatest authority on the subject of selenium, but to-day it will not hold good. I hold in my hand a small vial containing some "thermit," which was discovered by Dr. Goldschmidt. It consists of oxide of iron, such as one would get off of a blacksmith's anvil or from the

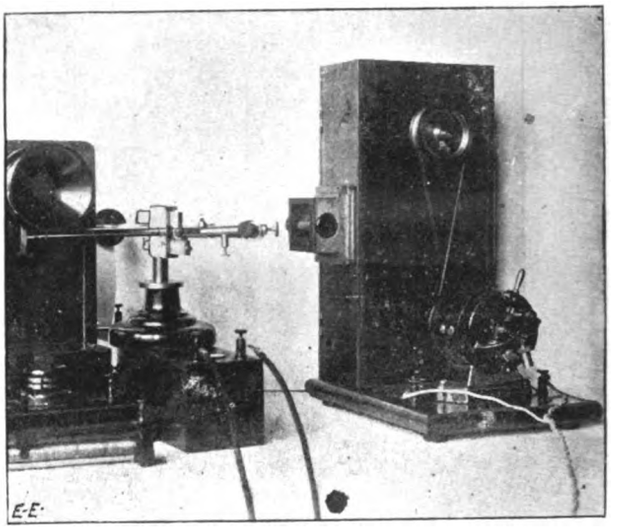

FIG. 25.—Ernest Ruhmer's Photographophone, showing Exterior View, together with Telephone Transmitter and Arc Lamp.

rolls of a rolling mill, and is mixed with powdered metallic aluminium. A red-hot iron or molten cast iron poured into this mixture produces no effect, but if a little barium preparation or magnesium powder be placed on top of this mixture and touched off by a match, an extraordinary reaction takes place, producing a temperature of about 3,000deg. C., and the mechanical equivalent of a kilo (2·2lb.) of thermit is about 1,730 horse-

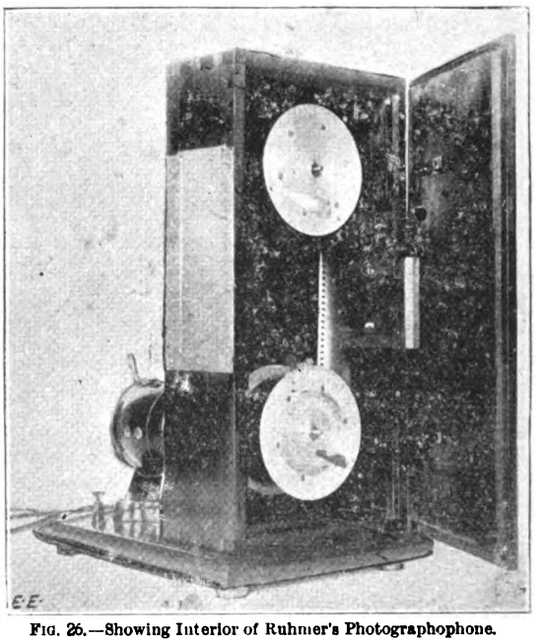

FIG. 26.—Showing Interior of Ruhmer's Photographophone.

power seconds, or 1,273 kilowatt-seconds. I have seen some very interesting experiments made in welding girder rails, pipes, etc., by this process, and have here some interesting samples of manganese, chromium, ferro-titanium, and other metals prepared in this way. I have also seen steel safes in which enormous holes had been burned by employing thermit, and it would be possible for a burglar to carry some thermit in his pocket and burn a hole in a safe large enough to insert his arm and extract the valuables. I also saw in Germany last summer

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a substance called "anti-thermit," which it is intended to place in the lining of safes to prevent the reaction taking place, thus protecting the safe. But a simple plan would be to place a selenium cell in or near the safe, so that the moment the reaction was started a signal would be given to the police in a similar manner, as suggested by Mr. Bidwell in the case of the burglar's bullseye lantern. An important commercial application of the selenium cell has recently been made by Mr. Ernest Ruhmer in connection with his electrically controlled buoy illustrated in Fig. 23.

. Pintsch has constructed a large number of buoys containing compressed gas, which would last from one month to upwards of a year; but it was heretofore necessary to burn these lights day and night, it being often impracticable, by reason of distance at which they were placed and frequency of storms, etc., to switch off the gas so that it would not burn during the daytime. Mr. Ruhmer has placed one of his selenium cells in the top of such a buoy connected with a switching device, which, as soon as the sun rises in the morning, causes the selenium cell to reduce its resistance, this causing the switching device to turn off the gas, which is again turned on upon the increase of resistance of the selenium cell by the approach of nightfall, or if desired in the case of a storm coming up. A buoy containing sufficient gas for one month could thus be made to answer without recharge for from three to five months. The arrangements of the circuits as originally devised by Mr. Ruhmer is shown in Fig. 24. The voltmeter needle has been replaced by a relay, and the apparatus simplified. A single dry cell is interpolated in the selenium cell circuit, as usually employed on the buoy, and this cell will last a year or more.

(To be continued.)

FORTHCOMING EVENTS.

Municipal and County Engineers.—Meeting at Hastings on September 11 and 12.

British Association.—Seventy-third annual meeting, Sept. 9-17, Southport.

Sanitary Institute.—Sept. 16, lecture by Dr. E. J. Steegmann, "Natural Forces: Light, Heat, Electricity; Chemistry."

THE BRITISH ASSOCIATION.

The following is a somewhat abridged reproduction of the presidential address delivered by Sir Norman Lockyer, K.C.B., LL.D., F.R.S., correspondant de l'Institut de France, at Southport on Wednesday evening last. The President said:

"My first duty to-night is a sad one. I have to refer to a great loss which this nation and this association have sustained. By the death of the great Englishman and great statesman who has just passed away we members of the British Association are deprived of one of the most illustrious of our past-presidents. We have to mourn the loss of an enthusiastic student of science. We recognise that as Prime Minister he was mindful of the interests of science, and that to him we owe a more general recognition on the part of the State of the value to the nation of the work of scientific men. On all these grounds you will join in the expression of respectful sympathy with Lord Salisbury's family in their great personal loss which your council has embodied this morning in a resolution of condolence. Last year, when this friend of science ceased to be Prime Minister, he was succeeded by another statesman who also has given many proofs of his devotion to philosophical studies, and has shown in many utterances that he has a clear understanding of the real place of science in modern civilisation. We, then, have good grounds for hoping that the improvement in the position of science in this country which we owe to the one will also be the care of his successor, who has honoured the association by accepting the unanimous nomination of your council to be your president next year, an acceptance which adds a new lustre to this chair. On this we may congratulate ourselves all the more, because I think, although it is not generally recognised, that the century into which we have now well entered may be more momentous than any which has preceded it, and that the present history of the world is being so largely moulded by the influence of brain power, which in these modern days has to do with natural as well as human forces and laws, that statesmen and politicians will have in the future to pay more regard to education and science as empire builders and empire guarders than they have paid in the past.

"The nineteenth century will ever be known as the one in which the influences of science were first fully realised in civilised communities; the scientific progress was so gigantic that it seems rash to predict that any of its successors can be more important in the life of any nation. Britain in the middle of the last century was certainly the country which gained most by the advent of science, for she was then in full possession of those material gifts of Nature, coal and iron, the combined winning and utilisation of which, in the production of machinery and in other ways, soon made her the richest country in the world, the seat and throne of invention and manufacture, as Mr. Carnegie has called her. Being the great producers and exporters of all kinds of manufactured goods, we became eventually, with our iron ships, the great carriers, and hence the supremacy of our mercantile marine and our present command of the sea. The most fundamental change wrought by the early applications of science was in relation to producing and carrying power. With the winning of mineral wealth and the production of machinery in other countries, and cheap and rapid transit between nations, our superiority as depending upon our first use of vast material resources was reduced. Science, which is above all things cosmopolitan—planetary, not national—internationalises such resources at once. In every market of the world

> 'things of beauty, things of use,
> Which one fair planet can produce,
> Brought from under every star,'

were soon to be found. Hence the first great effect of the general progress of science was relatively to diminish the initial supremacy of Britain due to the first use of *material* resources, which, indeed, was the real source of our national wealth and place among the nations. The unfortunate thing was that, while the foundations of our superiority depending upon our *material resources* were being thus sapped by a cause *which was beyond our control*, our statesmen and our universities were blind leaders of the blind, and our other asset, our mental resources, which was within our control, was culpably neglected. So little did the bulk of our statesmen know of the part science was playing in the modern world and of the real basis of the nation's activities, that they imagined political and fiscal problems to be the only matters of importance. Nor, indeed, are we very much better off to-day. In the important discussions recently raised by Mr. Chamberlain next to nothing has been said of the effect of the progress of science on prices. The whole course of the modern world is attributed to the presence or absence of taxes on certain commodities in certain countries. The fact that the great fall in the price of food-stuffs in England did not come till some 30 or 40 years after the removal of the corn duty between 1847 and 1849 gives them no pause; for them new inventions, railways, and steamships are negligible quantities; the vast increase in the world's wealth, in free trade and protected countries alike, comes merely, according to them, in response to some *political* shibboleth. We now know, from what has occurred in other states, that if our Ministers had been more wise and our universities more numerous and efficient, our *mental resources* would have been developed by improvements in educational method, by the introduction of science into schools, and, more important than all the rest, by the teaching of science by experiment, observation, and research, and not from books. It is because this was not done that we have fallen behind other nations in properly applying science to industry, so that our applications of science to industry are relatively less important than they were. But this is by no means all; we have lacked the strengthening of the national life produced by fostering the scientific spirit among all classes and along all lines of the nation's activity; many of the responsible authorities know little and care less about science; we have not learned that it is the duty of a state to organise its forces as carefully for peace as for war; that universities and other teaching centres are as important as battleships or big battalions—are, in fact, essential parts of a modern State's machinery, and, as such, to be equally aided and as efficiently organised to secure its future well-being.

"Now the objects of the British Association as laid down by its founders 72 years ago are 'To give a stronger impulse and a more systematic direction to scientific enquiry—to promote the intercourse of those who cultivate science in different parts of the British Empire with one another and with foreign philosophers—to obtain a more general attention to the objects of science and a removal of any disadvantages of a public kind which impede its progress.' In the main, my predecessors in this chair, to which you have done me the honour to call me, have dealt, and with great benefit to science, with the objects first named. But at a critical time like the present I find it imperative to depart from the course so generally followed by my predecessors and to deal with the last object named, for unless by some means or other we 'obtain a more general attention to the objects of science and a removal of any disadvantages of a public kind which impede its progress,' we

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shall suffer in competition with other communities in which science is more generally utilised for the purposes of the national life."

Sir Norman Lockyer proceeded to quote the opinions of our leading statesmen to show that our industries are suffering in the present international competition. Thus: "Mr. Chamberlain's views were stated in the following words: 'I do not think it is necessary for me to say anything as to the urgency and necessity of scientific training. . . . It is not too much to say that the existence of this country as the great commercial nation depends upon it. . . . It depends very much upon what we are doing now, at the beginning of the twentieth century, whether at its end we shall continue to maintain our supremacy, or even equality, with our great commercial and manufacturing rivals.' All this refers to our industries. We are suffering because trade no longer follows the flag as in the old days, but because trade follows the brains, and our manufacturers are too apt to be careless in securing them. In one chemical establishment in Germany 400 doctors of science, the best the universities there can turn out, have been employed at different times in late years. In the United States the most successful students in the higher teaching centres are snapped up the moment they have finished their course of training and put into charge of large concerns, so that the idea has got abroad that youth is the password of success in American industry. It has been forgotten that the latest product of the highest scientific education must necessarily be young, and that it is the training, and not the age, which determines his employment. In Britain, on the other hand, apprentices who can pay high premiums are too often preferred to those who are well educated, and the old rule-of-thumb processes are preferred to new developments—a conservatism too often depending upon the master's own want of knowledge."

This led to the consideration of the necessity for a body dealing with the organisation of science, and to the fact that the British Association was such a body. The President on this point said: "A careful study of the early history of the association leads me to the belief that the function I am now dwelling on was strongly in the minds of the founders; but be this as it may, let me point out how admirably the organisation is framed to enable men of science to influence public opinion and so to bring pressure to bear upon Governments which follow public opinion: (1) Unlike all the other chief metropolitan societies, its outlook is not limited to any branch or branches of science. (2) We have a wide and numerous fellowship, including both the leaders and the lovers of science, in which all branches of science are and always have been included with the utmost catholicity—a condition which renders strong committees possible on any subject. (3) An annual meeting at a time when people can pay attention to the deliberations, and when the newspapers can print reports. (4) The possibility of beating up recruits and establishing local committees in different localities, even in the King's dominions beyond the seas, since the place of meeting changes from year to year, and is not limited to these islands. We not only, then, have a scientific Parliament competent to deal with all matters, including those of national importance, relating to science, but machinery for influencing all new councils and committees dealing with local matters, the functions of which are daily becoming more important. The machinery might consist of our corresponding societies. We already have affiliated to us 70 societies, with a membership of 25,000. Were this number increased so as to include every scientific society in the Empire, metropolitan and provincial, we might eventually hope for a membership of half a million. We in this Empire certainly need to organise science as much as in Germany they find the need to organise a navy. The German Navy League, which has branches even in our Colonies, already has a membership of 630,000, and its income is nearly £20,000 a year. A British Science League of 500,000, with 6d. subscription, would give us £12,000 a year, quite enough to begin with. I for one believe that the British Association would be a vast gainer by such an expansion of one of its existing functions. Increased authority and prestige would follow its increased utility. The meetings would possess a new interest; there would be new subjects for reports; missionary work, less needed than formerly, would be replaced by efforts much more suited to the real wants of the time. This magnificent, strong, and complicated organisation would become a living force, working throughout the year instead of practically lying idle, useless, and rusting for 51 weeks out of the 52 so far as its close association with its members is concerned. If this suggestion in any way commends itself to you, then, when you begin your work in your sections or General Committee, see to it that a body is appointed to enquire how the thing can be done.

"There is another matter I should like to see referred to the committee I have spoken of, if it please you to appoint it. The British Association—which, as I have already pointed out, is now the chief body in the Empire which deals with the totality of science—is, I believe, the only organisation of any consequence which is without a charter, and which has not his Majesty the King as patron." The first work of such an organisation, in Sir Norman Lockyer's opinion, is that of providing better university teaching, more opportunities for research, and many more well-endowed universities. By comparison with Germany and the United States, we were lamentably behind in this matter, and the President attributed this largely to the small State aid afforded. Thus: "If we take the 12 English university colleges, the forerunners of universities unless we are to perish from lack of knowledge, we find that private effort during 60 years has found less than £4,000,000—that is, £2,000,000 for buildings and £40,000 a year income. This gives us an average of £166,000 for buildings and £3,300 for yearly income. In the United States, during the last few years, universities and colleges have received more than £40,000,000 from this source alone; private effort supplied nearly £70,000,000 in the years 1898-1900. Next consider the amount of State aid to universities afforded in Germany. The buildings of the new University of Strassburg have already cost nearly a million—that is, about as much as has yet been found by private effort for buildings in Manchester, Liverpool, Birmingham, Bristol, Newcastle, and Sheffield. The Government annual endowment of the same German university is more than £49,000. This is what private endowment does for us in England, against State endowment in Germany. But the State does really concede the principle; its present contribution to our universities and colleges amounts to £155,600 a year. No capital sum, however, is taken for buildings. The State endowment of the University of Berlin in 1891-2 amounted to £168,777. When, then, we consider the large endowments of university education both in the United States and Germany, it is obvious that State aid only can make any valid competition possible with either. To compete on equal grounds with other nations we must have more universities. But this is not all—we want a far better endowment of all the existing ones, not forgetting better opportunities for research on the part of both professors and students. The buildings of the most modern university in Germany have cost a million. For upkeep the yearly sums found, chiefly by the State, for German universities of different grades, taking the incomes of seven out of the 22 universities as examples, are: first class—Berlin, £130,000; second class—Bonn and Göttingen, £56,000; third class—Königsberg and Strassburg, £48,000; fourth class—Heidelburg and Marburg, £37,000. Thus, if Leeds, which is to have a university, is content with the fourth-class German standard, a rate must be levied of 7d. in the £ for yearly expenses, independent of all buildings. But the facts are that our towns are already at the breaking strain. During the last 50 years, in spite of enormous increases in rateable values, the rates have gone up from about 2s. to about 7s. in the £ for real *local* purposes. But no university can be a merely local institution."

Sir Norman Lockyer then called for an effort from the Government similar to that made in 1888, when it was found that our navy was getting insufficient to compare favourably with those of two rival States if combined together. That year £21,500,000 was voted for the navy. To bring our universities into line with those of our competitors only eight new ones were needed, and some £24,000,000 would be required for their construction and endowment. As to the question of how is this money to be raised, the President said: "I reply, with hesitation, *Duplicate the navy bill of* 1888-9; do at once for brain power what we so successfully did then for sea power. Let £24,000,000 be set apart from one asset, our national wealth, to increase the other, brain power. Let it be assigned and borrowed as it is wanted; there will be a capital sum for new buildings to be erected in the next five or ten years, the interest of the remainder to go towards increased annual endowments. There need be no difficulty about allocating money to the various institutions. Let each university make up its mind as to which rank of the German universities it wishes to emulate. When this claim has been agreed to, the sums necessary to provide the buildings and teaching staff of that that class of university should be granted without demur. It is the case of battleships over again, and money need not be spent more freely in one case than in the other. Let me at once say that this sum is not to be regarded as practically gone when spent, as in the case of a short-lived ironclad. *It is a loan* which will bear a high rate of interest. This is not my opinion merely; it is the opinion of those concerned in great industrial enterprises and fully alive to the origin and effects of the present condition of things.

"When dealing with our universities, I referred to the importance of research, as it is now generally acknowledged to be the most powerful engine of education that we possess. But education, after all, is but a means to the end, which, from the national point of view, is the application of old and the production of new knowledge. Its national importance apart from education is now so generally recognised that in all civilised nations except our own means of research are being daily more amply provided for all students after they have passed through their university career; and, more than this, for all who can increase the country's renown or prosperity by

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the making of new knowledge, upon which not only commercial progress, but all intellectual advance must depend. Years ago we had Faraday apparently wasting his energies and time in playing with needles; electricity now fills the world. To-day men of science in all lands are studying the emanations of radium — no research could be more abstract, but who knows what advance in human thought may follow or what gigantic world-transforming superstructure may eventually be raised on the minute foundation they are laying? If we so organise our teaching forces that we can use them at all stages, from the gutter to the university, to sift out for us potential Faradays—to utilise the mental products which otherwise would be wasted—it is only by enabling such men to continue their learning after their teaching is over that we shall be able to secure the greatest advantage which any educational system can afford."

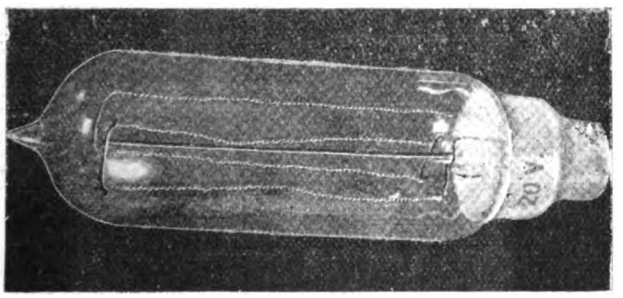
After dealing with the need of a Scientific National Council an able address was concluded in the following words:

"To sum up, then. My earnest appeal to you is to gird up your loins and see to it that the science of the British Empire shall no longer remain unorganised. I have endeavoured to point out to you how the nation at present suffers from the absence of a powerful, continuous, reasoned expression of scientific opinion, urging in season and out of season that we shall be armed as other nations are, with efficient universities and facilities for research to uphold the flag of Britain in the domain of learning and discovery, and which they alone can bring. I have also endeavoured to show how, when this is done, the nation will still be less strong than it need be if there be not added to our many existing councils another, to secure that even during peace the benefits which a proper co-ordination of scientific effort in the nation's interest can bring shall not be neglected as they are at present. Lest some of you may think that the scientific organisation which I trust you will determine to found would risk success in working on such large lines, let me remind you that in 1859, when the late Prince Consort occupied this chair, he referred to 'impediments' to scientific progress, and said, 'they are often such as can only be successfully dealt with by the powerful arm of the State or the long purse of the nation.' If the Prince Consort had lived to continue his advocacy of science, our position to-day would have been very different. His early death was as bad for Britain as the loss of a great campaign. If we cannot make up what we have lost matters cannot mend. I have done what I feel to be my duty in bringing the present condition of things before you. It is now your duty, if you agree with me, to see that it be put right. You can if you will."

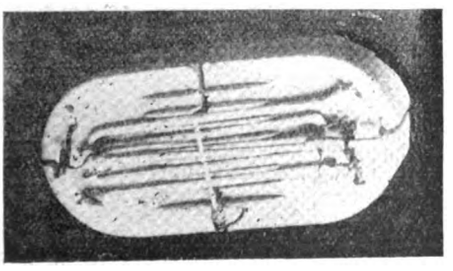
TRADE NOTICES AND NOVELTIES.

"Luna" Nernst Lamps.

A new type of Nernst lamp, called the "Luna," intended more especially to take the place of small arcs, is being introduced by the Electrical Company, Limited, 122 and 124, Charing Cross-road, London, W.C. The feature chiefly remarkable about this lamp is its very high efficiency. The one-ampere 100-volt size has a candle-power of 105, while the sizes taking one ampere at 250 volts, two amperes at 100 volts, and two amperes at 150 volts, yield respectively about 285 c.p., 210 c.p., and 320 c.p. In other words, the "Luna" Nernst lamp consumes less than one watt per candle-power. The principal improvement which the lamp combines is a new form of burner, the construction of which is shown in one of the illustrations herewith. By the use of a flat heating coil the partial screening of the light, which was unavoidable with the helical form of coil hitherto employed, is eliminated, and the efficiency of the burner thus increased. Among the other advantages claimed for the "Luna" Nernst over small arc lamps may be mentioned better diffusion of light, suitability for any direct-current voltage between 100 and 260, longer life, and low initial cost. At present, we understand, this lamp can be supplied for direct current only.



Resistance for "Luna" Nernst Lamp.



Burner for "Luna" Nernst Lamp.

"Luna" Nernst Lamp.

Telpherage in Goods Yards.

The above question is dealt with in Circular 104 issued by Messrs. Siemens Bros. and Co., Limited. The system described is one which lends itself to many useful applications, and will doubtless come rapidly into vogue for the purpose which it is primarily intended to fulfil—namely, the handling of miscellaneous goods at terminal stations. The accompanying illustrations are reproduced from this circular, to which we are also indebted for the following explanatory matter. It is well known that one chief source of expense in connection with goods traffic arises from the fact that on the average trucks are at work for a very small proportion of their total time, being obliged to remain idle for long periods in goods yards waiting their turn for unloading. Telpherage overcomes this defect by providing a means for unloading and loading trucks at any position in the yards, so as to obviate the necessity for their being taken to the goods station for that purpose. The work which telpherage can readily undertake with advantage may be divided into three classes—viz.: (1) the removal of goods from trucks standing on the rails to warehouses or goods sheds; (2) the transference of goods to wagons or trucks for local distribution; (3) the removal of goods to other rails for reloading in other trucks. In doing this, telpherage replaces to a very large extent the most costly of all labour—viz., manual labour—by an electrical substitute which is at once flexible, easily controlled, and cheap. The telpher line is supported upon posts or bents, or suspended from overhead beams, as circumstances may determine. The locomotive power is furnished by a double telpher, to which is attached an electric hoist. Suspended below the hoist is a carrier which is usually of the platform type, but may be of any convenient form, such, for example, as a sling, bucket, or

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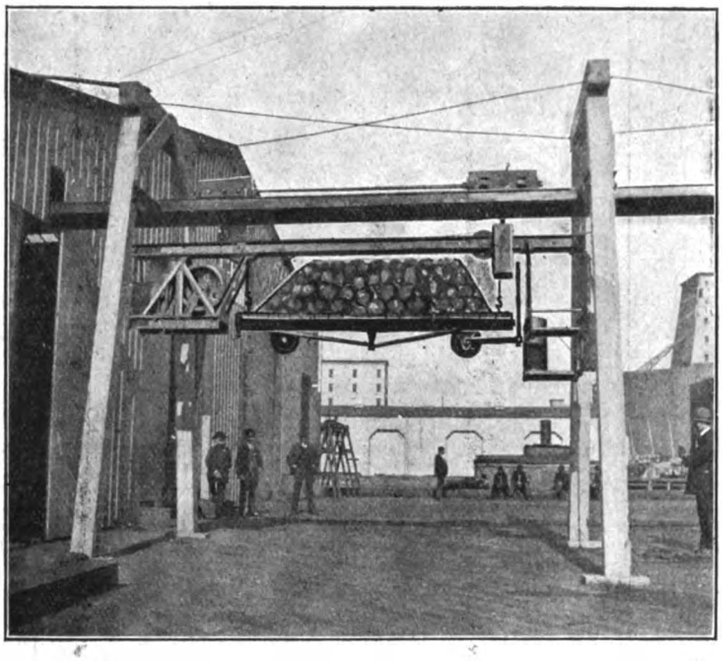
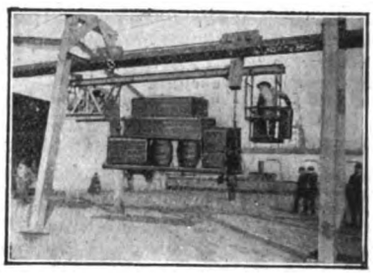
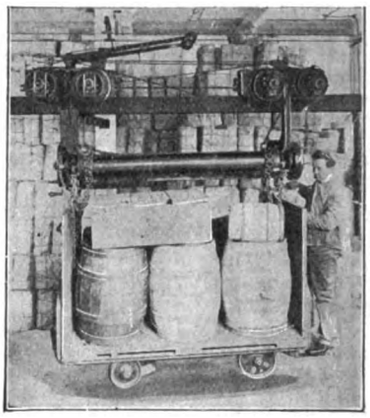
hook. In the accompanying diagram a telpher is shown brought to rest opposite the opening of a goods truck. After the carrier has been loaded it is raised by the hoist and conveyed by the telpher to the warehouse or other destination. The telpherman controls both hoist and telpher by means of switches. Hogsheads may be carried separately or in trains made up of telphers and trailers up to loads of 20,000lb. either automatically or in charge of a telpherman, the hoisting the line run parallel with the walls. In some instances it is desirable for the track to pass through the centre, with branch or gravity line to the centre, or, as is occasionally preferable, to have two side tracks and one or more movable tracks. It is claimed that the transference of goods from railway trucks or warehouses to wagons for local distribution, or from wagons to warehouses, or directly to the trucks, is done much more satisfactorily by a well-designed system of telpherage than by



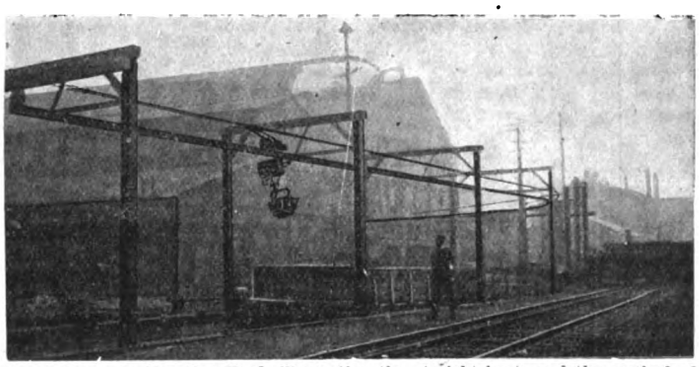
An Electric Hoist attached to a Telpher elevating a loaded truck for transport by the Telpher.



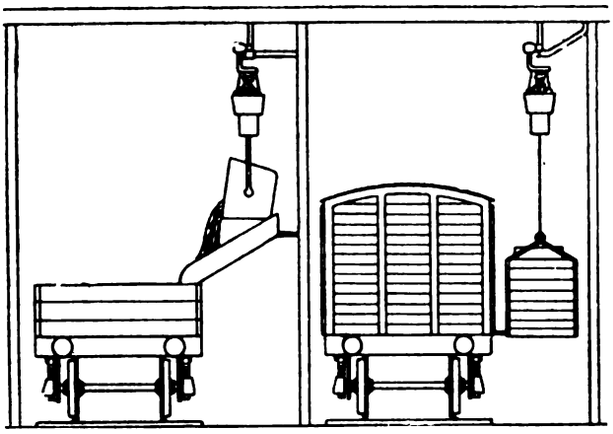
A Load of Miscellaneous Goods approaching a warehouse. The Telpherman's seat is carried by an extension of the Telpher frame.



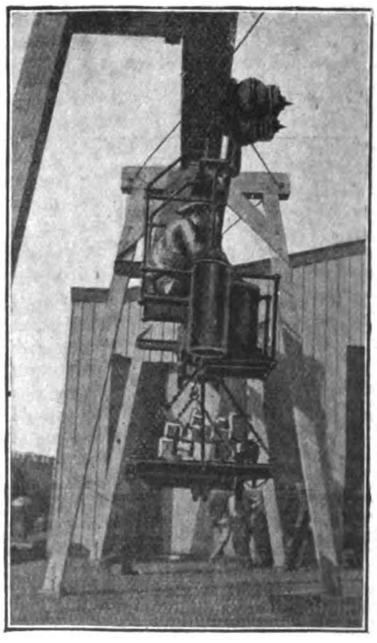
The Telpherman stands at one end of the truck and assists in loading and unloading.



Track Curve in Shunting Yard, illustrating the straight bents and the method of supporting the track and double trolley wire. The line is worked automatically.



An End Elevation of trucks standing on different tracks and served by different Telpher lines.



Load on a trolley in course of being transhipped.

as well as the conveying being done electrically. The construction of the telpher tracks needs little further explanation than the illustrations herewith supply. They are arranged, as shown, in such a manner and at such an elevation as to pass above the wagons and to dispense with the necessity of employing manual labour for the operations of loading and unloading. In interiors it is in most instances desirable to use steel girder rails. The precise form of track, of course, depends greatly upon the local conditions. Usually it is convenient to make any other method, and that the handling of goods to be transhipped is greatly facilitated. The speed of the telpher on straight level stretches of the track may be 800ft. to 1,500ft. per minute, or higher if circumstances permit. Taking into consideration the total work done in a working day, including hoisting, it is found in practice that the average expenditure of power is only about 1 h.p. per ton of average load. Many other advantages are claimed, but for further information we must refer the reader to the source of the above.

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ABERDEEN ELECTRICITY UNDERTAKING.

Mr. J. Alex. Bell, the borough electrical engineer, has presented to the Electric Lighting Committee his report on the progress of the above undertaking during the year ending July 31, 1903. He states that with the exception of some lighting switchboard panels, and the erection of the motor-driven pump for the supply of condensing water from the Dee, the whole of the works contemplated in the original contracts are now complete at the Ferryhill station. The committee have now had a full year's working of the whole of the tramways electrically equipped, and that department has consequently become a larger consumer. Two hundred and nine additional consumers have been coupled during the year, making the total number now coupled 1,159. Again, good progress has been made with motor-using consumers; 81 new motors, of an aggregate horse-power of 328, have been connected during the 12 months, 57 of these being hired out from the Corporation. These additions bring the total number of motors on the mains up to 302, representing 1,160 h.p. The units sold for motors during the last four years are as follows: year ending July 31, 1900, 42,326; 1901, 67,244; 1902, 137,486; 1903, 275,038. It will thus be seen that the 1903 and 1902 consumpts have each been 100 per cent. over the consumpt for the previous year. Electrical heating has increased by an equivalent of 387 33-watt lamps; 115 private arc lamps have been added during the year, making the total coupled to date, 350; and 46 public arc lamps have been added, making a total, including the harbour, of 281. There are now coupled to the mains for lighting, heating, cooking, and motors, not including traction, an equivalent of 126,327 33 watt (8-c.p.) lamps. Extension of mains during the year has given an additional frontage of three odd miles of supply. During the year there have been removed from Cotton-street and fitted up at Ferryhill station two 110-kw. and one 200-kw. sets. These three sets were thoroughly overhauled when diamantled. All station plant is in good order, and the capacity of the two stations at present stands as follows: Cotton-street, 760 kw., or 1,270 h.p.; Dee Village, 1,680 kw., or 2,700 kw. A further 700-h.p. set is on order for Ferryhill, which will be delivered in September. The total costs per unit sold, not including interest, depreciation, and sinking fund, come out this year to 1·25d. This is the lowest figure yet reached. Due to the increased tramway consumpt, and to the additional day load obtained from the use of motors, the load factor this year is 17·4 per cent., whereas last year it was only 14·9 per cent. The average price obtained per unit for private supply works out at 3·69d., as against 4·19d. for last year. This is due to the increased number of units sold at 3d. and 1d. for power, and the reduction made in the price per unit to lighting consumers. This latter reduction has affected the revenue to the extent of £1,029. Mr. Bell does not recommend the committee to make any alteration in the present charges for supply, as he thinks they should have another 12 months' working before any further reduction is made.

Below we give an abstract of the accounts for the 12 months ended July 31 last, on which date the capital expenditure stood at £194,079.

General Balance Account.

Liabilities.	£	s.	d.
Amount borrowed on mortgage	156,440	7	6
Amount of mortgages redeemed by sinking fund	12,653	0	0
Reserve fund	9,557	12	3
Amount due to sundry creditors	3,524	10	1
Amount due to tramway department—excess paid for current	949	12	10
Amount deposited in security for current	337	18	0
Temporary loans	43,626	8	2
Balance due to bank	2,953	1	1
	£230,042	9	11

Assets	£	s.	d.
Amount expended on works, £212,918. 8s. 11d.; less depreciation written off, £18,839	194,079	8	11
Sundry debtors and miscellaneous	13 534	5	8
Stores on hand	14,764	0	1
Reserve fund invested	7,664	15	3
	£230,042	9	11

Revenue Account.

Dr.	£	s.	d.
Fuel	5,929	6	4
Oil, engine-room stores, etc.	665	7	0
Wages at generating station	1,905	0	9
Repairs on buildings, plant, etc.	2,398	18	0
Rents and feu-duty	113	7	10
Taxes	1,634	15	5
Management	332	7	2
Engineer's salary (proportion)	395	16	8
General establishment charges	251	13	10
Engineer's travelling expenses	62	8	4
Stationery, printing, and advertising	120	4	8
Insurance	83	3	6
Inspectors' wages	44	15	1
Auditor's fee	15	0	0
Bad debts	56	7	2
Abatements	461	4	10
Special services	254	1	0
Cost price of lamps sold	34	16	0
Expense of removal from Cotton-street	32	11	8
	14,791	5	3
Balance carried to net revenue account	15,544	14	9
	£30,336	0	0

Cr.	£	s.	d.
Sale of current per meter	19,600	8	2
Public lighting	2,360	13	7
Traction, £8,365. 17s. 10d.; less difference between amount charged and actual cost, £949. 12s. 10d.	7,416	5	0
Sale of lamps	39	10	10
Hire of motors	442	9	1
Attendance on harbour lamps	476	13	4
	£30,336	0	0

Statement of Electricity Generated, Sold, etc.

Quantity generated in B.T. units			2,987,487
Quantity sold: Public lamps	217,212		
Quantity sold: Traction	1,085,306		
Quantity sold: Private consumers	1,274,790		2,577,308
Quantity used in works			160,004
Total quantity accounted for			2,737,312
Quantity not accounted for			250,157

Number of public lamps, 187 arcs.

ST. PANCRAS ELECTRICITY ACCOUNTS.

The following is the report of Mr. Albert E. Pycraft, chief clerk to the St. Pancras Borough Council, on the working of the electric lighting department during the year ended March 31, 1903, the capital expenditure to that date being £423,500. Abstracts of the revenue account, general balance-sheet, and statement of electricity generated, sold, etc., are also appended:

Loans have been received during the year amounting to £40,000, making the total loans sanctioned and borrowed £375,620, of which the sum of £33,243. 17s. 5d. has been repaid. The expenditure on account of capital during the year was £45,514. 5s., making a total capital expenditure at March 31, 1903, of £423,500 12s. 8d. The gross revenue for the year amounts to £68,372. 2s. 7d., and the net revenue £32,275. 16s. 11d., which after meeting charges for interest and repayment of loans, etc., leaves a credit balance of £16,818. 0s. 6d. on the year's trading. In making comparison with past years it should be recorded that of this balance a sum of £2,344 is due for accrued interest which has not been taken to account this year in deference to the wishes of the district auditor, who states "that interest only which has become due for payment or has been actually paid should be taken account of." It should also be borne in mind that in the last statement of accounts the income taken to account was not for a full period, by reason of the earlier reading of consumers' meters, and there was a consequent shortage of revenue of about £2,250, to which I drew attention in my last report, whereas the present accounts are for an exact period of 52 weeks' income and expenditure. The increase in revenue from private supply over the previous year is £3,717. 3s., equivalent to 18·5 per cent., which I think may be regarded as satisfactory. The following table shows the progress of the electricity undertaking since the commencement:

Year ending Dec.	No. of consumers.	Current sold to consumers (not including public street-lighting). 3d. per unit. £	s.	d.	4d., 5d., and 6d. per unit. £	s.	d.	No. of lamps, etc., applied for. Incandescent. 16 c.p.	Arc.	Motors.
1892	172	—			8,167	7	8	9,990	82	11
1893	238	384	11	6	9,161	6	0	12,851	110	19
1894	349	1,236	13	9	10,818	15	9	15,542	129	22
1895	447	2,142	9	6	12,682	6	0	19,195	139	37
1896	672	2,948	19	9	19,430	8	8	26,423	187	47
1897	808	4,081	10	0	25,220	11	5	32,250	256	78
1898	984	8,415	0	0	23,446	5	2	38,124	292	91
1899	1,184	11,699	12	3	25,992	17	6	46,172	315	126
1900	1,438	12,563	16	7†	25,914	5	9	57,456	426	152
March, 1902*	1,806	20,996	4	1†	38,228	8	5	66,999	523	211
1903	2,046	20,647	3	7†	35,290	16	8	75,156	646	269

* 15 months. † 2d. and 3d. per unit.

General Balance Sheet.

Dr.	Liabilities.	£	s.	d.
Capital account—amount received		375,620	0	0
Amount received on loan from bankers		44,464	17	2
Sundry creditors		5,346	3	8
Amount due under contracts		9,847	19	10
Net revenue account		18,152	17	9
Reserve fund		13,856	18	10
		£467,288	17	3

Cr.	Assets.	£	s.	d.
Capital account—amount expended for works		423,500	12	8
Stores in hand		6,297	17	5
Debtors for current supplied, less deposits		20,925	13	1
Sundry debtors		776	9	10
Amounts due on account of street lamps, etc.		1,128	0	11
Reserve fund investment account		13,856	18	10
Suspense account		658	18	10
Cash in hand		144	5	8
		£467,288	17	3

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Dr. Revenue Account.	£	s.	d.
Coal or other fuel	13,928	1	10
Oil, waste, water, and stores	1,339	1	5
Proportion of salaries of engineers (generation)	577	0	1
Wages at generating stations	4,208	2	6
Sundry petty expenses	218	1	9
Repairs and maintenance (generation)	3,189	6	8
Proportion of salaries of engineers, etc. (distribution)	473	3	6
Wages of outdoor staff	1,021	8	5
Repairs, etc., buildings	92	17	1
Repairs, etc., of mains	672	18	9
Sundry petty expenses	189	18	5
Alterations in connection with changing pressure on mains, etc., to 220 volts and changing services from copper strip to cables	684	6	3
Repairs, etc., of meters, etc.	433	17	10
Repairs at distributing stations	6	17	11
Water, etc., at distributing stations	12	1	7
Public lamps	2,121	6	7
Salaries—engineer's department and clerical staff	1,958	13	8
Stationery and printing	274	4	1
General establishment charges	405	18	5
Law expenses	111	0	10
Licenses and wayleaves	27	10	6
Rents, rates, and taxes	2,840	14	7
Insurances, etc.	286	4	9
Fees, testing meters	3	5	0
Expenses obtaining loans	66	16	0
Compensation claims	217	1	3
Smoke prevention apparatus	39	8	9
Oil fuel experiments	74	7	9
Rearranging switchboard cables and removing plant	170	9	8
Sundry chargeable works	453	19	10
Total expenditure	360,096	5	8
Balance carried to net revenue account	32,275	16	11
	£68,372	2	7

Cr.	£	s.	d.
Sale of current per meter at 6d. per B.T.U.	22,165	12	0
,, ,, 5d. ,,	11,283	3	4
,, ,, 4d. ,,	1,842	1	4
,, ,, 3d. ,,	17,649	19	3
,, ,, 2d. ,,	2,997	4	4
	55,938	0	3
Sale of current (minimum charges)	18	0	0
Public lighting (sale of current and all charges)	11,183	1	9
Indicator rentals	184	12	0
Sundry chargeable works	511	4	9
Fees for testing installations	10	0	6
Rents receivable	377	3	4
Proportion of office expenses chargeable to the Lighting (Gas) Department	150	0	0
	£68,372	2	7

Statement of Electricity Generated, Sold, etc.

Quantity generated in B.T. units		5,124,617
Quantity sold: Public lamps	894,647	
Quantity sold: Private consumers	3,206,487	
Quantity sold: Public buildings	103,916	4,205,050
Quantity used on works and testing-room		309,972
Total quantity accounted for		5,097,545
Quantity not accounted for		582,523
Number of public lamps		453
Total maximum supply demanded (kilowatts)		*2,741

* Maximum kilowatts drawn from the stations.

ISLINGTON ELECTRICITY ACCOUNTS.

The total expenditure on capital account on March 31 last in respect of the borough of Islington electricity undertaking stood at £403,650. Below we give an abstract of the accounts for the year ended on that date.

Revenue Account.

Expenditure.	£	s.	d.
Coal and other fuel	12,863	2	6
Oil, waste, water, and stores	1,996	12	4
Wages at generating station	3,753	0	10
Repairs, etc., of buildings, engines, etc.	2,272	13	1
Wages (distribution)	327	10	5
Repairs, etc., of mains and meters	1,017	10	9
Public lamps	2,255	6	3
Rates, £1,864. 17s. 9d.; less amount of income tax on loan interest, £478. 18s. 5d.	1,385	19	4
Salaries	2,064	18	2
Printing and stationery	294	1	3
Insurance	218	3	4
Legal expenses	26	16	0
General establishment charges	340	19	3
	28,816	13	6
Balance carried to net revenue account	15,610	16	6
	£44,427	10	0

Income.	£	s.	d.
Sale of current—Public lamps	13,958	11	9
Private lighting	29,590	4	5
Rent of meters, etc.	636	16	0
Coronation decorations	103	14	9
Liquidated damages for breach of contract	111	0	0
Unclaimed balances on deposits	5	4	7
Miscellaneous fees	21	18	6
	£44,427	10	0

Balance-Sheet.

Dr. Liabilities.	£	s.	d.
Mortgages	367,435	3	5
Sundry creditors	3,010	17	2
Balance due to treasurer on capital account, £589. 6s. 9d., and on revenue account, £12,449. 1s.; less in cashier's hands as per official disbursements, £149. 6s.	12,889	1	9
	383,335	2	4
Excess of assets	19,149	9	8
	£402,484	12	0

Cr. Assets and Capital Outlay.	£	s.	d.
Capital outlay	388,670	3	5
Sundry debtors	12,527	12	8
Stores on hand	1,286	15	11
	£402,484	12	0

Mr. Albert Gay, in his report on the above accounts, says he is disappointed with the result. A net deficit of £1,740 does not appear very encouraging. On going into the figures, however, the reasons for this deficit become obvious. He finds that the average increase in the number of units sold year by year during past years is about 370,000, while the total increase in the year under review as compared with the previous year is only 178,314, which would amount to over £3,000. The reduction in price, and the abolition of meter rents, which came into operation on Jan. 1 last, accounts for a fall in the revenue of £435, while the rates and taxes having been increased from £1,400 to £1,800 is accountable for a further £400. With regard to the cost per unit, he regrets to say that this has increased from 2·71d. to 2·97d., or practically ¼d. per unit, the chief items being repairs, rates and taxes, coal. Unfortunately, the repairs necessary to buildings, machinery, and mains have been exceedingly heavy during the past year, having increased from £1,671 in 1902 to £3,852 last year. This, and the increase in rates and taxes, virtually make up the difference of ¼d. per unit in the costs, a slight increase in the cost of coal accounting for the balance. The above items summarised show results as follows: (1) reduction in price, £435; (2) increase due to enhanced price of coal, £512; (3) increase in rates and taxes, £400; (4) increase in cost of repairs, £2,281—£3,628; and but for these items there would have been a profit of £1,888. Mr. Gay has not the slightest doubt that the accounts for the current year will be far more satisfactory.

LEGAL INTELLIGENCE.

ELECTRIC TRAMWAYS TRUST.

In the Vacation Court on Wednesday Mr. Justice Walton heard the petition of W. Bratby for a winding-up order against the Electric Tramways Trust, Limited.

Mr. Mulligan said the company was registered on Dec. 21, 1900, at which time it had a capital of only £100; but the business had so increased since then that the present authorised capital was £60,000. Of this, there had been issued £2,167. The petitioner was a creditor for £516, and his debt was admitted. It was due upon bills accepted by the company, and which matured in July last. The company had passed extraordinary resolutions to wind up voluntarily.

Mr. Bramwell Davis, for the company, said there were no assets, not even enough to pay the costs of the petition. The British Motor Traction Company and the British Electric Street Tramways Company, which held shares in the company, were both in liquidation.

His Lordship granted a supervision order for winding up, with liberty to apply in chambers for an additional liquidator.

FERRANTI LIMITED.

Before Mr. Justice Walton in the Vacation Court on Wednesday, **Mr. Bramwell Davis, K.C.**, said that in the matter of Ferranti Limited—Poole *v.* Stirling—it was a case in which his Lordship had already appointed the *ex parte*, a receiver and manager, with leave to borrow £2,000. He (counsel) appeared for one of the trustees for the debenture holders (Mr. William Jones), and also for Parr's Bank, who hold second debentures for £30,000, and who were not parties to the action at that moment. His application was that Mr. Whittaker should be joined with Mr. Tate as receiver and manager of the company's property and business. Mr. Jones, in his affidavit, set out that this was a very large electric business, carried on at Manchester, and it was absolutely necessary for someone on the spot, like Mr. Whittaker, to supervise and carry on the business.

Mr. Justice Walton made the appointment as now asked, with leave to borrow £20,000, less the sum of £2,000 already borrowed, and with leave to apply £2,000 to meet the current weekly wages bill.

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COMPANIES' MEETINGS AND REPORTS.

ELECTRIC RAILWAY AND TRAMWAY CARRIAGE WORKS.

The report of the directors to be submitted to the ordinary general meeting of the shareholders on 24th inst. states that the works have been efficiently maintained during the year as regards buildings and machinery, the cost of which has been charged against revenue. After paying debenture interest amounting to £2,500, and charging £5,096. 3s. 9d. for depreciation, the profit for the year is £16,594. 14s. 11d., to which must be added £2,832. 3s. 8d. brought from last year, making a total of £19,426. 18s. 7d. The directors recommend that this amount be dealt with as follows: to carry to general reserve fund, £2,000; to pay a dividend of 8 per cent., less income tax, for the year ending June 30, 1903, £12,000; to carry forward to next year, £5,426. 18s. 7d.—total, £19,426. 18s. 7d.

CONTRACTS FOR ELECTRICAL SUPPLIES.

Macao.—The Colonial Office at Lisbon invite tenders for the electric lighting of Macao. Tenders by Oct. 21.

Lisbon.—The Public Works Department require tenders for the public electric lighting of Macao. Tenders by Oct. 21.

Bucharest.—The Government Railways require tenders for the installation of electric lighting and plant for their workshops. Tenders by Oct. 10.

Paris.—The Post and Telegraph Department, Rue de Grenelles 103, invite tenders for (1) 190,000 ko. bronze or copper wire and 94,000 joints, and (2) 12 kilometre submarine telegraph cable.

Transvaal Colony.—The Chairman of the Tender Board, Pretoria, requires tenders for installing and working the electric lighting of Potchefstrom for about five years. Tenders by Oct. 30.

Kirkcaldy.—The Corporation invite tenders for supply of all fittings for installing the electric light into the memorial halls in Bennochy-road. Tenders by Sept. 12. See advertisement.

Croydon.—The Council invite tenders (1) for the building works and (2) for the smith and ironfounders' work in connection with the extension of the electricity works, Factory-lane, Croydon. Tenders by Sept. 14. See advertisement.

Dublin.—The Port and Docks Board invite tenders for the supply of a 100-ton electric crane. Specification can be obtained at the office of the engineer to the Board, Mr. John P. Griffith, M.I.C.E., Eastwall, Dublin. Tenders by Oct. 5.

London, E.—The Whitechapel Guardians invite tenders for electric lighting of a portion of the infirmary. Specifications, etc., may be obtained from Mr. F. J. Tootell, clerk, Union Offices, 74, Vallance-road, N.E. Tenders by 12th inst.

London, E.—The Whitechapel Guardians invite tenders for electric lighting of a portion of the infirmary. Specifications, etc., from Mr. F. J. Tootell, clerk, Union Offices, 74, Vallance-road, N.E. Tenders must be sent in by Sept. 12.

Huddersfield.—The Corporation invite tenders for the supply and delivery of about 30 tons of steel tramway rails (girder section), with fishplates, tierods, bolts, trolley poles, bracket arms, overhead-line material, &c. Tenders by Sept. 16. See advertisement.

Shanghai.—The French Colony propose to instal motor-propelled tramways. Tenders may be sent by Oct. 31, 1903, to Secrétariat de la Municipalité Française de Shanghai. Particulars may be obtained from l'Office National du Commerce Extérieur, Rue Feydeau, 3, Paris.

Rotherham.—The Tramways Committee invite tenders for supply of an electric watering car and track sweeper. Full particulars may be obtained from Mr. Grant, Tram Depot, Rotherham. Tenders to Mr. H. Hampton Copnall, town clerk, Town Hall, Rotherham, by 18th inst.

Brussels.—The Post and Telegraph Department require tenders for 111,500 ko. galvanised iron wire, 5,100 ko. wire cable, 1,875 ko. copper wire, 532,900m. copper wire, 153,650 insulators, etc. Specification No. 200 at above. Tenders by 11 a.m. on Sept. 16 at the Bourse.

Rochdale.—The Guardians invite tenders for certain new underground cables and switchboard alterations and additions required at the workhouse, Dearnley. Specifications, etc., may be obtained from Messrs. Shepherd and Watney, Greek-street-chambers, Leeds. Tenders by 26th inst.

Russia.—The Russian Minister of the Interior has sanctioned a plan for the reconstruction of three lines of municipal tramways—namely, those in Newsky, Sadovaia, and Wassiliostrow districts. Each car is to provide for two classes of travellers, and will accommodate 52 persons.

Utrecht.—The Town Council will receive tenders for supply and erection of a central electric establishment for lighting, power supply, and working tramways. Contract, conditions, etc., to be obtained at the "Gemeente Secretaire" of Utrecht, on payment of 5fl. (8s. 4d.). Tenders by Oct. 1.

Southend-on-Sea.—The Corporation invite tenders for steam dynamo, boiler, and condenser. Specification, etc., may be obtained from Mr. W. E. J. Heenan, M.I.E.E., borough electrical engineer and general manager, Southend-on-Sea. Tenders by noon on Sept. 14. See advertisement.

Brighton.—The Town Council invite tenders for the (1) supply of steel girder tramrails, fishplates, etc.; (2) tramcars; (3) points and crossings and other fittings. Specifications, etc., may be obtained from Mr. Francis J. Tillstone, town clerk, Town Hall, Brighton. Tenders by 10.30 a.m. on Oct. 5.

Leeds.—Tenders are invited for concrete engine and dynamo foundations in Whitehall-road, for the Electric Lighting Committee. Plans, etc., may be obtained at the office of Messrs. Milnes and France, 99, Swan-arcade, Bradford. Tenders by 15th inst. to Mr. W. J. Jeeves, town clerk, Leeds.

West Ham.—The Guardians invite tenders for the supply of various articles to the workhouse infirmary and schools for 12 months from Sept. 29, including asbestos goods, electrical fittings, engineers' sundries, etc. Tenders to the Clerk's Office, Union Workhouse, Leytonstone, N.E., by 10 a.m. on Sept. 16.

Madrid.—The Telegraph Section of Posts and Telegraph Department, Madrid, invite tenders for telegraph and telephone apparatus (Morse receivers, Morse manipulators, switches, Ericcson instruments, etc.) of a total estimated value of about £2,190. Tenders by 19th inst. A provisional deposit of 5 per cent. is required.

Glasgow.—The Corporation invite tenders for the supply and erection of electric cables, main switches, distributing boxes, and other accessories required for Baltic-street baths and wash-houses. Specifications, etc., may be obtained from Mr. J. Lindsay, clerk, City Chambers, Glasgow. Tenders by 10 a.m. on 16th inst.

Johannesburg.—The Municipality require tenders for gas generating plant or for steam generating plant and for gas motors or steam motors, with electric generators and accessories. Particulars may be obtained from the Town Clerk, Johannesburg, or from Messrs. Mordey and Dawbarn, 82, Victoria-street. Tenders by Oct. 19.

Launceston (Tasmania).—The Mayor and Aldermen invite tenders for the supply of 500 or more electric meters. Particulars may be obtained on application to Mr. William Corin, city electrical engineer, Launceston, Tasmania, or to Messrs. John Terry and Co., 7, Great Winchester-street, London, E.C. Tenders by Sept. 28.

Cienfuegos (Cuba).—The Municipal Authorities require tenders for the installation and working of electric lighting. They will pay an annual subsidy of 24,000 piastres for 150 arc lamps of 1,500 c.p. each and 350 incandescent lamps of 50 to 100 c.p. each for street lighting, and 16 to 25 lamps in public buildings. Tenders by 1 p.m. on Sept. 28.

Edinburgh.—The Council invite tenders for the following works in connection with the proposed extension of Macdonald-road electric power station: (1) building works, including excavator, mason, brick, joiner, slater, plasterer, plumber, and glazier's work; and (2) smith and ironfounder's work. Tenders must be sent to Mr. R. Morham, city architect, by 10 a.m. on Sept. 14.

London, S.E.—The London County Council invite tenders for the supply, delivery, and erection in the electricity generating station to be established by the Council at Greenwich of four 5,000-h.p. vertical-horizontal steam-engines, each suitable for driving a three-phase generator. Particulars, etc., may be obtained at the County Hall, Spring-gardens, S.W. Tenders by 10 a.m. on Oct. 6.

Bradford.—The Corporation invite tenders for the construction of about 13 miles of light railways and tramways in connection with the Angram storage reservoir works. Plans may be seen and specifications, etc., obtained at the office of Mr. James Watson, M.I.C.E., waterworks engineer, Town Hall, Bradford. Tenders to Mr. Frederick Stevens, town clerk, Town Hall, Bradford, by 10 a.m. on Oct. 1.

Birmingham.—The Tramways Committee require the names of contractors who are desirous of tendering for the supply and delivery of materials and fittings as follows: (Section A) manganese steel points and crossings; (B) tapered steel side poles and bracket arms; (C) suspension ears, pull-offs, section insulators, and other overhead materials; (D) hard-drawn copper trolley wire and stranded steel span wire. Mr. John Price, city engineer, Council House, Birmingham.

Stoke-upon-Trent.—The Corporation invite tenders for the supply and erection of the following plant in connection with the proposed electricity and destructor works: (Contract 10, Section A) pipework; (B) non-conducting covering; (C) water-softening plant. Persons are at liberty to tender for any single section. Specifications, etc., can be obtained from Mr. P. J. S. Tiddeman, Field-place, Stoke-upon-Trent. Tenders to Mr. Jno. B. Ashwell, town clerk, Town Hall, Stoke-upon-Trent, by 5 p.m. on Sept. 11.

Bermondsey.—The Borough Council invite tenders for (Contract No. 12) the construction, supply, and erection of two dust-destructor cells, with furnaces, flues, etc., and storage bins, one water-tube boiler and brickwork settings, one water storage tank, with supports for same, and extensions to the steam, feed, and exhaust piping system; (13) the construction, supply, and erection of two 300 kw. steam generators, two 20-kw. feeder boosters, one 15 kw. motor-balancer, and sundry switchgear and connecting cables. Specifications can be obtained from Mr. Fredk. Ryall, town clerk, and may also be inspected (but not obtained) at the offices of the engineers, Messrs. Kincaid, Waller, Manville, and Dawson, 29, Great George-street, Westminster. Tenders by Sept. 21. See advertisement.

London, E.C.—Tenders will be received until noon on Sept. 28 (a for the supply of Swedish, Norwegian, or Finland red fir telegraph poles, to be delivered in London, at Northumberland Dock (River Tyne), West Hartlepool, Hull, or Grimsby, at Leven, Fifeshire, and at Swansea, Cardiff, or Newport; and (b) for creosoting the poles with 10lb. or 12lb. of creosote to the cubic foot, as may be directed. The poles to be felled during the winter of 1903-4, and to be delivered during the following summer at the port at which the creosoting is to be performed. Butt sections, 2in. thick, stamped with the shipper's mark, from not less than three poles, to show the quality of timber offered, must precede or accompany the tender of any person who has not already supplied the Postmaster-General with poles. Forms of tender may be obtained from Mr. S. C. Hoolley, controller of stores, Stores Department, 17-19, Bedford-street, London, W.C.

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RESULTS OF TENDERS.

Preston (Lancs.).—The Town Council have accepted the tender of T. B. Garnett, Preston, at £11,000, for the construction of a tramway car-shed.

Colchester.—The Electric Light Committee have accepted Messrs. Statter's tender to supply certain additions to the traction switchboard at a cost of £99.

Pietermaritzburg.—The tender of Messrs. Strong and Moore has been accepted for the laying down of the permanent way for the electric tramway system at £16,856.

West Ham.—The Town Council have accepted the tender of the British Thomson-Houston Company, Limited, Rugby, at £2,183, for traction switchboard, etc., complete with electrical equipment.

Johannesburg. — The Hadfield Steelfoundry Company have secured the contract for points and crossings for the tramways at £5,355 8s. 7d., f.o.b. British port; whilst Messrs. Askham Bros. and Wilson (p.p. Edgar Allen and Co., Limited, Sheffield), through the Brush Electrical Engineering Company, are to supply the tiebars, sole joists, bolts, etc., at £3,333, f.o.b. The bulk of the contract was secured by the Brush Company, who for grooved rails represented the interests of the Société Anonyme d'Ougrée, Belgium.

London.—The Metropolitan Asylums Board have received the following tenders for electric lighting of receiving home for children:

Buchanan and Curwen, 64, Victoria - street, S.W. (accepted)	£398	0	0
Wenham and Waters, Limited, Paragon Works, Croydon	407	0	0
V. G. Middleton, Broadway-chambers, Westminster, S.W.	443	0	0
Eastlakes, Limited, 4 and 5A, Cowley-street, Westminster, S.W.	450	0	0
Drake and Gorham, 66, Victoria-street, S.W.	496	0	0
Hayward-Tyler and Co., 90 and 92, Whitecross-street, E.C.	503	16	6

London, W.—The Chiswick Urban District Council have received the following tenders for gas-driven sewage pumping plant, compressors, and electric lighting sets:—

Bilbie, Hobson, and Co.	£6,500	0	0
Campbell Gas-Engine Company, Limited	3,513	7	6
Crossley Bros., Limited	3,304	0	0
Drysdale and Co.	1,930	0	0
J. and H. Gwynne, Limited	5,305	0	0
Gwynne and Co.	3,527	0	0
Pollock, Whyte, and Waddel	3,202	0	0
Sir Hiram Maxim Electrical Engineering Company (accepted)	3,197	2	0
D. Stewart and Co. (1902), Limited	2,772	0	0
Tangyes, Limited	4,470	0	0
J. Wolstenholme and Son	3,562	10	0

BUSINESS NOTES.

LIGHTING AND GENERAL.

Crewe.—Arc lamps are to be placed in the principal streets.

Nelson.—The Town Council have decided upon cable extensions at a cost of £250.

Halifax.—Sanction has been obtained for a loan of £19,000 for electric supply.

Accrington.—The borough accountant has been authorised to raise £6,890 for electric lighting.

Holland.—It is proposed to expend £4,000 in installing the electric light at the County Council asylum.

Wednesbury.—The Town Council have been authorised to raise a loan of £11,000 for electric lighting purposes.

Farnham.—The local gas company have offered to take over the order obtained by the Urban District Council.

Sheffield.—The Council propose to extend the electric lighting mains in various directions at a cost of £1,303.

Yarmouth.—The Guardians have decided that the electric light be installed at the workhouse at a cost of £19. 10s.

Warrington.—The Town Council have received sanction to the borrowing of £18,600 for the purpose of electric lighting.

Consett.—The Urban District Council have referred to a committee the question of lighting the district by gas or electricity.

Batley.—The Town Council intend to apply for sanction to borrow an additional £5,000 for the extension of the electric cable.

Lytham.—The Council are collecting information as to the cost of producing electric current by gas power as compared with steam.

Llandilo.—An enquiry is to be held into the Urban District Council's application for power to borrow £1,300 for additional plant.

Morpeth.—Plans for the erection of a power station on the Low Stanners for the Northern Electric Supply Company have been passed by the Town Council.

Bexley.—The District Council intend to apply for sanction to borrow £1,760 for purposes of public and private electric lighting in the East Wickham ward.

Penmaenmawr.—The District Council are conferring with Messrs. Lacey and Sillar, of Manchester, consulting engineers, *re* a report upon an electrical installation.

Hythe.—The Folkestone Electric Lighting Company have now taken over the whole of the public lighting of the town. It is proposed to provide a number of extra power lamps.

Dumbarton.—The Clyde Valley Electric Power Company intend to apply to the Board of Trade for an electric lighting order for parts of the parishes of Bonhill, Cardross, and Dumbarton.

Blaydon.—The Urban District Council are conferring with the Priestman Power Company, who are desirous of taking over the Council's responsibilities under their provisional order.

Mansfield Woodhouse.—Application is to be made by the Council for a provisional order to authorise the supply of electricity for public and private purposes within the urban authority's district.

Newport.—The Electricity Committee have decided that it would be contrary to the policy of the Council to accept the gas company's offer, and recommend that the scheme for arc lighting be proceeded with.

Personal.—The following appointments have been made in connection with the Bexley Council's electricity undertaking: senior charge engineer, Mr. H. Knorr; junior charge engineer, Mr. J. D. Laws.

Perth.—The Electric Lighting Committee are considering a request for a service in Kinnoull district. The Electric Committee propose to apply for powers in the new omnibus Bill to let out small motors on hire.

Brighton.—It has been resolved that as an experiment for one year the charge for the supply of electricity to premises controlled by a time switch be 1d. per unit from 8 o'clock, instead of from 10 o'clock in the evening.

Portsmouth.—The last electric light accounts show a net profit of £3,000, which will help to swell the reserve fund. The profit on the committee's operations during the year was £14,079, of which £11,079 went for interest on loans, etc.

Gloucester.—An enquiry has been held into an application of the Corporation to borrow £25,000 for purposes of their electricity undertaking, including the provision of the additional plant required for supplying power for the proposed light railway.

Bann Motor Company, Limited.—This company has been registered with a capital of £12,500, £2,500 being preference shares, for the purpose of dealing in all sorts of steam, electric, or other engines and motors. Registered office: Portadown, co. Armagh.

Yardley.—The Rural District Council have appointed a special committee for the purpose of consulting the British Electric Traction Company as to the lighting of the main roads in the parish of Yardley with electric light, and ascertaining the cost of same.

Eccles.—The Council have reduced the charge for energy supplied for the borough distributing mains for motor or power purposes. During the past three months the apparent loss has only been £229, whilst for the same period in 1902 it was £372, and in 1901 £515.

Ripon.—The Council will oppose the Empire Electric Light and Power Company, Romford, who intend to apply for an electric lighting order for the city in the next session of Parliament. The Council will probably apply for an extension of their electric lighting order.

Colchester.—At the last Council meeting the report of the Electric Light and Power Committee, which included a recommendation that certain tenders amounting to £99 be accepted, subject to the Local Government Board's sanction to a loan of £7,000 being obtained, was adopted.

Darlington.—The minutes of the Electric Lighting and Tramways Committee submitted to the last Town Council meeting showed a considerable increase in the number of units generated in the electricity department, and applications had also been received from 30 intending consumers.

Bognor.—The Urban District Council have adopted the scheme of the Industrial Engineering Company for installing electric plant in the town subject to an agreement and to the Board of Trade's approval of the same, and to the Local Goverment Board agreeing to the Council leasing the land.

Kirkcaldy.—The Tramway and Electric Lighting Committee have decided to lay electric lighting mains throughout Commercial-street, a sufficient number of connections having been guaranteed to warrant the committee undertaking the extension. The street is also to be lit with arc lamps.

Leicester.—Tenders will be advertised for plant for the electric lighting of the North Evington Hospital. The cost will be approximately £7,000. The Corporation will do the wiring at net cost, and Mr. Colson, the borough electrical engineer, has promised to superintend the work.

Glasgow.—The Electricity Committee have resolved to recommend that the department be authorised to supply electric motors on hire. A small motor, it is stated, may be let for about £3 per annum, while a motor of 25 h.p., which would cost £250 to purchase, may be rented for about £20 per annum.

Swansea.—The demand for electricity has increased by 94 per cent., 139,000 units being sold in the quarter ending June 30 last, as compared with 71,000 units during the corresponding period of last year. With regard to the proposed electric lighting of Morristown a canvass of the district affected is to be made.

Loughborough.—Last month the borough surveyor was given permission to act jointly with Mr. C. H. Gadsby, the electrical engineer, in preparing the architectural work in connection with the electricity power station. The resolution granting such permission was, however, rescinded at the last Town Council meeting.

St. Annes.—The electrical engineer in his last report states that the number of units sold to July 31 was 104,489, against 27,489 in 1902; the maximum load for lighting was 111 kw., against 93 kw., and for traction 220 kw.; the number of consumers is 194, against 113. A number of new electric lighting mains are to be laid.

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Whitby.—The Urban District Council are raising £2,500 for the extension of the cable in Fishburn Park and for a mechanical stoker. The Finance Committee in their last report state that the receipts from private consumers of the Council's electric light would amount to £500, as compared with £250 for the preceding half-year.

Automatic Fire Alarms.—Honorariums of £50, £30, and £20 are respectively offered for (1) the best form of and quickest operating thermostat for closed circuits; (2) a means of "testing back" from a fire station to a factory to distinguish from or ascertain if the fall of a drop indicator is caused by heat, or by short-circuit, or tampering, etc. Further particulars appear in our advertisement columns.

Automatic Signalling.—In consequence of the heavy rains of last week, the electrified portion of the District Railway was flooded in two places. The water partially submerged the running and negative rails. We are informed that, in spite of this, the track circuits of the Westinghouse automatic signal, with which this line is equipped, were not in any way affected, and the trains were signalled without a hitch.

Clydebank.—The poll to decide whether the burgh should or should not carry out its own electric light provisional order, combined with the building of a dust destructor, resulted as follows: Number of papers issued, 3,183; returned, 1,459; 1,104 against, and 355 for. This means that the order will be acquired by the Clyde Valley Electric Power Company, who are laying down a considerable amount of plant at Yoker.

West Hartlepool.—The following scale of charges for current for motors has been adopted: for less than 150 units per horse-power installed per quarter, at 2d. per unit; 151 units, and not exceeding 200 installed per quarter, at 1¾d. per unit; 201 units, and not exceeding 250 installed per quarter, at 1⅝d. per unit; 251 units, and not exceeding 300 installed per quarter, at 1½d. per unit; 301 and above installed per quarter, at 1¼d. per unit.

Gainsborough.—The question of procuring an electric lighting order was considered at the Council meeting, and it was agreed to make an application for a provisional order to produce and supply electricity within the urban area. The suggested streets upon which lines should be laid were Church-street (portion), Market-place, Silver-street, Bridge-street (portion), Market-street, Beaumont-street, and Trinity-street. The estimated cost is £12,000.

Lowestoft.—The electrical engineer in his last report states that there have been five new consumers connected up to the mains during the month, which, with extra lamps, represents 150 8-c.p. lamps added during the month. There are now 418 consumers, representing 23,347 8-c.p. lamps connected to the mains. The engineer has been instructed to communicate with free wiring companies and obtain tenders and report thereon to a future meeting.

Salford.—Application is to be made for permission to charge the sum of £34,443. 16s. 9d. over expended on the main building of the electricity works, machinery and plant, and mains, etc., against the borrowing power of £43,282 granted for feeding cables, section boxes, and electrical equipment for the tramways, but not used; and if such permission be declined, to apply for additional sanction to borrow the sum of £34,444, or such further sum as may be found necessary to cover the excess expenditure.

Dundee.—An immediate start is to be made by the North British Railway Company with the installation of electric lighting at the platforms and buildings connected with Tay Bridge Station, the goods yard, and the lyes, where extensive shunting operations are regularly carried on. The supply, it is understood, will be drawn from the Corporation works. The necessary plant will be furnished by the North British depôt, and the work of installation will devolve upon the engineers in the company's employ

New Issue.—The Weston-super-Mare and District Supply are issuing £35,000 4½ per cent. first mortgage debenture stock and 34,930 6 per cent. cumulative preference shares of £1 each. This company was formed in 1899 to take over the Weston-super-Mare Electric Lighting Order, 1891, granted to the Urban District Council of Weston-super-Mare. The company have since obtained the Weston-super-Mare Tramways Orders, 1900 and 1901, authorising the construction of tramways about four miles in length, of which nearly three miles have been constructed. The generating station was opened in May, 1901, and the tramways in May, 1902.

The Electrical Rugby Football Championship.—The long-deferred match between Glover's and Chloride was played off on Wednesday on the Broughton Rangers' ground at Manchester, and resulted in the "Cables" boosting the "Accumulators" by two tries to one. The game was chiefly remarkable for the number of personal injuries sustained, the losers having one man's shoulder broken within the first 10 minutes. The tries for the winners were scored by Horton and Brady, and Causer scored the losers' point. Both works closed early for the game, and despite the bad weather a large number of electrical works were represented among the spectators.

Bury.—The engineer (Mr. L. P. Greig) in his last report states that the new engine and dynamo have been erected and grouted down upon the foundations, and as soon as the closing pieces of the piping have been received, the engine and dynamo could be run on the load, which was increasing rapidly. The condensing plant had been running, and had effectually done away with the boom of the exhaust steam. It was suggested that the committee hold their next meeting at the works in order to inspect the whole of the new plant while in operation. The committee have resolved to place an additional lamp in Cotton-lane, and also to hold the next meeting of the committee at the works. The remuneration of the two assistant engineers has been increased by 5s. per week each.

Teddington.—The Twickenham and Teddington Electric Supply Company, who have leased the order for the supply of electric light obtained by the Teddington District Council, commenced the laying of the cable on Monday from Normansfield, Kingston-road, towards St. Albans. The company have deposited plans for laying cable in nearly the whole of the roads contained in the specified area. The company have already recouped the District Council the cost of obtaining the order, which amounted to upwards of £300, and besides undertaking to pay a rental of £100 a year, they have granted favourable terms for street-lighting. Purchase terms have also been arranged under which, we understand, the District Council may acquire the undertaking at the end of 7, 14, or 21 years, if they think fit.

Mountain Ash.—The Ocean Coal Company have erected at their Treharris Colliery an electric pump, displacing the old Cornish pump formerly used at the colliery, and relieving the use of several boilers, which undoubtedly will repay the owners for their enterprising outlay. The pump was supplied by Messrs. Ernest Scott and Mountain, Limited, Newcastle-on-Tyne, who were represented in the erection of same by Mr. Scott, agent, of Cardiff, the firm's local representative; and Mr. G. Gillender, the erector. The plant consists of a horizontal long-stroke compound 300-h.p. engine; a 170-kw. continuous-current dynamo, driven by ropes from the engine; main switchboard, with instruments and switches, shaft, and underground cable; 170-h.p. electric motor for driving the pump; and set of Scott and Mountain's special high-lift, three-throw ram pumps to deliver 250 gallons per minute against 1,500ft. head. The old pump will be kept in reserve in case of emergency.

Strike.—The Central News says the men employed by the Westinghouse Electric Company on the new electric generating station at Neasden, now in course of construction for the Metropolitan Railway, went out on strike in a bunch on Monday morning. The Westinghouse Company state that the men appealed for higher wages, and this being refused, all the employés, who number over 300, struck work. According to statements made by the men, it appears that there had been considerable friction between Mr. Huntingdon, the manager of the Westinghouse Company, and the workmen. The men allege that since the commencement of the work their manager has used the American system of driving. Their special grievance is, they aver, that unless they are at their places on the scaffold, etc., and start work the moment the hooter sounds, continuing to work right up to the last minute, they are dismissed. All the original staff of men are still out on strike, but the company have since filled their places by taking on an entirely fresh staff.

Cheltenham.—At the last monthly meeting of the Town Council the position of the electric undertaking was discussed, and it was said that in eight years there had been an absolute loss of £17,000. Alderman Norman, chairman of the Lighting Committee, replied that this sum of £17,000 had never come out of the ratepayers' pockets. It stood to a suspense account, and was balanced by £10,010 in the sinking fund and another £24,425 now awaiting investment. He went into an exhaustive explanation of the causes of the accumulation of the so-called "losses," one of which was the increased interest now payable on money borrowed from the bank compared with that paid on loans when the installation was put in, and showed that during the eight years the undertaking had made a profit of £21,038 over and above its working expenses. Had the concern been in the hands of a private company it would, on this basis, have earned a dividend of 4·88 or nearly 5 per cent. He repudiated the charge of mismanagement, and showed that the Cheltenham station cost in capital expenditure £3 per kilowatt less than the average throughout the country, and that its working expenses were only 1·57d. per unit, as compared with 2·10d. elsewhere.

Paper Mills.—The British Westinghouse Electric and Manufacturing Company are installing plant for the electrical driving of the mills of the Donside Paper Company, Aberdeen. The plant will include one Babcock and Wilcox boiler, fitted with chain-grate stoker, superheater, and economiser, which will supply steam at 200lb. steam pressure to a Browett and Lindley triple-expansion engine. This will in turn drive a 375-kw. Westinghouse double-current generator, giving on the alternate-current side three-phase current at 220 volts, 25 periods, and on the direct-current side current at 125 volts. Continuous current will be used for the variable-speed motors, of which about 75 kw. will be installed. All other motors will be of the Westinghouse polyphase induction type. These will include five 50-h.p. motors for the beaters and breakers, one 35-h.p. for driving a Marshall breaker, and three smaller motors driving the starching plant and edge runners. One 75-h.p. variable-speed motor will drive the dry end of the paper-making machine and a 30-h.p. motor the wet end. In addition to these, all the pumps will be electrically driven, as will also the finishing house, ink grinders, and so forth. It is anticipated that the electric driving will effect a very large economy in coal consumption, and a further consideration, which has no doubt proved of much importance in this case, is the flexibility of electricity as compared with mechanical driving in view of certain extensions contemplated in these mills.

TRACTION.

Liverpool.—The Board of Trade have sanctioned increased speeds on several of the tram routes.

Swansea.—Plans for the proposed tramway extensions have been approved and tenders will shortly be invited.

Hampton Wick.—Preparations are being made for the early construction of the proposed tramway through this district.

Perth.—At a meeting of the Town Council held on Monday it was agreed to borrow £17,000, the purchase price of the tramway company's undertaking.

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Mont Blanc.—It is proposed to construct an electric railway up Mont Blanc, utilising water power in the generation of the electricity.

Accrington.—The Town Council and the Tramways Comwany are discussing the question of the conversion of the local tramway system from steam to electricity.

Stockton.—The Rural District Council have decided to support any movement in favour of inducing the tramways company to extend their system to Haverton Hill.

Bury.—With reference to the question of the tramway purchase, Sir Frederick Bramwell will next week inspect the lines in the district on behalf of the Board of Trade.

Soothill Upper.—The Tramways Committee have arranged an interview with Mr. Paris, of the tramways company, with reference to the suggested Dewsbury Moor extension.

Leeds.—The system of ½d. fares on the tramways has been considerably extended. A new route from Malvern-road, Beeston Hill, to Kirkstall-road was opened for traffic on Monday.

Londonderry.—There is a proposal for the construction of an electric railway from Londonderry to Moville, and formal application is to be made to the Lord-Lieutenant in Council for an order.

Nottingham.—The present state of the money market and of the borough finances have been accepted by the Tramways Committee as reasons for delaying the construction of the London-road tramway for a time.

Chesterfield.—The Town Council on Tuesday adopted a scheme of tramways prepared by Mr. Goodyer, an expert, in conjunction with the resident engineer, Mr. Acland, for the borough, the estimated cost being £87,000.

Burnley.—At the last meeting of the Town Council the new by-laws permitting overcrowding in the trams to the extent of 10 persons inside were opposed, but after further discussion the by-laws were approved.

Woking.—The proposals for a system of light railways in Woking and Bagshot districts are gaining favourable reception locally, and the scheme is being pushed on energetically, with a view to an early application for an order.

Birkenhead.—The Corporation tramways annual report shows a gross profit of £22,509 on a car mileage of 1,279,037, and a net profit, after payment of interest and sinking fund, of £3,598, which has been placed to the renewals fund.

Colchester.—The Town Council have resolved that the Board of Trade be asked to sanction the inclusion of £887, half the cost of widening Middleborough and North Station road, in the loan of £61,164 sanctioned by the Board for tramway purposes

Rochdale.—The Town Council have adopted a resolution to give the requisite notice to the tramway company to purchase that part of the undertaking constructed in Rochdale borough under the Manchester, Bury, and Rochdale Tramways Extension Order of 1882.

Cardiff.—At the meeting of the Town Council on Monday it will be moved that the Tramways Committee be instructed to proceed with the work of constructing a new line from Talygarn-street, Cathays, along Crwys-road, so as to make a connection with the Castle-road route.

Nelson.—At the last meeting of the Town Council it was resolved that application be made to the Local Government Board for sanction to the borrowing of £25,000 for the purposes of the electricity department. The money is required for extension of plant in connection with the light railways.

Leicester Light Railways.—The Light Railway Commissioners have submitted to the Board of Trade for confirmation the order made by them for the construction of light railways in the borough of Leicester and in the rural districts of Barrow-upon-Soar, and of Market Bosworth in the county of Leicestershire.

Burton.—The Highways Committee having charge of the tramways, recommend the Council to grant workmen's tickets at the rate of 12 for 10d. for use on the cars any route, any distance, between 5.30 a.m. and 7.30 a.m. and between 5 p.m. and 6.30 p.m.; also that children under 12 ride on any single route for 1d.

Railway Motors.—A correspondent calls our attention to a printer's error in our "note" under this heading in last week's issue. It was stated that the North-Eastern Railway has commenced its service of motor 'buses in North Holderness, between Beverley and "Belford." The last-named place should have read "Beeford."

Darlington.—The question of the price to be charged for electrical energy to be supplied for the light railways has been referred to a sub-committee for consideration and report. Prof. Kennedy has been invited by the Tramways Committee to inspect the new permanent way which has been laid down in connection with the electric traction scheme.

Glasgow.—A special committee has been appointed to consider the report of Mr. Young, already published, and to report on the whole question of ½d. tramway fares. A proposal will be brought before the Town Council in favour of adopting a larger size of car. The whole question of the future extension of the tramways has been remitted to a sub-committee.

Darwen.—The Corporation tramways department has commenced a new express parcel delivery service, under which parcels will be delivered and carried over several sections. The committee have also started a new scale of parcel rates, including delivery within half a mile of the tram route; also for delivery within Darwen or Blackburn within one mile of the tram route.

Leigh.—The recommendation of the Tramways Committee, that a sub-committee be appointed to report as to whether the tramways within the borough should be constructed with a view to their being worked by the Corporation or leased to a company, was approved at the last meeting of the Town Council, and the sub-committee were authorised to engage expert assistance.

Herefordshire.—At the last meeting of the Ross Rural District Council the scheme for providing the county of Hereford with a system of light railways was discussed, and a resolution passed asking each council affected by the proposal to appoint three delegates to attend a meeting which the chairman of the County Council (or, failing him, the Mayor of Hereford), should be requested to convene to discuss the question.

Durban.—The Corporation have completed their "outer" circle of tramways, and passengers are now able to make a complete circuit of the town without disembarking. Since the installation of electric trams, some 15 months ago, the old horse cars have almost fallen into desuetude, and at the present time only about half a-dozen are running. In a few months the horse trams will be entirely swept away and replaced by electric cars.

"Tube" Breakdown.—Much inconvenience was caused about seven o'clock on Tuesday evening by an obstruction on the Twopenny Tube. A train was running between the Bank and the Post Office Station when a coach left the metals, bringing the whole train to an abrupt standstill. All the passengers reached the Bank Station without mishap of any kind. Traffic was considerably delayed between the Bank and British Museum Stations.

Lowestoft.—The general manager reports as follows: total receipts for the six weeks ending Sept. 1 amount to £2,294. 13s. 1d.; passengers carried, 494,623; miles run, 32,958; average receipts per day, £54. 12s. 7d.; average receipts per car per day, £5. 2s. 7d.; average miles run per car per day, 73 56; average receipts per car per mile, 16·70d. Four new cars are being obtained by the committee, and the car-shed is to be extended by one bay in consequence.

Newcastle.—At a meeting of the Finance Committee of the Corporation last Thursday, the 3rd inst., it was reported that the total amount paid for tramway construction was £962,000. Of this sum, £87,000 had been borrowed. Application was being made to the Local Government Board for power to borrow an additional £128,000 for tramway purposes and street improvements. The town clerk was instructed to press this matter forward, that the amount required may be obtained.

Batley.—In reply to questions at the last meeting of the Town Council, the Mayor said he could give no information as to when the trams would be running. No communication had been received from the British Electric Traction Company, who alleged that their cars were not adapted for the Batley lines. There was not sufficient bite, it was said, on the wheels, and if the company ran their cars some accident might occur. Everything was ready so far as they (the Corporation) were concerned.

Eastbourne.—After hearing a deputation urging the introduction of electric trams in the town, the Town Council at their last meeting rejected by 17 votes to 9 a proposal to promote a Tramways Bill in the next session of Parliament. A resolution in favour of calling a town's meeting was also thrown out. We understand that the reason for the Council's attitude in this matter is the fact that they have already decided to give the motor 'bus service, which has been running for only a month or two, a fair trial.

Scarborough.—Under the Tramway Act (1902) the Corporation can subscribe £10,000 towards the company's undertaking. If they do this, or only take £5,000 worth of shares, the mayor becomes *ex officio* director of the company. The Corporation has also the right to purchase the undertaking in 1926 as a going concern without any provision as to percentage. If in any year the undertaking pays a dividend of more than 4 per cent., then the company have to pay to the Corporation a percentage of the profits.

Wolverhampton.—The negotiations which have been going on between the Corporation and the Lorain Steel Company for some two months with reference to the 11 odd miles of tramway which have been equipped on the Lorain surface-contact system are reported to have concluded without an agreement being arrived at. It is stated that the Corporation's offer of £15,000 for the lines has been rejected by the company, who have decided to abide by their claim of £25,000. The matter is to be considered at a full meeting of the Town Council to-day (Friday), but failing agreement, we presume the whole question will be submitted to arbitration.

Additional Traffic Returns.—Anglo-Argentine, £1,234 increase; Barcelona Ensanche y Gracia, £218 increase; Barcelona, £81 increase; Brisbane, £14 increase (month of August, £11,736, increase £294); British Columbia Electric (month of March), gross earnings £10,352, net income £2,658; Buenos Ayres and Belgrano Electric, £431 decrease (month of August, £13,431, increase £533); Calcutta, £375 increase; Cape Town (month of April), receipts £16,003, expenditure £8,313; Isle of Thanet Electric, £193 decrease; Mexico Electric (month of August), receipts £48,600; expenses, £27,900; Perth Electric, £161 increase; Port Elizabeth (month of April), receipts £4,292, expenditure £2,281.

Newport.—It will be proposed at the next meeting of the Town Council that the fares on the electric tramways be altered so as to be ½d. fares on the Malpas-road route from the terminus to High-street, instead of 1d. from the terminus to the centre. At the last meeting Alderman Moses, in bringing up the report of the Tramways and Electricity Committee, referred to a statement that had been made that the tramways were being worked at a loss of £100 per week. An estimate had been prepared, in which the fullest allowance had been made for expenses, which showed that in the five ordinary weeks in which the full service had been running there was a balance of income over expenditure of £11 per week. He asked the Council to give the committee fair play, so that they might have an opportunity to show what the tramways could do now they had been placed upon a substantial business basis.

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Bolton.—The question of English *v.* Belgian rails was discussed at the last meeting of the Town Council, on a proposal of the committee to accept a Belgian tender for rails. An amendment in favour of accepting the tender of a British firm was ultimately carried by 35 votes to 18.

Portsmouth.—The summary of the tramway accounts for the year ending March 31 last is just to hand, and shows a balance of £6,918. 10s. 8d. to be disposed of. There was an actual balance on the working of £46,988. Of this £32,847 went to the sinking fund and in interest, and after paying other charges £13,064 remained. As the year started with a deficit of £6,146, the actual sum left for disposal is the one stated above. If the committee are wise, it will be retained as a provision for renewal of plant in the time to come.

Sunderland.—The Tramways Committee have recently been making application to the Board of Trade for permission to run at higher speeds than those generally prevailing in the borough. The highest speed at present sanctioned in the town is 10 miles an hour, but this is only in the more thinly-populated parts, and the speeds vary from that figure down to as low as six and even four miles an hour. As this is only the pace of a walk, the committee have felt themselves handicapped in their desire to give a quick service to all parts of the town.

Finsbury.—With regard to the proposal of the London County Council to adopt the overhead system of electric traction from High-street, Islington, *via* Liverpool-road, to Holloway-road, because of certain structural difficulties in connection with the conduit system, the Borough Council have resolved to inform the London County Council that whilst this Council have no desire to raise any difficulty in regard to the electrification of the tramway service, they regard that portion of the borough referred to as unsuited to the adoption of the overhead system, by reason of the narrowness of the thoroughfare.

West Bromwich.—There is an agitation amongst the working classes here in favour of the running of early morning workmen's cars, and also the trial of the system of ½d. fares. Large numbers of workmen in the outlying districts who are employed by firms in Birmingham complain of difficulty in getting to their work. It is stated that the British Electric Traction Company have already given a half promise to give the ½d. fares a trial. The West Bromwich Trades Council have taken the matter up, and have decided to bring pressure to bear upon the Town Council with a view to securing these concessions.

Llanelly.—At the monthly meeting of the Borough Council on Monday a letter was read from the British Insulated Wire and Cable Company repudiating all knowledge of any agreement entered into with the Council for the payment of costs incurred by the Council in respect of the opposition to the Carmarthen Power Bill and other matters. It had been understood by the Council that all these costs would be paid by the Wire Company. Mr. Tom Hughes said that the traction matters in the town had now got into a disgraceful state, and the best thing was to hold a special meeting to consider the position. This was agreed to.

Devonport.—Much surprise is expressed locally that those tramway extensions which have recently received the sanction of the Board of Trade, have not yet been opened for traffic. For the delay, apparently, blame attaches neither to the Corporation Tramways Committee nor to the Devonport and District Tramways Company, who will work the lines in connection with their present system. Up to the present the electric cables have not been tested, and until this is done the company will not open the extensions for public traffic. The lines from St. Budeaux Station to Saltash Passage and from Milehouse to the borough boundary have not yet been officially inspected.

Paris "Tube" Railway.—Parisians, says the *Standard's* correspondent, are but slowly recovering their confidence in the tube railway. Before the terrible accident at the Couronnes Station, the number of passengers carried were from Aug. 1 to 10 between 271,000 and 343,000. On Aug. 11 it fell to 155,000, and whilst the lowest figure since per day has been 143,000, the highest was only 204,000 this day week. Thus, during the first week in August, before the accident, the average per day was 297,000 passengers. From the 11th to the 16th the average fell to 148,000. During the next week, on the 23rd, it rose to 179,000, and last week the average per day was 197,000 passengers.

West Manchester Light Railway.—A meeting of the Davyhulme and Flixton Parochial Committees has been held to consider the plans submitted by the promoters for the construction of the West Manchester light railway, which is to connect the railways at the docks in Trafford Park with Irlam Locks. Hitherto the Davyhulme Committee have intimated that they object to the plans, inasmuch as it is proposed that the lines shall cross the main roads of Davyhulme and Flixton on the level. The Parochial Committee hold that the new railway crossing these roads on the level will cause a great inconvenience to the local traffic, to say nothing of the danger that will arise when the tramlines are laid.

Crewe.—At a meeting of the Electric Lighting and Light Railways Committee the town clerk read a letter from Messrs. Rowcliffe and Co., solicitors, Manchester, stating their intention to make application on behalf of clients in the next session of Parliament for an Act to construct tramways from Macclesfield to Congleton, Sandbach, and thence to the boundary of the borough of Crewe, and if the Council were prepared to favourably consider a scheme for continuing the line from Crewe to Nantwich by Willaston and back through Ledge Field they would be prepared to discuss the matter further, and suggesting that an interview between the engineers and a sub-committee of the Council might be arranged. Another poll on the whole question of the tramways has been asked for.

Bradford-Halifax.—For some considerable time there has been no service of tramcars between Buttershaw and Shelf, the steam cars having been stopped to enable the electrification of the line to be proceeded with expeditiously. That work has now been completed, and already electric cars are running through from Bradford to Shelf. Commencing on Monday last the cars ran direct from Stanningley to Shelf at half-hour intervals. These cars are to be run in connection with the Halifax and Shelf service, so that it will be possible to travel from Leeds to Halifax with only two changes. The cost of the journey from Bradford to Shelf will be 3d. Accordingly, at the cost of 1s. an interesting circular tour may be made from Bradford to Halifax by Queensbury, returning from Halfax by Shelf.

Bradford.—At Tuesday's meeting of the City Council the members were asked to agree to a resolution of the Waterworks Committee to accept the terms mentioned in a provisional agreement made between the Nidd Valley Railway Company, Power and Traction, Limited, and the Corporation for the purchase of the Nidd Valley light railway order, giving power to the Corporation to construct and work a light railway from Pateley Bridge to Lofthouse, with the requisite borrowing power. With respect to the proposed increase of the salary of the tramways manager (Mr. C. J. Spencer) from £500 to £700 per annum, as recommended by the Tramways Committee, an amendment was moved to the effect that the committee's recommendation be rescinded, on the ground that the salary of the tramways manager was fixed for five years by an agreement dated July 20, 1900. The amendment was ultimately defeated by 29 votes to 22.

York.—Speaking on the question of the proposed purchase by the Corporation at the half-yearly meeting of the York Tramways Company on Tuesday, the Chairman said the company "would be prepared to meet them (the Corporation) very fairly, but they thought the Corporation were rather acting the 'dog in the manger' policy, because the Corporation had absolutely refused to allow the company to either work the tramways by electricity or extend them to the suburbs. The company thought that was very unreasonable, and not in the interests of the Corporation, because if they had worked the tramway by electricity they would have been a very large customer for the purchase of electricity, which would have made a considerable difference in the accounts of the Electric Lighting Committee of the Corporation. The directors thought the position a very unfortunate one, certainly not in the interests of the company or the Corporation."

Dewsbury.—Reference was made at the last meeting of the Town Council to the decision of the committee not to entertain, at present, the application of Soothill Upper to co-operate with the Corporation in a scheme for the construction of tramways from Dewsbury Market-place, *via* Crackenedge-lane to Hanging Heaton and Shaw Cross, but it was explained that the reason the committee had come to the decision they had done was because there would be insufficient time to go into the details necessary for the provisional order so far as Soothill Upper was concerned. A special meeting of the Town Council is to be held on the 1st prox. for the purpose of considering the desirability of applying to the Board of Trade for a provisional order to empower the Corporation to construct electric tramways, commencing in Vicarage-road, near the parish church, and passing along Long-causeway, through the Market-place, and up Wakefield-road to the borough boundary, where they will join the yet to be constructed lines of Earlsheaton and Ossett.

South London.—In the electrification of the tramways in South London fresh developments of the work of an important character have been commenced. In Southwark Bridge-road a number of men have begun to tear up the eastern side of the roadway, a temporary line having been previously laid down on the western side. The new portion of the line which is being laid down in the Marshalsea-road, to connect the lines between the Borough High-street and Southwark Bridge-road, is also being proceeded with rapidly, while in that portion of Southwark Bridge-road which runs right up to the bridge itself the metals have been laid down and the necessary junction lines made for the trams to resume the return journeys. When the lines running round the Marshalsea-road and down Southwark Bridge-road nearly to the Elephant and Castle have been completed, one of the most important developments of the new electric system of trams in South London will be ready for use, and new services will be commenced which will run from Streatham and Brixton, New Cross and Camberwell, and probably Balham and Clapham, direct to the foot of Southwark Bridge. The new line along St. George's-road, between the Elephant and Castle and the Westminster Bridge-road, is also being rapidly laid down, and when completed will enable the trams from New Cross and Camberwell to proceed *via* this wide thoroughfare, and so ease the congestion along the London-road and at the Obelisk.

London Rapid Transit.—The *City Press* states that Mr. Yerkes is again on the move with one, if not two, new "tube" schemes. One of these, it is definitely stated, embodies a proposal for a "tube" which, having the Mansion House for a starting point, will proceed along the Strand, and there join up with the other railways in the Yerkes combination. Nor is the London County Council idle in the matter of prospective Bill legislation. It is generally understood that in the ensuing session the Spring-garden authorities will promote a couple of measures dealing with the vexed and difficult problem of locomotion in the Metropolis in particular, and Greater London in general. In their main features both schemes have already been submitted to Parliament for consideration, and will, therefore, come by no means as strangers to the committees in Lords and Commons. One thing is quite certain—viz., that another determined effort will be made to obtain powers to run tramways along the Embankment, and thence over Westminster Bridge. In connection with the Embankment scheme, it may also be mentioned that the Council further propose to seek for powers to extend their surface system in various directions—a step, by the way, that will necessitate the widening of several thoroughfares. Naturally, the question of the subway for trams from Theobalds-road to the Embankment, by way of Southampton-road, Aldwych, and the Strand, will again crop up when the Bill comes on for consideration. Last session,

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it may be remembered, Parliament authorised the construction of the subway, but at the same time it refused powers to run tramways further than a point at the junction of the Strand with the new street now in course of formation. To give practical effect to the scope of the Embankment proposal, this decision, it will at once be seen, will have to be revised in the event of the Bill passing through both Houses, inasmuch as the one part of the scheme is essential to the other if the object aimed at is to be achieved. Happen what may, there is at least every prospect of a very determined fight between the conflicting interests at St. Stephen's in the coming year.

Johannesburg.—The special correspondent of the *Sheffield Daily Telegraph* at Johannesburg has sent his paper a long account of the proceedings of the Town Council on the 16th ult., when the subject of tenders for the tramways was under discussion. As will be seen from our "Tenders Accepted" columns, one or two English tenders were accepted for steelwork, but we regret having to record that the main order for rails will go to Belgium. The real fight lay between Messrs. P. and W. MacLellan and the Brush Electrical Company, the latter representing the interests of the Société Anoyme d'Augres for grooved rails. In a report on the tenders the town engineer, Mr. D. W. Leitch, stated: "For grooved rails and fishplates there is practically no satisfactory British tender at a reasonable rate. The lowest of such tenders is that of Messrs. MacLellan and Co. Messrs. Mordey and Dawbarn (who had also reported on the tenders) pointed out that, comparing it with the lowest foreign offer f.o.b. at port of shipment, the difference in cost is about 11 per cent. If, however, the same basis for freight charges be taken in the two cases, the difference comes down to about 3 per cent. A more important objection lies in the fact that Messrs. MacLellan's tender is for rails of much softer quality than that specified for. If British manufacturers insist on prescribing the quality of the goods which they are willing to supply, instead of making what their customers ask for, they can hardly complain if they fail to secure orders. Messrs. MacLellan also offer rails of British standard section at 2s. less per ton, but as the weight of these considerably exceeds what is specified, this alternative cannot be recommended on economical or other grounds." Discussing the tenders for Vignoles rails and fishplates, Mr. Leitch takes into account the fact that it is considered British rails are probably worth 10s. more a ton than those of Belgian manufacture, and if allowance be made for this he works out the difference between Messrs. Cammell's tender and the lowest tender at about £200 in favour of the foreign rails. During the discussion it transpired that the difference in the tender of Messrs. MacLellan and that of the Brush Company was over £3,000, but on an amendment in favour of the English tender the voting was equal, until the Chairman gave his casting vote in favour of the foreign tender.

Brighton.—By 25 votes to 22 the Town Council at their last meeting confirmed their decision at a previous meeting to construct tramways in Preston-road. The tramway along Dyke-road is to be constructed with Corporation labour, under the supervision of Mr. J. B. Holliday, the tramways manager. According to the statement of accounts for the year ended March 31, 1903, the amount authorised in loans was £221,170, all of which has been borrowed with the exception of £20,946. The total expenditure on the capital account is given at £205,041. 16s. 5d., of which sum £181,378. 4s. was expended prior to March, 1902. The revenue account provides some very interesting figures. Traffic expenses are given at £23,575. 15s. 5d.; repairs and renewals, £4,426. 19s. 10d.; management expenses, £2,676. 7s.; rates and taxes, £237. 15s.; special expenses (insurance and law), £698—making a total expenditure of £31,615 8s. 1d. On the other side, the traffic receipts show that 10,432,528 penny fares were paid, producing an income of £43,468. 17s. 4d. A further sum of £231. 6s. was received as rents of malthouses and premises in Viaduct-road, so that the total income was £43,700. 3s. 4d., which left the substantial balance of £12,084. 15s. 3d. to be transferred to the net revenue account. This account shows that last year there was an adverse balance of £3,051. 5s. 11d. The other items on the debtor side are £6,170. 15s. 11d. for interest, £1,779. 0s. 3d. sinking fund charges, and a balance of £4,134. 19s. 1d., being a surplus on the revenue account at March, 1903, to be carried to the next account. The creditor side shows that the deficiency has been paid off. The general balance-sheet shows the following liabilities: redeemable stock, £147,592. 11s. 1d.; debenture debt, £48,224; premiums on stock issued, £3,407. 8s. 11d.; floating liabilities, £11,301. 17s. 9d.; revenue account, £4,134. 19s. 1d.; surplus account (amount of loans paid off), £1,000—total, £215,660. 16s. 10d. The assets are given as follows: capital outlay, £205,041. 16s. 5d.; stores in hand, £3,472. 5s. 4d.; floating assets, £7,146. 15s. 1d.—total, £215,660. 16s. 10d. After last year's deficiency has been paid off it will be noticed there is still a balance to the good of £1,083. 13s. 2d., and it is proposed that this should be a nucleus of a special fund to be styled the depreciation and contingency reserved fund.

Underground Electrification.—A railway expert has written to the *Financial Times* with reference to the following passage, which occurred in a leading article in that paper's issue for the 8th inst. The passage read: "At one time it was not possible to regard the electrification proposals with unstinted approval. There was once a distinct danger that the Inner Circle, instead of being a self-contained system, worked in the interests of the two owning companies—the District and the Metropolitan—would become disjointed by the adoption of two distinct systems of electric traction. That danger has disappeared and a joint committee of the two Boards has been appointed to ensure uniformity in equipment, etc." The correspondent says: "My information, unfortunately, leads me seriously to doubt whether the danger of discord between the two companies in the working of the Inner Circle is so completely a thing of the past as this article states. Mr. Perks has, indeed, stated publicly quite lately that the two managements are by no means in agreement as to the future of the Circle traffic, the Metropolitan wishing greatly to increase the number of trains which run round the Circle when the electrification is complete, whilst the District authorities attach greater importance to developing the through east and west service which they have recently established in conjunction with the Tilbury Company. But this is not all. Despite the appointment of a joint committee of the two Boards to harmonise the electrification of the two lines, there is yet grave danger of a want of uniformity in their respective electrical equipments. The *Financial Times* has already chronicled the letting of the District's 'multiple-unit' contract to the British Thomson-Houston Company; but the Metropolitan, if my information be correct, had already contracted to adopt the rival system of the great Westinghouse firm. In principle, it is true, these two methods of electric train control are very similar, but there are considerable differences in mechanical details between the two, and if the Metropolitan trains are equipped with the one and the District's with the other, any interchange of rolling-stock between the two companies will be rendered quite impracticable. Also, if the joint 'electrification' committee of the two Boards be really an active body, it seems strange that the Metropolitan authorities have not kept themselves more closely in touch with the exhaustive tests of the respective merits of the Westinghouse and Thomson-Houston train-control systems which have been going on for some four months past on the Ealing and Harrow section of the District. I hear that the Metropolitan made some tests of their own at Neasden before deciding to let their contract to the Westinghouse Company, whereas the District's tests at Harrow resulted . . . in favour of the Thomson-Houston system. But surely this was a matter coming within the sphere of action of the joint committee of the two Boards, who might have been expected to have taken some steps to ascertain why similar experiments on the two lines led to such contrary conclusions. Which of two rival firms obtain a contract of this sort is no concern either of the shareholders or of the public; but that the better of the two systems should be selected, and that there should be no needless sacrifice of uniformity, are matters of vital public concern."

PROVISIONAL PATENTS, 1903.

AUG. 31.

18710. Chambers for the combustion of fuel under pressure, valves, purifiers, loading apparatus, and air-compressors in connection therewith; means for applying the gaseous products to smelting, steelmaking, and the production of electricity. David Cook, 30, Lancaster-park, Richmond.

18712. A double point for electric rails of the conduit system so that the car can always pick up the current. Alexander Cass Holbrow, Holmwood House, Grove-vale, East Dulwich, London.

18713. Automatic working of points of electric tramways. Alexander Cass Holbrow, Holmwood House, Grove-vale, East Dulwich, London.

18731. Improvements in electrical switches. Henry Crowe, 53, Chancery-lane, London.

18740. A method of actuating switches or the like. William Edward Evans, 27, Chancery-lane, London. (Allgemeine Electricitäts-Gesellschaft, Germany.) (Complete specification.)

18745. Improvements in and relating to excess indicators for use with an electric current. Llewellyn Birchall Atkinson, 1, Queen Victoria-street, London.

18754. Improvements in semi-automatic telephone systems. Ernest August Faller, 19, Holborn-viaduct, London. (Complete specification.)

18755. Improvements in or relating to electrical indicating apparatus for communicating and recording instructions. Heinrich Blender, 37, Essex-street, Strand, London. (Complete specification.)

SEPT. 1.

18818. Improvements in voltmeters and ammeters. Amos Lawrence Weekes, 55, Chancery-lane, London.

18829. Improvements in electric insulators. William Edward Langdon, John Crisp Fuller, and George Fuller, 33, Chancery-lane, London.

18841. Improvements in selective systems for electrical communication. Sylvanus Albert Reed, 55, Chancery-lane, London. (Complete specification.)

18853. Improvements in and relating to relays. James Tarbotton Armstrong and Axel Orling, 323, High Holborn, London.

18854. Improvements in and relating to telegraphic recording and perforating apparatus. James Tarbotton Armstrong and Axel Orling, 323, High Holborn, London.

18860. Improvements in and relating to electrical switches. Louis Marino Casella, 1, Queen Victoria-street, London.

18867. Improved telegraph apparatus. Oliver Imray, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Société des Telegraphes Multiplex Systeme E. Mercadier, France.) (Complete specification.)

SEPT. 2.

18907. Improvements in electrical controllers. Wallace Fairweather, 62, St. Vincent-street, Glasgow. (Diehl Manufacturing Company, United States.) (Complete specification.)

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18934. Improvements in electric storage batteries or accumulators. Henry Pratt and Frederick Vince, 1, Portland-street, Wardour-street, London.

18953. Improved check or indicator applicable to the electric controllers of electrically-driven vehicles. August Richard Louis Wille, 40, Chancery-lane, London. (Complete specification.)

18953. Improvements in and relating to electrolytic manufacture of caustic soda and other products. James Ballantyne Hannay, 18, Southampton-buildings, Chancery-lane, London.

SEPT. 3.

18964. Improvements relating to the regulation of the voltage of dynamos. Charles Turnbull, jun., 34, Castle-street, Liverpool.

18980. Improvements in and connected with electrical signalling on railways and tramways. James Wood Tunstall, 10, St. George's-crescent, Liverpool.

18998. Electric current generating and motive power machine. Walter Shelverton Frost, 135, High-street, Homerton, London.

19012. Improvements in electric lampholders. Victor Zingler, 20, Sarre-road, West Hampstead, London.

19015. Improvements in contacts especially suitable for induction coils. Marconi's Wireless Telegraph Company, Limited, and Edward Priddle, 24, Southampton-buildings, Chancery-lane, London.

SEPT. 4.

19029. Improvements in switch trolley heads for electric cars. James Henry Armstrong McGuire, 221, Belle Vue-avenue, North-lane, Roundhay, Leeds.

19053. Improved method of guiding trolley heads along frogs and crossings attached to overhead wires in connection with electric railways and tramways. Horatio Cooley, 52, Luther-street, Leicester.

19054. Improvements in and applicable to overhead equipment, electric or otherwise, of railways and tramways, to work in connection with railway carriages, tramway car or cars, or vehicle or vehicles, truck, trucks, or part or parts of the same. William Pettinger West Weatherill, 33, Beech-street, Waterloo-road, Cheetham, Manchester.

19063. Improvements in and relating to electro-capillary detectors, relays, and recording apparatus. James Tarbotton Armstrong and Axel Orling, 323, High Holborn, London.

19065. Improvements in or relating to electrical measuring instruments. Charles Edwin Foster, Edwin Rudolf Grote, and Milton Victor Ely, 165, Queen Victoria-street, London.

19092. Improvements in electrical locking apparatus for railway signals. William Robert Sykes, jun., 53, Chancery-lane, London.

SEPT. 5.

19139. Improvements in incandescent gas and electric globe lamps. John Westwood Lea and John Hall Perrins, Midland Works, Bracebridge-street, Birmingham.

19142. Improved driving and speed-regulating mechanism for dynamo-electric generators when carried by railway and other vehicles. Alfred Townley Metcalf, 17, Hanover-street, Keighley.

19172. Improvements in apparatus for controlling the working of electrically-driven cars. Siemens Bros. and Co., Limited, and Francis Lydall, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

COMPLETE SPECIFICATIONS ACCEPTED.

To be published September 24, 1903.

1902.

19368. Electrodes for electrolytic purposes. Hargreaves.

19562. Emergency brakes. Lake. (General Electric Company.)

19566. Electric switch regulators. Lake. (General Electric Company.)

19655. Alternating-current meters. May.

21488. Trolley heads for electric tramcars to guide the live wire into the groove of pulley when changing the direction of car. Cook, Cook, and Partington.

21913. Alternating-current motors. Schüler and Ferranti Limited.

22327. Incandescent electric lamps. Soc. Anon. la Lampe Hollub. (Date applied for under International Convention, Nov. 30, 1901.)

22329. Electro-pneumatic controlling systems for railway vehicles. Le Tall. (Westinghouse.)

23116. Current regulators for use in connection with the charging of storage batteries and for other purposes. Niblett.

23491. Magnetic wheels. Heinze. (Date applied for under International Convention, Feb. 24, 1902.)

26106. Combined lampholders and switches for glow lamps. Davies.

23666. Maximum current registering indicators. Isabella Christina Clark, Alfred John Davies, and William Livingstone Russell (executrix and executors of Alexander Melville Clark). (Hartmann and Braun.)

26163. Electrical cut-outs. Evered and Co., Limited, and Evered.

27184. Devices for operating electrically the points on electric tramways and railways. Tierney and Malone.

27887. Magneto-electric ignitors for internal-combustion engines. Tangye Tool and Electrical Company, Limited, and Bate.

27957. Electrical apparatus for controlling signals on railways and the like permanent ways. Weiss.

28322. Telephone exchanges. Cohen.

1903.

7191. Means for protecting underground cables or conduits against being damaged. Rayner. (Wilhelmi.)

8488. Magneto-electric generators. Remy and Remy.

11738. Telephone switchboards. Lake. (Elektriak Bureau.)

12683. Underground or conduit systems for electric tramways and railways. Cope.

14888. Electric motors. Klemm and Reiss.

15929. Road vehicle for conveying electric cable drums and other cylindrical bodies. Jones, Jones, and Sedwell.

15955. Charge indicators for secondary batteries. Maxim. (Date applied for under International Convention, Aug. 4, 1902.)

16569. Field magnet for electrical machines. Hearson. (Electric itäts-Geßellschaft Alioth.)

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.		Last price
Commercial and Industrial.—	£		£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1	..	½ xd
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1	..	⅛-¼
British Insulated and Helsby Cables, Ord., 1-100,000	5	..	6¼-7½
—— 5 per cent. Cum. Pref., 1-100,000	5	..	6½-5¾
—— 4½ per cent. Mortgage Debentures	100	..	102-106
British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red.	100	..	104-106 xd
British Westinghouse Elec. and Manuf., 6 per cent. Pref., 275,001-375,000	5	..	5⅜-5½
—— 4 per cent. Mortgage Debenture Stock	100	..	100-102
Brush Electrical Engineering, Ordinary, Nos. 1-105,751	2	..	¾-1¼
—— Non. Cum., 6 per cent. Pref.	2	..	1-1¼
—— 4½ per cent. 1st Debenture Stock	100	..	99-102
—— 4½ per cent. 2nd Debenture Stock	100	..	85-90
Callender's Cable, Debentures	100	..	106-110
—— Ordinary	5	..	11¼-12½
—— 5 per cent. Pref.	5	..	6½-5¾
Crompton and Co.	3	..	2-2½
—— 5 per cent. Debentures	100	..	100-104
Edison and Swan United, "A" Shares, 1-99,261	3	..	¼
—— "A" Shares, 01-017,139	5	..	1¼-2½
—— 5 per cent. Debentures	100	..	75-80
—— 4 per cent. Deb. Stock, Red.	100	..	71-75
Electric Construction, Limited, Nos. 1 to 112,100	2	..	1¼-1⅜
—— 7 per cent. Cumulative Pref.	2	..	2¼-3
—— 4 per cent. Perp. 1st Mort. Deb.	100	..	98-101
Ferranti Limited, 5 per cent. 1st Mort. Deb. Stock, Red.	100	..	90-95
General Electric Company (1900), 5 per cent. Cum. Pref.	10	..	9¼-10
—— 4 per cent. 1st Mort. Deb. Stock	100	..	97-100
W. T. Henley's Telegraph Works, Ordinary	5	..	13¼-14½ xd
—— 4½ per cent. Preference	5	..	5-5¼
—— 4½ per cent. Debentures	100	..	107-111
India Rubber, Gutta Percha, and Telegraph Works	10	..	18¼-19¼
—— 4 per cent. Debentures	100	..	100-103
Parker, Thos., Limited, Ordinary	10	..	14¼-15¼
Telegraph Construction and Maintenance	12	..	34-37
—— 5 per cent. Bonds	100	..	100-103
Electric Lighting and Supply.—			
Blackheath & Greenwich District Ordinary 1,201-101,200	1	..	⅛-¼
—— 4½ per cent. Deb. Stk. Certs., Red. and Conv.	100	..	118-121
Bournemouth and Poole, Ordinary	10	..	12½-13½
—— 4½ per cent. Cum. Pref., 7,501-15,000	10	..	10-11
—— 6 per cent. Cum. Second Pref., 15,001-22,500	10	..	10¼-11¼
—— 4½ per cent. Debenture Stock, Red.	100	..	103-106
Bromley (Kent) Electric Light and Power Co., 4½ per cent. 1st Debenture Stock, Red.	100	..	102-105
Brompton and Kensington, Ordinary	5	..	10¼-11
—— 7 per cent. Preference	5	..	10¼-10⅜
Calcutta Electric Supply Corp., Ordinary, Nos. 1-40,000	5	..	6¼-7⅛
—— Nos. 20,001-30,000	5	..	7-8
Cambridge Electric Supply Company, Ltd., £10 Ord.	8	..	14⅜
—— ,, ,, £10 Ord.	6	..	10⅜
Central Electric Supply, Ld., 4 per cent. Guar Deb. Stock	100	..	106-109
Charing Cross and Strand, Nos. 1-70,000	5	..	9-9½
—— 4½ per cent. Cum. Pref.	5	..	5¼-5⅝
—— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000	5	..	4⅜-5
—— 4 per cent. Debenture Stock, Red. (Prov. Certs.)	100	..	104-106
Chelsea Electricity Supply	5	..	5¾-6¼
—— 4½ per cent. Debentures	100	..	108-111
City of London, Ordinary	10	..	10¼-11
—— 6 per cent. Cumulative Pref.	10	..	13-14
—— 5 per cent. Debenture Stock	100	..	122-127
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100	..	102-105
County of London and Brush Provincial, Ordinary	10	..	7¼-8¼ xd
—— 6 per cent. Cum. Pref.	10	..	11¼-12¼
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	100	..	109-112
Edmundsons' Electricity Corporation, Ordinary, 1-50,000	5	..	6¼-7
—— 6 per cent. Cum. Pref.	5	..	6¼-6⅞
—— 4½ per cent. First Mort. Deb.	100	..	107-110
Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-30,000	5	..	3¼-4¼
—— 5 per cent. Debenture Stock, Red.	100	..	86-96
Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000	5	..	6-6¼
—— 4½ per cent. First Deb. Stock, Red.	100	..	100-103
Hove Electric Lighting, Limited, Ord., 1-13,000	5	..	7¼-8¼
Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000	5	..	10¼-11¼
—— 4 per cent. Debenture Stock Red.	100	..	103-106

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Name.	Amount paid. £	Last price. £
Kensington and Knightsbridge and Notting Hill	100	103-106
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	9⅜-10⅛
London Electric, Ordinary	3	2-2⅛
—— 6 per cent. Pref.	5	5⅛-6 xd
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	100-102
Metropolitan, Ordinary	10	17½-18½
—— 4½ per cent. First Mortgage Debenture Stock	100	108-112
—— 3½ per cent. Mortgage Debenture, Red.	100	97-100
Newcastle-upon-Tyne Electric Supply, Ordinary	5	98-101
—— Preference	4	100-103
Notting Hill Electric Lighting	10	13-14
—— 4 per cent. First Mort. Debs., Nos. 1-500 (Reg.)	100	99-102
Oxford Electric, Ordinary, 1-96 and 407-14,310	5	4½-5½
—— 4 per cent. Debenture Stock	100	98-101
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100	100-102
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5	3½-3⅝
—— 4 per cent. Debenture Stock	100	88-90
South London, Ordinary	5	3⅝-4⅛
St. James's and Pall Mall, Ordinary, 101-20,080	5	15⅛-16¼
—— 7 per cent. Pref.	5	8-9
—— 3½ per cent. Deb.	100	98-101
Urban Electric Supply Co., Ordinary, 8-30,007	5	5-5⅛
—— 5 per cent. Cumulative Preference, 50,001-80,000	5	5-5⅛
Westminster, Ordinary	5	13-14
—— 5 per cent. Cum. Pref., 110,101-138,251	5	6-6½

Electric Railways.—

Central London, Ordinary	100	98-101
—— 4 per cent. Pref.	100	100-103
—— " " deferred	100	101-104
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100	115-118
City and South London, Consolidated Ordinary	100	59-61
—— 4 per cent. Debenture Stock	100	116-119
—— 5 per cent. Pref. Stock '91	100	127-130
—— " " " '96	100	126-129
—— " " " '01	100	125-128
Liverpool Overhead, 5 per cent. Pref.	—	13-13½
—— Ordinary, 1-50,000	—	7⅛-8
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	—	102-104
Waterloo and City, Ordinary	100	95 98

Electric Tramways.—

Anglo-Argentine, 1-260,007	5	4⅜-4⅞
—— Permanent 6 per cent. Debenture Stock, 1888	100	125-130
Blackpool and Fleetwood Tramroad	10	13½-14½
Brisbane Tramway Invest., Lim., Ord., 1-75,000	5	2-3
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5	4-4½
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100	101-104
British Columbia Electric Railway Co., Ord., Nos. 1-20,000	100	77-80
—— Non-Cum. 5 per cent. Pref., Nos. 25,001-38,600	100	91-94
—— 4½ per cent. 1st Mt. Debs., Nos. 1-6,250, of £40 each	40	104-106 p.c

Name.	Amount paid. £	Last price £
British Electric Traction, Ord. 1-300,000 & 60,001-90,000	10	12½-13
—— 6 per cent. Cm. Pf., 30,001-60,000	10	11½-12
—— 5 per cent. Perpetual Debenture Stock	100	122-125
Buenos Ayres and Belgrano Tram., Ord., 1-100,000	5	2⅜-2⅝
—— "A" 6 per cent. Cm. Pf., 1-40,000	5	5-5⅛
—— "B" 6 per cent. Cm. Pf., 1-27,500	5	4⅜-5⅛
—— 5 per cent. Deb. Stock, Red.	100	107-110
—— Prov. Cert., all paid	100	97-102
Cape Electric Tramways, Nos. 1-480,000	1	2⅛-2⅜
City of Birmingham Tramways, 5 per cent. Cum. Pref.	10	5-5⅛
—— 4 per cent. 1st Mortgage Deb., 1-3,000 (1917)	100	99-102
Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red.	100	102-105
Cork Electric Tramways and Lighting Co., Ordinary	10	13-14
—— 5 per cent. Cum. Pref.	10	11-12
—— Debentures	100	96-99
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10	12½-13½
—— 6 per cent. Pref., Nos. within 1-60,000	10	15-16
—— 3½ per cent. Mort. Debs., 1-3,000, Red.	100	94-97
Imperial Tramways Ordinary	all	22-22½
—— 6 per cent. Cum. Pref.	all	14½-15½
—— 4½ per cent. Deb Stock	100	112-114
Isle of Thanet Electric Tramways and Lighting, 5 per cent. Cum. Pref., Nos. 30,001-60,000	5	3⅜-4⅛ xd
—— 4 per cent. Debenture Stock	100	92-95
Kidderminster and District Lighting and Traction, Pref.	5	3¾-4
London United Trys. (1901), 5 per cent. Cum. Pref.	10	11⅜-12⅛
—— 4 per cent. 1st Mt. Db. Stock, Red.	100	105-107
Metropolitan Electric Trams., Deferred, 1,000 001-1,314,016	1	3/16-5/16
—— 5 per cent. Cum. Pref., 500,001-814,016	1	⅞-1⅛
New General Traction, Ordinary	5	1-1⅛
—— 6 per cent. Cum. Pref.	5	2-3
—— 5 per cent. Mortgage Debentures, 1-1,713 (Regd.)	100	88-93
Oldham, Aston, and Hyde Tramway, Ordinary	10	10½-10⅞
—— 5 per cent. Cum. Pref.	10	11½-12½
Perth Elec. Tramways (W.A.) 5 per cent. 1 Mort. Deb. Stk.	100	99-102
Potteries Electric Traction, Ordinary, 20,001-40,000	10	9-10
—— 5 per cent. Cum. Pref., 1-20,000	10	9-10
—— 4½ per cent. Debenture Stock	100	103-106
South Lancashire Electric Traction and Power Company—		
—— £250,000 Ordinary	1	1
—— £101,132 6 per cent. Preference	1	1
—— £528,093 4½ per cent. Debenture Stock	100 p.c.	100 p.c.

Telephones.—

National Telephone, Preferred	100	100-102
—— Deferred Stock	100	78-80
—— 6 per cent. Cum. First Pref.	10	13-14
—— 6 per cent. Cum. Second Pref.	10	13-14
—— 5 per cent. Non. Cum. Third Pref.	5	5-5⅛
—— 3½ per cent. Deb. Stock, Red.	100	95 97
—— 4 per cent Deb. Stock, Red.	100	101-103
Oriental Telephone and Electric Company	1	13/16-15/16

TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line	Traffic Returns for week: Ending	1903. £	1902. £	Increase or decrease: Week. £	Current year. £	Miles of single track open: 1903.	1902.	Accounts for past year: Ending	Total receipts £	Passengers carried.	Car miles run.	Receipts per: Pas-s'nger d.	Car mile. d.	Mile of track. £	Cost per car mile d.
Aberdeen Corporation	Sep. 5	1,311	1,142	+ 169	+ 2,382	19¼	17¼	May 31	37,931	9,099,715	794,641	0·98	13·02	1,970	6·14
Ayr Corporation	—	—	—	—	—	8	6	Sept. 25	12,503	2,979,276	290,099	1·00	10·34	1,560	4·7
Birmingham Tramways	" 5	5,199	5,137	+ 62	+ 8,214	6½	6½	—	—	—	—	—	—	—	—
Blackburn Corporation	" 4	788	987	− 199	+ 442	24	24	March 25*a*	40,964	7,234,106	826,558	1·36	11·87	1,705	7·44
Blackpool Corporation	—	—	—	—	—	17½	16½	" 31	211,169	6,169,121	784,443	1·52	10·8	—	—
Blackpool-Fleetwood Tramways	" 5	1,368	1,655	− 287	—	16½	16½	Dec. 31	30,923	2,049,677	584,989	3·62	12·68	1,932	6·99
Bolton Corporation	" 6	1,913	1,731	+ 182	+ 5,836	38	25	March 31	85,704	17,761,605	1,896,247	1·15	10·75	3,430	5·87
Bournemouth Corporation	—	—	—	—	—	10½	—	—	—	—	—	—	—	—	—
Bradford Corporation	" 6	4,035	3,692	+ 343	+10,515	41	—	—	—	—	—	—	—	—	—
Brighton Corporation	" 6	1,107	1,113	− 6	—	6½	—	" 31	—	10,432,508	1,031,928	1·00	10·10	—	—
Bristol Tramways Company	" 4	5,199	4,978	+ 221	—	51½	51½	Dec. 31	223,480	41,192,899	5,724,114	1·30	9·38	4,348	—
Burnley Corporation	" 5	844	755	+ 89	—	—	—	—	—	—	—	—	—	—	—
Burton Corporation	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Cardiff Corporation	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Carlisle Tramways Company	—	—	—	—	—	—	—	" 31	—	2,216,583	320,129*h*	—	—	—	—
Central London Railway	" 5	5,493	5,663	− 170	− 1,948*h*	6	—	" 31	367,225	45,305,110	1,276,971*a*	1·87	66·6*a*	59,076	35·6*a*
City and South London Railway	" 6	2,415	2,157	− 242	− 3,061	6⅝	—	" 31	165,003*a*	19,069,319*a*	—	—	—	—	—
Cork E. T. and L. Company	" 3	633	872	− 239	− 1,545	—	—	—	—	—	—	—	—	—	—
Darwen Corporation	—	—	—	—	—	7·23	—	March 31*g*	12,341	2,360,735	254,279	1·25	11·65	1,707	9·36
Dover Corporation	" 5	310	300	+ 10	+ 66	3	—	—	—	—	—	—	—	—	—
Dublin & Lucan Electric Railway	" 6	165	147	+ 18	+ 80*h*	—	—	Dec. 31	5,796	364,796	102,087	3·81	13·62	859	7·68
Dublin U. T., electric cars	" 4	4,344	4,480	− 136	} —	46	46	March 31	126,121	24,553,133	3,429,356	1·23	8·82	2,741	5·06*h*
Dublin S. District, Electric	" 4	1,160	1,209	− 49											
Dundee City Tramways	—	—	—	—	—	22	22	May 15	35,874	9,084,522	752,814	0·93	11·276	1,630	—
East Ham Corporation	" 5	753	515	+ 223	+ 5,087	10·75	7·52	March 31	25,341	9,971,337	650,224	0·61	9·35	2,357	—
Farnworth U.D.C.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Glasgow Corporation	" 5	13,625	12,584	+1,041	+20,537	124	101	May 31*g*	656,572	177,179,549	14,008,750	0·88	11·25	5,489 *b*	7·40*d*
Halifax Corporation	—	—	—	—	—	30½	27⅔	—	—	—	—	—	—	—	—
Huddersfield Corporation	—	—	—	—	—	34	35	March 31	56,631*h*	9,738,213	1,218,539	1·4	11·14	1,618	6·38
Hull Corporation, E. S.	" 5	1,847	1,783	+ 64	+ 1,935	19	19	" 31	87,707*h*	21,065,999	2,218,696	1·00	9·49	5,004	5·07
Ilkeston Corporation	" 2	192	—	—	—	—	—	—	—	—	—	—	—	—	—
Kirkcaldy Corporation	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Leeds Corporation	" 5	5,532	5,329	+ 123	+ 7,524	77	—	March 25	252,656	57,239,779	5,773,651	1·11	10·91	3,283	—
Liverpool Corporation	Aug. 30	10,401	10,661	− 260	+11,873	101	95	Dec. 31	504,304	108,906,472	11,705,425	1·11	10·34	5,000	6·88
Liverpool Overhead Railway	Sep. 6	1,714	1,608	+ 106	+ 938	15½	15½	June 30	79,252	10,456,726	986,185*a*	1·82	19·30*a*	5,110	— *a*
Lowestoft Corporation	" 5	357	—	—	—	—	—	—	—	—	—	—	—	—	—
Nelson Corporation	" 8	111	—	—	—	3	—	—	—	—	—	—	—	—	—
Newcastle-on-Tyne Corporation	" 5	3,389	2,932	+ 457	—	38½	36	March 25*g*	150,334	33,474,122	3,379,119	1·08	10·93	4,175	6·17
Portsmouth Corporation	—	—	—	—	—	29	29	Sept. 30	47,651	9,168,137	868,157	1·24	13·17	1,643	—
Rochdale Corporation	—	—	—	—	—	4½	—	March 31	5,416	925,281	127,456	1·38	10·27	—	7·66
Rotherham Corporation	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Salford Corporation	Sep. 7	4,048	2,819	+1,229	+27,023	—	—	—	—	—	—	—	—	—	—
Sheffield Corporation	" 6	4,703	—	—	—	53½	46½	Mar. 25*g*	216,709	56,812,049	4,926,083	0·904	10·428	7,510	7·0
Southampton Corporation	Aug. 13	1,270	1,270	—	—	11	11	" 31	35,874	9,084,522	752,814	0·946	11·436	3,760	—
Sunderland Corporation	Sep. 6	1,374	1,327	+ 47	+ 810	18·48	17·18	" 31	59,930	13,987,121	1,270,857	1·03	11·3	3,243	6·43
Wallasey U.D.C.	" 5	771	737	+ 34	+ 2,191	10·5	10·5	" 31*g*	31,307	5,690,378	654,553	1·32	11·47	2,981	6·97

* Includes maintenance of permanent way and proportion of profits paid to the tramway companies for term of unexpired lease. *a* Train mile. *b* Per mile of single track. *c* Include rail and tram. *d* including depreciation. *f* Including one section of horse traction *g* 1903. *h* Half-year's figures.

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NOTES.

Books Received. — "Governors and Governing Mechanism," by H. R. Hall (2s. 6d.), and "The Manufacture of Iron and Steel Tubes," by Edward C. R. Marks (5s.), published by the Technical Publishing Company, Manchester.

Dr. Fleming's Cantor Lectures.—Many of our readers will no doubt be interested to hear that Dr. J. A. Fleming's Cantor lectures on "Hertzian Wave Telegraphy," recently delivered before the Society of Arts," can now be had in pamphlet form at the price of 1s. a copy. Application should be made to the secretary of the society, Adelphi, W.C.

Electricity for Australian Railways.—There is considerable talk of adopting electric traction on some of the railways in the State of Victoria in the Australian Commonwealth, particularly on the suburban railway system of Melbourne. The possibilities of the proposed change from steam to electric traction have been the subject of discussion with the Railway Commissioners of that State for some time past. The matter has also come under the notice of the Victorian Parliamentary Standing Committee on Railways, and a sub-committee of that body has been appointed to make enquiries on the whole subject. The committee is now busily prosecuting its enquiries in Sydney, where, as our readers know, a large scheme of conversion from steam to electric traction on the State tramways is nearing conclusion. It is the opinion in Victorian railway circles that electricity could be advantageously adopted on several of the lines now worked by steam power.

North-East Coast Institution. — We have to acknowledge parts 8 and 9 of vol. xix. of the *Transactions* of the North-East Coast Institution of Engineers and Shipbuilders. This issue, in addition to a couple of papers relating to steamship vibrations and the construction of large steel steamers, contains some valuable remarks by Mr. John Tweedy and others on education in technical science and the general training of youths. In this connection it may not be generally known that the Institution has appointed an educational committee to consider questions which may arise in regard to the education in technical science and general training of youths entered or preparing to enter engineering and shipbuilding works, to discuss such questions with public and other educational bodies, and to advise upon them. The committee has been empowered to associate itself by sub-committee or otherwise as may be arranged with similar committees of kindred institutions.

American Institute.—The latest volume of the *Transactions* of the American Institute of Electrical Engineers has just reached us. It opens with a full account of the proceedings of the 177th meeting held in New York, at which the annual report of the board of directors was presented. We are pleased to be able to record the great advance which the American Institute has made in the matter of numbers. In the past year the membership has nearly doubled, the total number of members of all grades being close on 740, compared with 390 the previous year. This increase is no doubt due to the establishment of several local sections—nine in number—all of which have been successfully launched during the past year. Among the papers which are reprinted in this volume are the following: "Experimental Basis for the Theory of the Regulation of Alternators," by Mr. B. A. Behrend; "Study of the Heyland Machine as Motor and Generator," by Mr. C. A. Adams; "Compounding of Self-Excited Alternating-Current Generators," by Mr. A. S. Garfield; "Alternating-Current Theory," by Mr. W. S. Franklin; and "Some Features of Telephone Traffic," by Mr. J. G. Wray.

Wind Power.—For more than two years two small factories, one near Leipsic, the other near Hamburg, have been driven successfully by windmills, which are also used as a means of generating electricity for lighting purposes. According to the *Elektrotechnischer Anzeiger*, the windmills have a diameter of 5m. and 5½m. respectively, and are mounted on the roof of the works. To ensure reliability the wind wheel itself has no moving parts, the speed regulation being obtained by turning the windmill so as to vary the angle under which the wind impinges upon the sails, which are built of steel sheets. This is performed by a small auxiliary wind motor, and is said to be done so quickly and accurately that the voltage of the dynamo remains practically constant throughout the range of ordinary wind pressures. An automatic switch cuts out the battery connected in parallel with the dynamo as soon as the wind falls below a certain point. In one of the cases mentioned the battery may be divided into two parallel groups when it is necessary to utilise unusually low winds.

Paris Metropolitan Railway.—Appearances incline to the belief that the question of possible reforms on the underground electric railway in Paris after the recent disaster, will lead to a state almost approaching open rupture between the Municipal Council and the railway company. We have already enumerated the various recommendations of the special committee of enquiry as to what precautions should be taken against future accident, and it seems that the Permanent Metropolitan Railway Committee of the Municipal Council have authorised the committee of enquiry to see that they are carried out. In addition, the Municipal Committee have passed a resolution in favour of the municipal officials entrusted with the control and inspection of the Metropolitan being empowered to exercise this control in a permanent fashion over the traffic and management. The relations between the two principal authorities are thus considerably strained. Although the city has a right to see that precautions are taken to prevent, as far as possible, the recurrence of serious accidents, and the city is in partnership with the company, the cost of the suggested reforms will have to be borne entirely by the latter, for the partnership exists only to the extent that the city receives about one-third of the gross receipts.

London Traffic Enquiry.—The Royal Commission which was appointed some months ago to enquire into the subject of locomotion in London generally, has already covered much of the ground of its enquiry in the Metropolis; and the great mass of evidence which it has been enabled to collect at its weekly sittings will no doubt prove of the utmost value when the time comes to make a report. The many and important sources of information on this subject of locomotion, however, have by no means been exhausted, and after the parliamentary recess the Commission will return to its labours in London. In the meantime the Commission has wisely decided to pay a visit to the States, where, it is admitted, the most up-to-date practice in electric tramway and railway work prevails. Mr. L. L. Macassey, the secretary to the Commission, is now in New York making arrangements for a tour of the principal cities in the States, and the members of the Commission forming the party leave England this week. We are sure the Commission will receive every courtesy during their American tour from engineers on the other side, and there is little doubt but that it will derive great benefit from an investigation of

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the systems of traction and transport as they exist in the United States to-day.

Electrically Operated Swingbridge.—Sydney, in New South Wales, will soon be in possession of a swingbridge, operated electrically, to replace the present Pyrmont Bridge. The swing span of the new bridge, which is now under construction, will be 225ft. long and 54ft. wide, and will weigh 600 tons. The swing is of the ring bearing type, and the whole weight—some 800 tons when swinging—is distributed by an arrangement of girders to 16 points on the drum, thus ensuring an even load on 66 cast-steel rollers upon which the span travels. Two 50-h.p. motors will be provided for operation, and it is estimated they will either open or close the bridge in 60 seconds. Both slewing and end-lift motors will be carried on a platform inside the drum, the former working, through a chain of gears, a vertical shaft, on the lower end of which is a cast-steel pinion meshing with a cast-steel rack secured to the top of a pivot pier, while the end lift will be effected by means of cones on horizontal shafts worked by a 35-h.p. motor geared to a longitudinal shaft running the whole length of the pier. The whole of the operations connected with the swing span and the gate on the side span will be controlled by one man from the controller house over the footpath of the centre of the swing span. The new swing will afford two clear fairways of 70ft., as against the 57ft. 6in. and 35ft. openings as at present.

Magnetic Separation.—The use of magnets for the separation of para-magnetic particles from other materials is of considerable practical value in different manufacturing industries. The idea is employed, for instance, in attrition machines, which are used for grinding rice chaff into small particles, to be mixed with more nutritious ingredients, to make cattle food. These attrition machines consist of two metal discs turning in opposite directions, being separated by $\frac{1}{8}$in. to $\frac{3}{16}$in. The discs are indented to give a grinding surface, and with each revolving at a rate of from 1,500 to 2,000 revolutions a minute, it can readily be seen that iron or steel particles in the light chaff ground between the discs may cause sparks which would give rise to a destructive fire. To extract such particles, the chaff, before reaching the discs, is passed in close proximity to strong magnets, which attract any bits of metal with enough force to draw them from the chaff. A similar contrivance has been used in flour mills, where it is well known that a slight spark will oftentimes cause a violent explosion of the fine dust which collects in flour mills. A third application of magnetism, according to the *Western Electrician*, is adapted for paper-pulp manufacture. It is embodied in a recent invention by Charles J. Reed, of Philadelphia. To extract the particles of metallic substances from the pulp, a cylindrical shell is arranged to rotate in the pulp tank or trough. Stationary magnets within the shell are so mounted that the pulp, as it is tossed about by the rotation of the shell, comes in contact with the magnets some time during its passage, and all para-magnetic substances are thus separated from the remainder of the mass.

Colonial Patents.—Both Australia and Canada have been amending their patent laws within the past 12 months, with, however, but indifferent success. In each case the objection is placed on the same ground, the main provision being practically identical, with the exception of the term of years named. Thus, in the case of the Australian Federal Patents Bill, of which we gave some particulars last week, it is laid down that the patentee, or some person authorised by him, shall, within five years after the date thereof, commence, and after such commencement continuously carry on, in Australia the construction, manufacture or working of the invention patented in such a manner that any person desiring to use it may obtain it, or the use of it, at a reasonable price. A further proviso is that after four years the patentee shall not import the invention, or cause it to be imported in Australia. The Canadian Bill is practically in the same terms with this difference, that the period in which the patentee must commence to manufacture is limited to two years, and he is not to be allowed to import into Canada the invention for which the patent is granted after the expiration of 12 months. These conditions are so widely different from the law as it stands to-day in this country, and they are likely to so seriously affect the position of British patentees, that a good deal of opposition is being shown to the proposals. It follows from the above that an English manufacturer who obtains a patent for his product in the Australian Commonwealth must actually manufacture on the spot, and refrain from exporting the same from this country after a period of four years, or lose his patent. In the case of Canada it is even worse, the period being limited to two years for working the patent and one year for importing the article.

French Telephones.—There is a good deal of adverse criticism going on in France just at present concerning the telephone question. Probably in no other Continental country has the telephone made such advances in public and private life, and this fact perhaps largely accounts for the present inadequacy of the system. As an example the Telephone Department of the French Government shows that the receipts increased from £995 in 1885 to £930,700 in 1899. The fault seems to lie, not in the paucity of the receipts, but in the manner of their disposal. Thus the bulk of the profits goes to help the Budget, and only a small fraction is set aside for improvements and extensions. The result is a clamouring outcry on the part of the people for better facilities. These the authorities declare their inability to provide owing to lack of funds, and undoubtedly the financial question is the root of all the evil. Last April the Government introduced a Telephone Extension Bill in the Chamber of Deputies, but no action has been taken by Parliament. The proposal is to obtain a loan of nearly a quarter of a million sterling with which to carry out the much-needed improvements. The Telephone Department is confident that it could repay the amount in less than five years, but the Legislative Assembly appears to be in no hurry to discuss the proposal. As an example of the inadequacy of the present system, we may quote an instance in which a subscriber only succeeded in obtaining communication with Paris from a provincial town 24 hours after ringing up. We are assured that such instances as this are not infrequent when communication is required with the capital from one of the favourite French seaside resorts, such as Trouville. No wonder, then, that there the public is dissatisfied. In this case it is the Government that is responsible for providing the telephone service of the country, but we are curious to know what would happen if the undertaking were in the hands of the private company?

Russian Electrical Industry.—In our last issue we dealt with this subject from the point of view of the good progress which is being made in Russia in the application of electricity to commercial purposes. We endeavoured to show that its use as a motive power in factories and works, and also for lighting purposes, has already advanced with rapid strides, so much so that the bulk of the electrical machinery has to be imported, the home manufacturers being unable to meet the demand.

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In the light of these facts it is a curious circumstance that the electrical industry, as an industry, is having an unfortunate experience in Russia at the present time. Most of the German electrical companies which have established branches in Russia have but a sorry tale to tell. The majority of these branches have so far resulted in heavy losses, whether conducted as sales bureaux for their original promoters or whether formed as Russian companies with workshops in that country. In this connection Prof. Salomon, general manager of the Lahmeyer Electrical Company, of Frankfort-on-the-Maine, which has incurred a loss of over £140,000 in the past two years, told the shareholders at the annual meeting the other day that all the German electrical companies with Russian branches had been disillusioned, but that scarcely anything better was expected from connections with other companies. Instead of the prospect of an early improvement in the present state of affairs, things look like going from bad to worse. It is stated that the purely Russian electrical companies have forwarded a petition to the Government praying that new branches of foreign works should no longer be permitted to be established, and that the foreign branches already located in Russia should be excluded from participating in competitions for public contracts in that country. The apprehension seems to be that if the petition receives sufficient support, the Government may be disposed to sanction the application. The result would be to practically close most of the German branches in Russia, while the position of those already formed as Russian companies would be jeopardised.

Precipitation of Colloidal Solutions.—Mr. H. Freundlich describes in a recent paper an investigation into the precipitation of colloidal solutions by electrolytes. Colloidal solutions of arsenious sulphide, ferric hydroxide, and platinum were employed in this investigation, and the precipitating power of various salts was compared by determining the concentration of the salt solution that, within a given time and under otherwise equal conditions, caused a separation of flocks large enough to be kept back completely by a filter of a standard type. For colloidal solutions exibiting anodic convection under the influence of a current (arsenious sulphide and platinum), the precipitating power of a salt is practically independent of the anion, the valency of the cathion being the determining factor. Tervalent ions are more effective than bivalent ions, and these again are more effective than univalent ones. For a colloidal solution of ferric hydroxide which exhibits colloidal convection, the valency of the anion is the chief determining factor. Further, in the case of the univalent ions, an influence of the rate of migration may be detected; thus, in the precipitation of a collodial solution exhibiting anodic convection, the acids are more effective than the salts yielding univalent cathions. Speaking generally, equivalent solutions of equally dissociated electrolytes, yielding ions of the same valency and with nearly equal rates of migration, are equally effective in the precipitation of collodial solutions. It has been shown that the precipitating effect is dependent not only on the concentration of the precipitating salt, but also on the rate at which the latter is added to the colloidal solution. This leads the author to regard the process in question as one involving the element of time (as a process of diffusion); it cannot be explained by a displacement of the statical equilibrium. As a working hypothesis, the author supposes the colloidal substance to be semipermeable to the ions, the character of the semipermeability being closely bound up with the direction of the convection (anodic or cathodic). We take the above from an abstract in the Chemical Society's *Journal*.

Aluminium Conductors.—One of the chief objections in the way of the general use of aluminium for electrical conductors is the difficulty of obtaining a satisfactory joint, but this has apparently not stood in the way of the adoption of aluminium conductors on some of the North American transmission lines. Indeed, aluminium has now almost entirely displaced copper on the three longest electrical transmission systems in that country. The longest single line in California—that from Electra power-house to San Francisco, a distance of 154 miles—uses aluminium entirely, while the 144-mile transmission line between Colgate and Oakland is accomplished with three aluminium and three copper wires. Again, the Shawinigan Falls-Montreal transmission over a distance of 85 miles is carried out with three aluminium conductors alone. In the face of these facts, Mr. Alton D. Adams in the *Engineering Magazine* claims that not only has copper lost its former place as the only conductor to be seriously considered for transmission circuits, but that aluminium has actually gained the most conspicuous place in the long-transmission work. The decisive factor in this victory of aluminium has been that of cost for a circuit of given length and resistance. From the standpoint of cross-sectional area, aluminium is inferior to copper as an electrical conductor. Comparing wires of equal sizes and lengths, the aluminium have only 60 per cent. of the conductivity of the copper. The inferiority of aluminium as an electrical conductor in terms of sectional area is more than offset by its superiority over copper in terms of weight. One pound of aluminium drawn into a wire of any length will have a sectional area 3·33 times as great as 1lb. of copper in a wire of equal length. This follows from the fact that the weight of copper is 555lb., while that of aluminium is only 167lb. per cubic foot, so that for equal weights the bulk of the latter is 3·33 times that of the former metal. Hence, for equal resistances, the weight of an aluminium is only one-half as great as that of copper wire of the same length. From this fact it is evident that when the price per pound of aluminium is any less than twice the like price of copper, the former is the cheaper metal for a transmission line of any required length and electrical resistance

Cooper-Hewitt Vapour Lamp.—A notable improvement has quite recently been added to the Cooper-Hewitt mercury vapour lamp, which has already been illustrated and described in this journal. The improvement consists of a new method of starting, and an interesting account of it is given in the *Electrical World*. Up to the present the lamps put into commercial use have been started by a high-potential kick from an inductance coil. A special quick-break switch under oil was used to make and break a circuit across the coil, the discharge of which passed through the lamp, breaking down the initial reluctance to starting. The new process of starting is known as the "tilting" method, and is somewhat similar to that employed by Arons and other early investigators, in that an absolute connection is established between the two electrodes of the lamps by means of the fluid of the electrodes themselves. In the Hewitt lamp the electrodes are placed one above the other, and a connection is established by first tipping the lamps so that there is an excess of mercury in the normal upper electrode, and then allow ing the mercury to flow by gravity in a stream down the length of the tube. This stream momentarily establishes a metallic connection between the electrodes and then breaks, usually at the bottom, where it ends in a spray. The lamp lights across the break, the luminous area rapidly extending up the tube as the stream falls away. The liquid mercury has the property of stringing out into a

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long, fine, continuous stream, and lamps over 4ft. long have been lit in this manner using no more mercury than is required for their normal operation. It is usual, however, to use lamps about 2ft. long to operate on 55 or 60 volts. To operate on 110-120 volts, the lamps are connected two in series. If it is intended to light both lamps simultaneously, they are mounted in one frame and tilted together. With an apparatus of this kind, a simple rheostat and choke oil for resistance are all that is required. When the lamps are to be lighted independently, each is furnished with a resistance having in shunt across the vapour lamp another resistance which is automatically cut out when the lamp is started. Two 40-volt, 1·5-ampere incandescent lamps are used as the shunt, so that being first turned on by an ordinary switch the operation of tilting the vapour lamp may be readily accomplished in an otherwise dark place. They also serve as pilot lamps to show when the switch is left closed and the vapour lamps unlit.

Wireless Telegraphy.—Another international conference on this subject has been arranged to be held in Berlin next year, by invitation of the German Emperor. It is assumed that in the meantime further developments will be made in the art, which will enable the countries represented to view the question of an international agreement from a more practical standpoint. The recommendation agreed to at the last conference, that all coast stations would be obliged to receive and forward wireless telegrams without distinction of system, will probably remain in abeyance until a more definite conclusion can be arrived at. England and Italy have all along stood out against any such proposal, and it will be interesting to see what line of action those countries will take at the next conference. The American Press is greatly exercised over the failure of the preparations made by the Marconi and the De Forrest Wireless Telegraph Companies to send reports of the progress of the America Cup race to the shore. The managers of the two companies insist that their instruments were rendered useless by the efforts of some evil-disposed persons who transmitted at the same time nonsensical rhymes, letters of the alphabet, and meaningless expressions, so that their instruments recorded nothing but a jumble of incoherences. The president of a rival corporation, at whom these inuendoes are supposed to be aimed, retorts that the trouble arose through the transmission of their own bickerings, which, he declares, went on during the whole time of the races. Mr. Marconi, on his arrival in New York the other day, was "cornered" by the interviewers, with the result that some high-flown reports have been circulating among the English newspapers. Among other things, Mr. Marconi is stated to have said: "The four new inventions that I have made will not only make it impossible for anyone to interfere with our messages, but will obviate the necessity of sending and receiving messages from great altitudes. They also make it possible to reduce greatly the amount of current necessary for the transmission of the messages. It will also now be possible to establish a great many more stations, as the height is not so important a consideration. Because of the convexity of the earth, it was formerly necessary for us to transmit messages from a great height in order to avoid the interference of the obstructing land or water. I am of the opinion that we have now overcome every obstacle to the successful establishment of our system on a commercial basis that will prove of great value to the business and scientific world." We can only trust that Mr. Marconi's hopeful prognostications will be realised.

Large Transformer.—*Scientific American* describes in its current issue what is styled the largest transformer ever built. It has been constructed for the Pittsburg Reduction Company, and will be used at their Niagara plant for the manufacture of aluminium by the electric process. The transformer is rated at 2,000 kw., which is said to be 250 kw. more than the capacity of any other transformer. But more remarkable still is the large current which is induced in the secondary winding, it being required by the peculiarities of the aluminium process, in which the current used may be very heavy, though the voltage must be low. The primary winding of the transformer is designed to receive a current of 908 amperes at 2,200 volts, and this will be transformed in the secondary winding to a current of 40,000 amperes at 50 volts pressure. At its base the transformer measures 7ft. 2in. square, and its height is 8ft. 8in. Several details of the construction are interesting in view of the unusual capacity of the machine. The secondary winding consists of heavy laminated copper bars, a large size being required to carry the enormous current for which the transformer is built. These bars obviously cannot be bent to form coils in the ordinary sense of the word, but are connected at the top and bottom by copper plates clamped thereto. The primary winding of the transformer is made up of copper ribbon coil sections, a coil section being placed between each successive pair of bars in the secondary winding. Taps from each coil section of the primary winding are run up to a switching device called the "regulator head," whereby any number of coils may be cut in or out to change the voltage to any pressure desired, the ratio between the primary and secondary voltages being, of course, directly proportional to the number of turns in each. The iron core consists of thin sheets of soft iron built up about the coils. The upper part of the apparatus, after the core is in position, is surrounded by a coil of piping through which cold water is circulated to carry off the heat generated by hysteresis and by the resistance losses caused by the current in the conductors. An additional coil is placed above the primary winding and within the secondary winding. The entire apparatus is encased in a tank filled with oil, which circulates through the transformer and carries the heat from the lower heated sections to the top, where it is taken up by the cooling coils. The oil also serves as an insulating medium in the gaps between the coil sections and between the coils and the iron core. These parts are also separated from each other by sheets of insulating material. The transformer was built by the Stanley Electric Manufacturing Company, of America.

Electrical Coal-Cutting.—Chief interest at the recent annual meeting of the Institution of Mining Engineers held at Nottingham centred on the subject of coal-cutting by electrical methods, which was exhaustively dealt with in a paper by Mr. W. Walker. He showed that coal-cutting by machinery was developing but slowly at the present, but predicted in the near future it would become an urgent necessity. However, the introduction of such machinery could only be successfully carried out under certain conditions, such as in new collieries with thin seams, collieries with an ample area of unworked coal, and old collieries commencing the working of new seams with a fair roof. He went on to give his experience of electric coal-cutters, which had been a varied one, comprising failure on the one hand and success on the other. A Scott and Mountain machine was tried at the new London Colliery of the Digby Colliery Company. It was guaranteed to cut in the floor at the rate of 60 yards, 5ft. under, in nine hours. The distance cut per shift varied considerably. Sometimes the machine cut eight or ten yards, then 20 or 30, and on one occasion 70 yards, but a

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portion of this length was cut in the coal, and the average distance was about 20 yards per shift. The output of coal, too, was very varied, owing to the short length of the cut and the break downs. The use of the machine was abandoned after an exhaustive trial. The author thinks that probably this failure was due to the character of the seam on which the machine was tried. The opening out of the Tupton Low Main, or furnace coal, seam at Digby Colliery suggested once more the trial of an electric coal-cutter. This seam was noted throughout the Erewash Valley for its hard holing, but its nature varied considerably. The seam was worked end-on, and the dip of the face, which was practically the dip of the seam, was 1 in 9. The holing was so hard and compact that six out of every ten men who were sent into the district as holers would refuse to work a second shift, and frequently holers failed to complete one stint—6ft. long by 4ft. deep—per shift. The greatest length ever holed for six days of work was 18 yards 4ft. under, and this was only performed on two occasions. After careful consideration it was decided to try a specially built Hurd machine to hole in the seam. Mr. Walker stated that this machine, which has a 4ft. parallel bar, proved a remarkable success, cutting a length of 57 yards in 2¾ hours, or at the rate of 20 yards per hour, and this with a remarkable reduction in the power used. The parallel bar was undoubtedly a great success, but he thought that there were one or two ways in which it could be improved. The Hurd machine was in use in the Tupton seam now, and was doing its work efficiently.

Electrolytic Refining of Lead.—Mr. Anson G. Betts contributes a long illustrated article to the current number of *Electrochemical Industry*, in which he gives full details concerning his lead-refining process, which is among the most interesting recent achievements in electrometallurgy. The solution of the problem found by Mr. Betts is probably the first one enabling the electrolytic process to enter into successful commercial competition with the older metallurgical methods, and the fact that the electrolytic process furnishes lead completely free of bismuth appears to be the main argument in favour of its success. An incidental advantage, which, however, is equally important, is the diminution of the danger of lead-poisoning to which the workmen are exposed. The novel feature of the process is the electrolyte, which is a solution of lead-fluosilicate, containing an excess of fluosilicic acid. It is easily prepared from inexpensive materials; it may be made to contain a considerable amount of dissolved lead; it conducts the current well, is easily handled and stored, and is non-volatile and stable under electrolysis. Mr. Betts states that the electrolyte takes up no impurities, except possibly a small part of iron or zinc. On the basis of a content of 0·01 per cent. of zinc and soluble iron in the anodes, and on the basis of 150 cubic feet of solution required for every ton of lead turned out per day by the refinery, Mr. Betts estimates that in one year the 150 cubic feet will have taken up 93lb. of iron and zinc, or about 1 per cent. These impurities can accumulate to a much greater extent than this before they become objectionable. Mr. Betts also points out that the electrolyte may be easily purified in several ways. An interesting detail of importance is the simple method by which a dense, coherent, and solid cathodic deposit of lead is obtained. The lead "trees" produced under ordinary conditions are well known. When the Betts process was first operated with the pure fluosilicate solution containing an excess of fluosilicic acid the lead grew from the cathode towards the anode, and in order to avoid short-circuits it became necessary to periodically remove the cathode and roll down the lead. This difficulty was overcome by the addition of some gelatine or glue in small quantities to the electrolyte. With this addition to the solution a dense deposit of lead is obtained, its density being greater than can be produced by rolling the crystalline deposit unless great pressure is used. Commenting editorially on the Betts method, our contemporary expresses the hope that the success thus obtained in the electrolysis of lead, generally accepted as impracticable, may give some encouragement to the employment of similar methods in the treatment of some other metals. This hope appears justified, especially in view of the fact that in the Betts process it has been found to be possible to obviate the chief difficulty—spongy deposits—by inexpensive means.

The Future of the Telephone.—Under this heading Mr. F. E. Bains, one time a prominent official in the Government Post Office service, writes a long letter to the *Times*, which is published in last Monday's issue. Taking as his text the acquisition last year by the National Telephone Company of the Tunbridge Wells municipal undertaking, Mr. Bains, who is himself a resident in that district, enters a protest against the manner in which the telephone system in Tunbridge Wells is conducted. His own personal experience has been anything but encouraging. Four months ago he formally applied to the company for a telephone service to the borough exchange, but so far no notice whatever has been taken of his application. The writer hits upon this treatment of an individual as an excuse for raising the question of the renewal of the company's license now approaching expiration, and, in short, advocates the telephone service being in the hands of the Post Office Department. Surely, he demands, it is time that a definite policy, of which the public at large could really approve, should at last be laid down for regulating the development of "that simple but mighty engine of public convenience and social order, the telephone." It has never yet had a fair chance in the 30 years of its young life. Such a policy he outlines thus: (*a*) The telephones, with a single but substantial reservation, to be constructed and worked exclusively by the Postmaster-General, under the terms of his legal monopoly; (*b*) on the expiration of the licenses to the National Telephone Company, such of the plant as may be suitable to be acquired by the Post Office at a valuation; (*c*) all incorporated towns not already equipped to be supplied with a telephone service by the Post Office, just as that office supplies them with telegraphic accommodation; (*d*) all other towns, and even considerable villages, to be similarly equipped, so far as an annual vote of Parliament allows, preference being given to such as guarantee from the rates actual working expenses; (*e*) the reservation to be that such cities and towns as have already (under license) constructed systems of their own with possibly extensions into a rural area defined, or at least agreed to, by the Postmaster-General to be confirmed in their equities, and other towns prepared to construct local systems to be licensed to do so. Probably there should be a reduction of the royalty now payable to a lower percentage, and certainly a substantially cheapened and, for local services, uniform tariff fixed by the Legislature would be a public boon. In touching on a further point, the writer admits having no exact data to go upon, but his impression is that to the public—in the main, in fact, to all users of the telephone, wholesale traders excepted—local services, which are usually swift and certain, are greatly more in request than those over long distances, which in many cases have been found to be uncertain and slow. If so, this is an argument for the rapid and effective establishment of municipal systems.

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SOME NOTES ON THE DESIGN OF MAGNET SYSTEMS FOR CONTINUOUS-CURRENT MACHINES.

BY T. SQUARE.

(Concluded from page 396.)

Yokes.—Cast-iron yokes are to be preferred to cast-steel (except in cases where weight is a great disadvantage), for the following reasons: (1) Owing to the greater elasticity of cast steel, it takes up mechanical vibrations much quicker than cast iron, especially as it is only about one-half the section. These mechanical vibrations will aggravate any tendency to "buck" if such be present. (2) Cast iron being of twice the section, there will be a greater amount of eddy currents set up in it, tending to resist any change of flux, so making a more "stable" machine, especially on low fluxes. (3) Cast steel when obtained is rather uncertain in its magnetic qualities, and also very liable to large blowholes, especially in large castings. This is a very serious defect, and one which is practically absent in cast iron. These blowholes, unless they happen to be broken into during machining, often entirely escape observation until the machine has been completed and is about to be tested. We then find that it cannot be made to give its correct voltage, or that one pole is much stronger than another, etc., the only cure being to drill a series of test holes and fill up any cavities so found by means of "thermite" or some other similar mixture. (4) The cost of a cast-steel yoke is more than that of a cast-iron one, and the time required for delivery, more especially for large castings, is considerably longer, it being much more difficult to make. For these reasons most of the principal firms are now adopting the cast-iron yoke, which they can cast at their own foundry.

Most old multipolar machines used to have a *metal spool* on which the field winding was wound, and which served to keep each wire in its place. Many engineers also thought that this metal sheet encircling the pole acted somewhat as a Hutin and Leblanc amortisseur, large eddy currents being set up in it whenever the flux in the pole changed, the effect of these eddy currents being, of course, to oppose the change. This is a very useful effect, and no doubt exists to some extent, but from experiments which the writer has made it does not appear that this effect is very large. At any rate, these spools have been dispensed with on many modern machines, it being found that when the field coil had been soaked in insulating compound and dried in the vacuum oven, and finally whipped round with string and tape, the winding was quite stiff enough to withstand any knocking about it was liable to receive. On doing away with these spools also it was found that the bobbins ran cooler, and might have, of course, a slightly shorter length of mean turn.

Calculation of the Maximum Ampere-Turns per Pole Required.—In order to determine this we must first draw the open-circuit magnetisation curve of the machine, which gives us the ampere-turns required for any given flux when the machine is running on no load. The method of doing this is described fully in many text-books, and need not be entered into here. In order to find the maximum ampere-turns required on full load, we must add to the no-load value a certain number to balance the extra flux density in the air-gap and teeth on load caused by the cross-magnetising ampere-turns of the armature distorting the flux, as shown in Fig. 1. We must also add sufficient to balance the demagnetising ampere-turns of the armature if the brushes are not placed at the neutral position. As the demagnetising ampere-turns are in direct opposition to the main field, we must just add to the main field the same number of ampere-turns in order to keep the flux constant. This number is easily calculated. Let the total number of armature conductors be N, and the current in each conductor on full load be C, then

$$\frac{N\,C}{2\,p} = \text{ampere-turns per pole on armature,}$$

and if $\rho = \dfrac{\text{displacement of brushes from neutral position}}{\text{pole-pitch}}$, then

$$\frac{\rho\,N\,C}{2\,p} = \text{demagnetising ampere-turns per pole of armature.}$$

Again, if the armature is that of a large multipolar machine, with parallel or lap winding, we must also make some allowance for the circulating currents, which will undoubtedly exist owing to unavoidable small differences in the magnetic circuits, no matter how carefully the machine is balanced. If equalising rings are fitted (as is done in most modern machines to obviate the sparking caused by these circulating currents passing through the brushes, by offering a path of lower resistance), these circulating currents will naturally be of even greater dimensions than before. They increase both the demagnetising and cross-magnetising effect of the armature, but owing to the fact that they sometimes oppose the main current instead of increasing it, their effect is not so great as might be imagined. In a well-designed machine their demagnetising effect should not be more than from 6 to 12 per cent. of the armature ampere-turns per pole.

Supposing we have determined the flux we require on full load to give the machine the correct voltage at its terminals, taking into account the C R drop of the armature and brushes. Then we have from above:

A.T. per pole on full load = A.T. to give full load flux on open circuit + A.T. required for cross-magnetising + A.T. required for demagnetising + A.T. allowed to balance the effect of circulating currents.

In addition to all this, it is usual to allow a margin of from 5 to 20 per cent. more, in case the iron should not be of good quality, or the steel contains blowholes. If the machine is *shunt wound*, we should then take the maximum ampere-turns per pole as found from the above considerations, and make a first preliminary shot at the section of winding required by taking 90 to 60 ampere-turns to each square centimetre of winding section for 70deg. F. final temperature rise. The depth of winding of a coil should not exceed 6cm. to 8cm. on any machines, as a coil with a greater winding depth than this does not get rid of its heat so readily, and hence, in order to obtain a certain number of ampere-turns, we have to use a greater weight of copper. In fact, the smaller the winding depth the more efficiently is the copper used, for it not only gets rid of its heat more quickly, owing to its larger radiating surface, but also, owing to its small winding depth, the length of the mean turn of winding is smaller, and hence the watts wasted are less. We must, however, not carry this too far, as the increased length of pole required increases the size and cost of the magnetic system. The best depth of winding in any case is, of course, that in which the saving in copper obtained by still further reducing the depth of winding is just equal to the extra cost of the magnetic system. Dividing the approximate cross-section of winding obtained as above by the winding depth we have selected, we obtain the length of field coil parallel to its axis.

The ampere-turns of a shunt coil with a given voltage across its terminals depends only on the diameter of the bare wire and the length of mean turn—*i.e.*, the mean resistance of a turn. If we had only one turn, we should still get the same ampere-turns, provided we could keep the copper at the same temperature. But this would waste much more watts than a many-turn coil, and would not have nearly so much cooling surface to get rid of the heat; hence the wire would, in practice, be burnt up almost at once. In other words, the ampere-turns a coil will give depends only on the bare diameter of the wire and the length of mean turn, but the more turns we put on the less the watts wasted, and hence the more efficiently do we produce those ampere-turns; hence the cooler the bobbin will run, especially as the cooling surface is increasing with the number of turns. This can easily be seen.

Suppose we have one turn of wire of one ohm resistance with one volt across its terminals. Then the current flowing $= \dfrac{E}{R} = \dfrac{1}{1} = 1$, and ampere-turns $= 1 \times 1 = 1$ and $C^2\,R$ watts $= 1^2 \times 1 = 1$.

Now take two turns: resistance = two ohms, with still one volt across; current flowing = $\frac{1}{2}$, and ampere-turns $= \frac{1}{2} \times 2 = 1$ and $C^2\,R = (\frac{1}{2})^2 \times 2 = \frac{1}{2}$.

Or with 10 turns, resistance 10 ohms: current flow-

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ing $= \frac{1}{10}$; ampere-turns $= \frac{1}{10} \times 10 = 1$; and $C^2 R$ watts $= (\frac{1}{10})^2 \times 10 = \frac{1}{10}$. We thus see that by increasing the turns from 1 to 10, while the ampere-turns have kept the same, the watts wasted have gone down in the ratio of 10 to 1. So that, in determining the best winding cross-section, we should balance the extra cost of copper against the saving in excitation watts which it effects, keeping within the specified temperature rise.

Let R = cold resistance per bobbin;
R × 1·15 = hot resistance per bobbin;
E = volts per bobbin—*i.e.*, $\frac{\text{volts of machine}}{\text{No. of poles}}$;
C = shunt current in amperes;
D = winding depth of coil in centimetres;
L = axial length of coil in centimetres;
D × L = gross winding cross-section in square centimetres;
D × L × S = net winding cross-section after allowing for slack and all insulation except that around the wires themselves (S is usually about ·7);
d = insulated diameter of wire in millimetres;
d_1 = bare diameter of wire in millimetres;
l = length of mean turn in centimetres;
σ = resistance of wire 1cm. long of diameter d_1;
W = permissible watts wasted per coil for specified temperature rise.

The length of mean turn and length of outside turn can be calculated from the following formulæ:

For Rectangular Poles (see Fig. 8)—

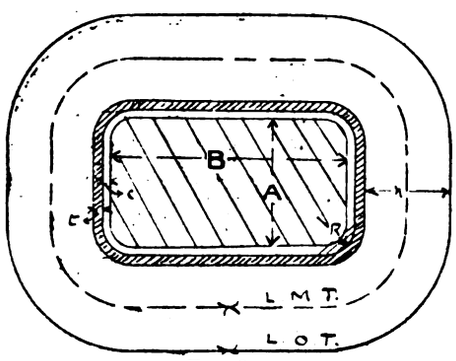

Fig. 8.

L.M.T. cm. = 2 A + 2 B + 8 c + 2 π t + π n − 1·717 R.
L.O.T. cm. = 2 A + 2 B + 8 c + 2 π t + 2 π n − 1·717 R.

For Round Poles (see Fig. 9)—

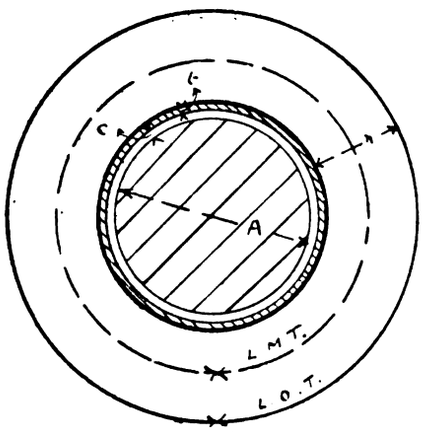

Fig. 9.

L.M.T. cm. = π (A + 2 c + 2 t + n).
L.O.T. cm. = π (A + 2 c + 2 t + 2 n),

where A and B = dimensions of pole limb in centimetres;
c = clearance between bobbin and pole limb in centimetres;
t = thickness of spool in centimetres, if any;
n = winding depth in centimetres;
R = radius to inside of spool at corner, if bobbin edges are rounded off.

The radiating surface is usually taken as the outside peripheral surface only, which is in contact with the air. It has been found from experience, that if the ratio $\frac{\text{axial length of coil}}{\text{winding depth}}$ is greater than 1·5, we can waste, taking this radiating surface, ·1 watt per square centimetre when the armature has a peripheral speed of 5m. per second; ·12 watt per square centimetre for a speed of 20m. per second. Hence we can at once work out the permissible watts, W, the radiating surface being the product of the length of outside turn of the winding and its axial length.

Now, considering one turn, we have:

Ampere-turns per coil when hot = current × turns

$$= \frac{E}{\text{Resistance} \times 1{\cdot}15} \times 1.$$

Resistance per turn

$$= \frac{(\text{Resistance of wire 1 sq. mm. section and 1em. long}) \times l}{\text{Section of wire in sq. mm.}}$$

$$= \frac{{\cdot}00017 \times l}{{\cdot}7854\, d_1^2} = \frac{l}{4{,}620 d_1^2}.$$

$$\therefore \text{ ampere-turns per coil hot} = \frac{E \times 4{,}620\, d_1^2}{l \times 1{\cdot}15};$$

or,

$$d_1 = \sqrt{\frac{\text{ampere-turns} \times l}{E \times 4{,}000}}.$$

From this formula we get the bare diameter of wire required, and knowing the thickness of insulation on the wire, we can also find the insulated diameter, d.

Now,

$$\text{turns} = \frac{D \times L \times S \times 100}{{\cdot}7854\, d^2},$$

and hence

$$\text{Resistance of coil cold} = \frac{l}{4{,}620\, d_1^2} \times \frac{D \times L \times S \times 100}{{\cdot}7854\, d^2}$$

and watts wasted per coil hot

$$= \frac{E^2}{R} = \frac{E^2 \times 4{,}620 \times d^2 d_1^2}{D \times L \times S \times l \times 127 \times 1{\cdot}15}$$

$$= \frac{E^2 \times 31{\cdot}7}{D \times L \times S \times l}.$$

If this figure is less than the permissible watts, W, we know that the temperature rise will be less than the specified in the same proportion. If the temperature rise is too high, we must alter L or D and l until we obtain a satisfactory figure.

It is sometimes required to work out the converse problem to this—*i.e.*, to find the maximum ampere-turns which can be obtained from a given winding section. We then proceed as follows:

Watts wasted = C E and $C = \frac{E}{R}$

$$\therefore \text{ watts wasted with coil hot} = \frac{E^2}{R \times 1{\cdot}15}$$

$\therefore$ minimum cold resistance of coil in order for it not to overheat $= \frac{E^2}{W \times 1{\cdot}15}$

$$\text{But cold resistance} = \frac{l}{4{,}620\, d_1^2} \times \frac{D \times L \times S \times 127}{d^2}$$

$$\therefore \text{ equating } d^2 d_1^2 = \frac{W \times l \times D \times L \times S \times 127 \times 1{\cdot}15}{E^2 \times 4{,}620}$$

or,

$$d\, d_1 = \sqrt{\frac{W \times l \times D \times L \times S}{E^2 \times 31{\cdot}7}}$$

All we have to do, therefore, is to find two diameters whose product is equal to the expression on the right, and whose difference is equal to the increase of diameter due to insulating the wire. The following table gives the thickness of double cotton covering adopted by a large firm of wire manufacturers in London:

Wire up to 1mm. in diameter, add ·2mm.
Over 1mm. and up to 1·5mm., add ·3mm.
Over 1·5mm and up to 2mm., add ·4mm.
Above 2mm., add ·5mm.

From this table it will be seen that the thickness of insulation is increased with the size of wire. This is because the larger wires, being stiffer, are more likely to

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damage their insulation in the process of winding than the thin wires. It will easily be seen that if the grading is carried out systematically—*i.e.*, the ratio $\frac{\text{diameter of wire bare}}{\text{diameter of wire insulated}}$ is always roughly constant—then the weight of wire which we can get into a given space is also roughly independent of the diameter of the wire. Having determined d and d_1, we have

Maximum ampere-turns

$$= \frac{E}{R} \times \text{turns}$$

$$= \frac{E}{1{\cdot}15 \times R} + \frac{D \times L \times S \times 127}{d^2}$$

$$= \frac{E \times D \times L \times S \times 110{\cdot}5}{R \times d^2}.$$

Compound Machines.—By means of a suitable series coil we can make the difference between the volts at no load and full load vary as we like over a fairly large range. We work out the ampere-turns required at no load and full load, and then design the shunt coil to give at no load the required no-load ampere-turns. Next work out the ampere-turns of the shunt coil at full load and subtract this figure from the full-load ampere-turns required. The difference is the series ampere-turns.

The series coils on each pole are best connected in series, for if they are connected in parallel the resistance of one coil may be slightly different from another (very probably owing to a difference in the joint contacts), and the ampere-turns per pole would consequently be unevenly divided, tending to set up circulating currents, etc. This effect is, however, self-corrective to some extent, as the coil with the higher current reaches a higher temperature, which increases its resistance and so tends to reduce the current to its proper value. If the series coils are connected in series, practically the whole main current of the machine flows through each coil. This means that as the current density can rarely be allowed to exceed 1·1 amperes per square millimetre, the cross-section of copper per effective turn is rather large. For ease of manufacture, in order to make these turns easy to wind, they are made up of a great number of laminations, ·5mm. to 1·0mm. thick, all in parallel. This makes the connections between coil and coil rather bulky, and in order to have plenty of room for these, it is a good thing to place the series coil next the yoke.

The writer in these few notes has not attempted to give anything like a full description of all the considerations entering into the design of magnet systems, but has merely put forward a few points in connection with the subject which may be of interest to those engaged in designing work.

PROTECTIVE DEVICES FOR HIGH-TENSION ELECTRICAL SYSTEMS.*

BY W. B. WOODHOUSE, A.M.I.MECH.E., A.M.INST.E.E.

The extending use of high-tension polyphase transmission is resulting in a gradual standardisation of the methods adopted to protect such systems against breakdown, but there is still some considerable diversity of opinion shown. The writer proposes to discuss several points in connection with the operation of a high-tension polyphase transmission system.

Nature of System.—Power is supplied to sub-stations through underground cables; in the sub-stations the converting machinery may consist of static transformers, motor-generators, and rotary converters. The economical voltage of transmission is decided by the cost of cables; above 10,000 volts, step-up transformers are needed at the generating end, but in such schemes as are working or projected in this country 10,000 volts is the higher limit. The design of the system should be such that each part of the system is automatically disconnected in the event of a breakdown of that part; the continuity of supply being of primary importance, all parts should be duplicated. The duplication of feeders to each sub-station does not involve excessive expenditure when the generating station is at the centre of the area of supply, as in Fig. 1, wherein two feeders are shown running from the generating to each sub-station; where this is not so, as when a number of sub-stations are closely grouped, such an arrangement becomes too costly, and interconnecting cables must be run between the sub-stations to provide alternative ways of supply. Fig. 2 shows such an arrangement, which is the case more frequently met with. In the first arrangement, power always flows in the same direction along any cable; in the second, power may be required to be transmitted in either direction on any interconnector.

Stresses on the System.—In switching on an unloaded cable a wave of pressure passes along the cable and is reflected; there may be a rise of pressure to twice the working value. In switching on a transformer or an induction motor, or any apparatus with considerable inductance, the full pressure exists for the moment between adjacent coils, the greatest stress falling on the end coils. An inductive circuit has stored energy to the amount of $\frac{I^2 L}{2}$ joules, which must be dissipated when the circuit is broken. In a transmission system, such as is considered, this energy may be converted to the electrostatic form on opening circuit with a resultant rise of pressure; neglecting damping effects, the pressure may rise to a value of $E = I\sqrt{\frac{L}{C}}$, or the rise of pressure is proportional to the current flowing at the moment of interruption. Pressure rise from resonance is not likely to occur in commercial systems in this country.

Protective devices may be divided into two classes: (1) circuit breakers; (2) devices which prevent or relieve excessive rises of pressure.

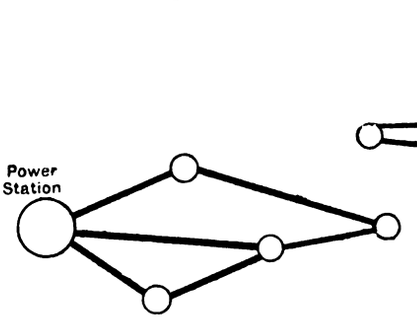

FIG. 2.

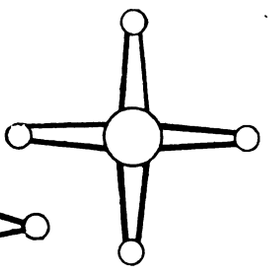

FIG. 1.

Circuit breakers are required to operate automatically (*a*) on an overload; (*b*) on a reversal of the direction in which power is flowing. The overload device should be fitted to every circuit breaker; the use of the "return current" relay is limited to generator switches and those at the sub-station ends of feeders; should one of a number of generators break down, power will flow from the sound machines to the faulty one when the switch automatically opens. In a feeder system as in Fig 1, should one of a pair of feeders break down, power will flow into the fault from both ends, the reverse current relay disconnects the sub-station end, and the overload relay the power station end. In such a system as is shown in Fig. 2, it is obvious that the interconnecting cables can only be protected by overload relays. The interval of time between the occurrence of an overload and the opening of the circuit should be inversely proportional to the magnitude of the overload, that is to say, on a moderate overload there should be a time-lag of some seconds. A little consideration will show that all circuit breakers on a system should be capable of breaking the whole power which can flow into that part of the system.

Fuses.—The use of fuses as circuit breakers on high-tension systems has followed from low-tension practice. There are two main types in common use: the one in which strips of fusible metal, 10in. or 12in long, are enclosed in a porcelain or glass tube, the arc being blown out by the heated air; the other type in which the fuse is a short wire or wires, $\frac{1}{2}$in. to $\frac{3}{4}$in. long, held in tension by springs over a pot of oil, the arc being quenched by the withdrawal of the contacts into the oil. In the first type, which finds extensive use on the Continent, the fuse strips are made of tin, aluminium, or silver. Tin is most commonly used, but aluminium has been used because its high specific heat has advantages where a large time-lag is required. The results of tests on these types

* Paper read before the British Association.

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of fuses are shown in Fig. 3, in which the time taken for a fuse to blow after the application of a definite overload is marked as a point on a curve. It will be seen that the

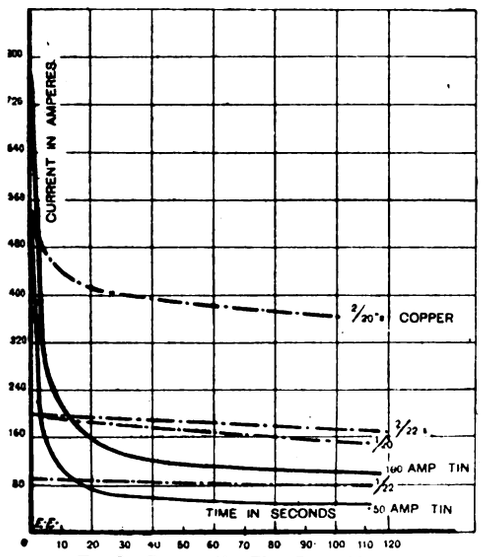

FIG 3.—Comparative Time Lags of Fuses.

second, the Ferranti type of fuse, blows almost immediately the current reaches the fusing value, whatever be the magnitude of the overload, but the long fuse takes many seconds to blow on a moderate overload, and an appreciable time even on a heavy overload; or, one has practically no time-lag, and the other has too much on heavy overloads. In the design of fuse receptacles, it must be remembered that in opening a circuit power is absorbed by the resistance of the fuse. In an inductive circuit the maximum power put into the fuse (a non-inductive receiving circuit) occurs when the resistance of the fuse is equal to the impedance of the remainder of the system, and is $\frac{k^2}{2(r+z)}$. For the same power flowing under normal conditions, the power delivered

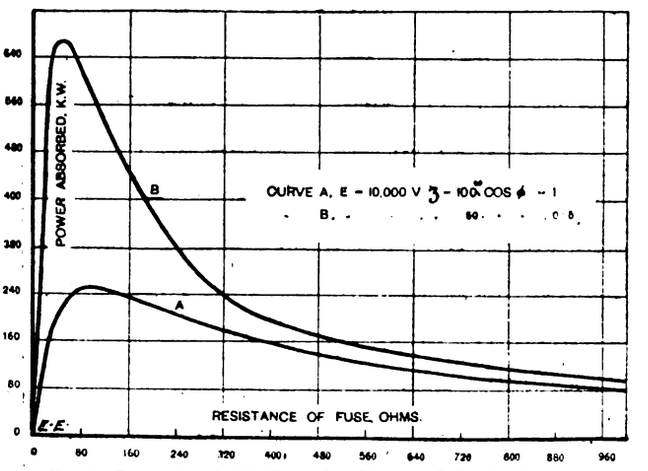

FIG. 4.—Power Absorbed in Fuse when Blown on Inductive Circuit.

to the fuse increases with a decrease of the power factor. Practical experience fully confirms this, and a fuse which takes some seconds to blow will absorb a considerable amount of energy. The exact rate of variation of the resistance of the fuse is a matter of conjecture, but Fig. 4 shows curves plotted on the assumption of a uniform increase of resistance for two cases: 1,000 kw. at 10,000 volts cos $\phi = 1$; 1,000 kw. at 10,000 volts cos $\phi = 0{\cdot}5$. The inheritance of fuses from

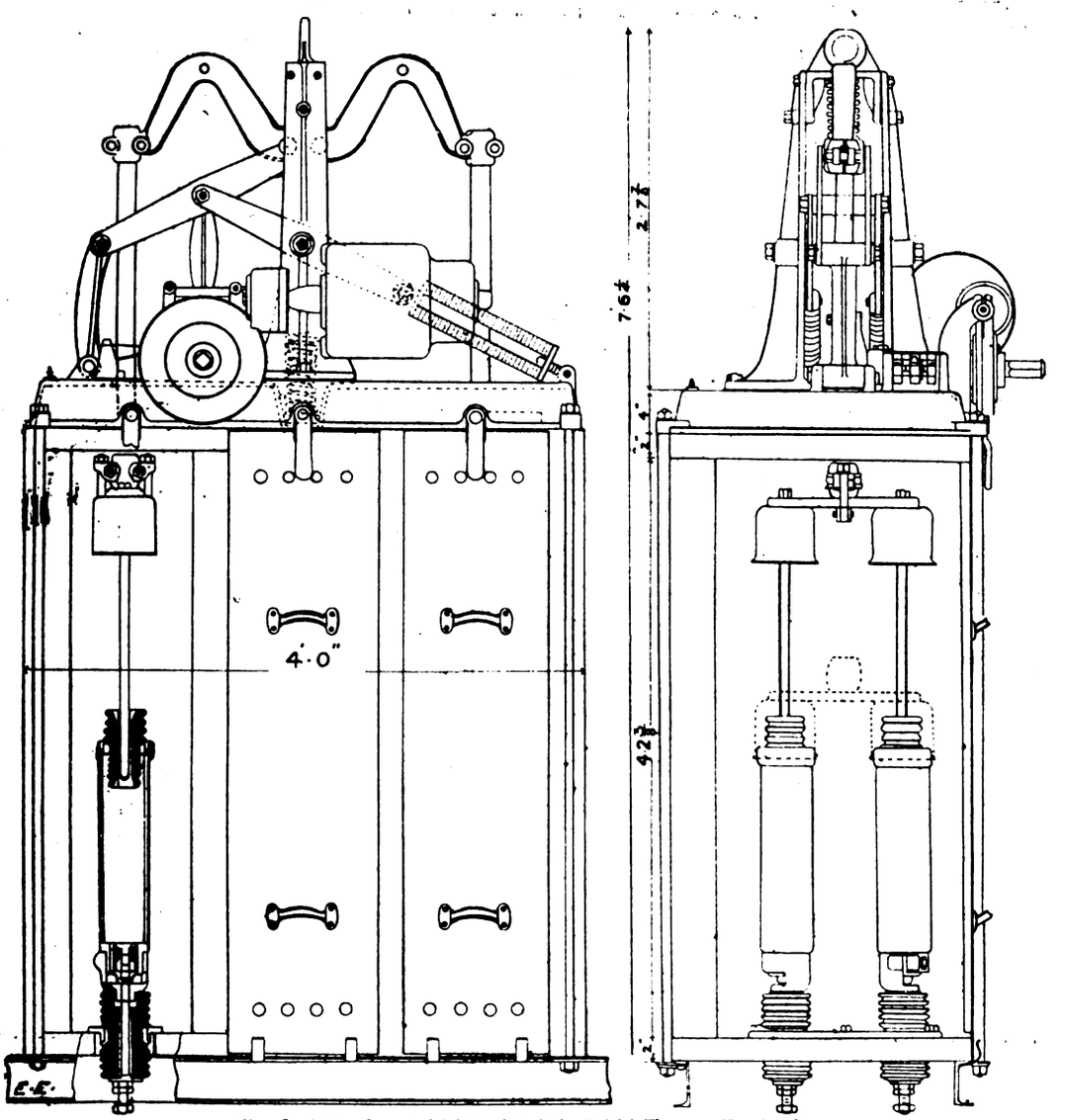

FIG. 5.—Motor-Operated Oil-Break Switch—British Thomson-Houston Co.

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low-tension working has not been an unmixed blessing; they become unreliable with age, and as a switch is necessary wherever a fuse is placed, it is becoming increasingly the practice to attach an automatic relay to the switch and

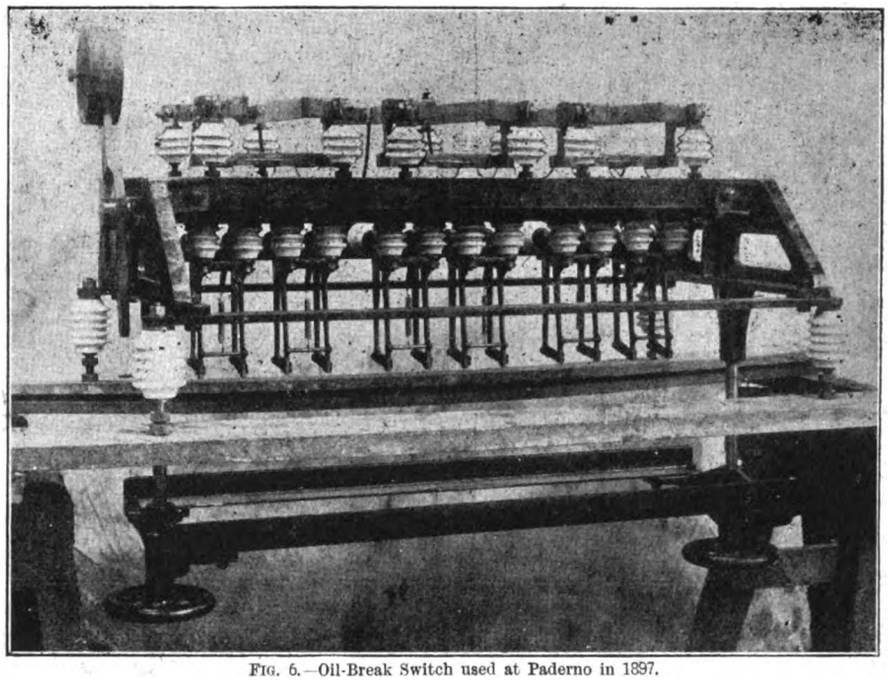

FIG. 6.—Oil-Break Switch used at Paderno in 1897.

dispense with the fuse altogether. Potential transformers for operating instruments may be excepted from the above; the breakdown of such transformers is of rare occurrence, and they are usually protected by fuses of the tube type.

Switches.—It may be laid down as an axiom that any part of a high-tension system which allows an arc to play in air is bad, on account of the dangerous pressure rises which may be occasioned. Air-break or "flare" switches are hence to be avoided. Although a time-lag is advisable on circuit breakers, yet the circuit should be opened rapidly

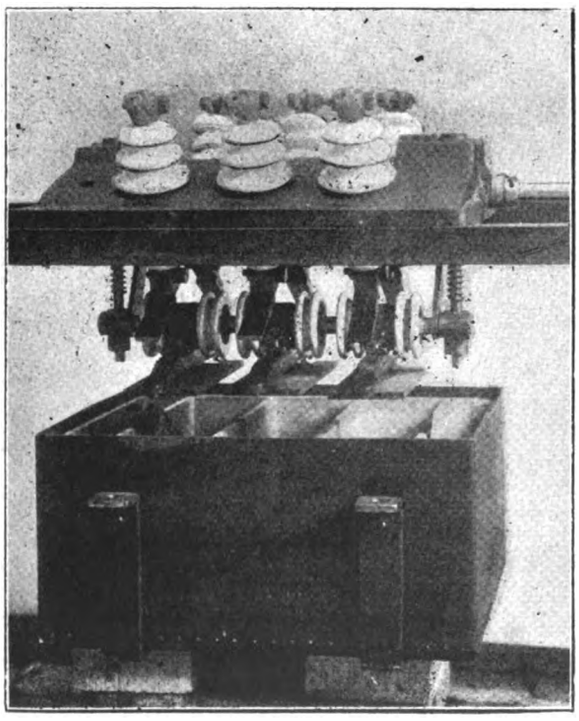

FIG. 7.—Brown-Boveri Oil-Break Switch as used at Newcastle.

when once the operation starts; it is yet more important that the opening should take place when the current passes through its zero value.* The results of many experiments seem to show that an oil-break switch does break circuit at the moment of zero current, and for this reason such switches are now generally adopted. The switchgear is so designed that each switch is in a separate fireproof chamber of metal, brick, slate, or concrete. For safety the switches, 'bus bars, etc., are placed some distance from the operator, the switches being operated by links and levers, chains, pneumatically, or electrically. In a large board the operation by means of electrical motors is the most convenient, as the "control board" may be made quite small. Control by means of direct-current motors find most favour, as the direct current is used also in the actuation of the relays, and may be supplied from a storage battery which is used for exciting. There should be no possibility of an arc

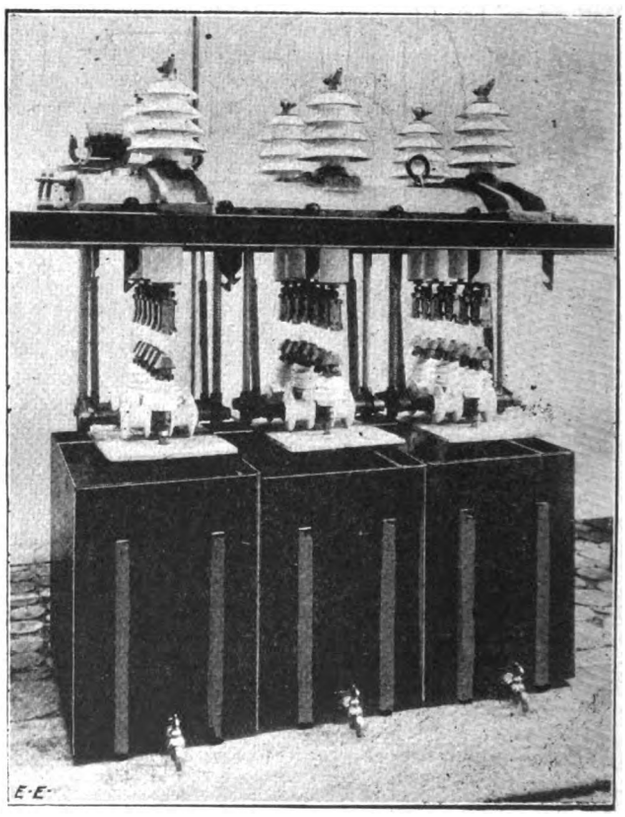

FIG. 8.—Oil-Break Switch for 40,000 volts, with Overload Release—Brown, Boveri, and Co.

on one phase of a switch passing to another phase, or to any other metal work. In switches for large currents, contacts external to the oil are sometimes fitted so that there shall be no danger from heating of a contact in the oil; these external contacts do not make or break circuit, but are in parallel with the oil-break contacts when the switch is closed. Fig. 5 is a typical example of an oil-break switch for heavy work

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made by the British Thomson-Houston Company. The switch is operated by a direct-current motor seen at the top. Circuit is made or broken on each pole in two cylindrical oil vessels containing the contacts, the top contacts consisting of two rods yoked together and sliding through insulators. All the live metal parts are in compartments made of brick and soapstone slabs, connection to the operating gear being made by wooden rods. The motor works a crank through a worm gear. When the crank is on a dead centre, a spring is compressed ready to operate the switch; the slightest movement of the motor causes the spring to come into play, at the same moment a friction clutch releases the motor from the gear, the motor continues running until it has compressed the spring ready for the next operation, when an automatic switch opens the motor circuit and lights a lamp to indicate that the switch has acted. The motor is controlled by a double-throw hand switch; the automatic overload or return current relays operate by closing the motor circuit. The first oil-break switch to be put into practical use was at the Paderno power station in 1897. This was designed by Messrs. Brown, Boveri, and Co. for three-phase currents at 16,000 volts. Fig. 6 shows the general arrangement of this switch, with the oil-chamber removed. Fig. 7 shows a hand-operated switch, of which a large number are in use on the system of the Newcastle Electric Supply Company. There is one oil-chamber for the three phases, but a wooden lining partitions the chamber into three. There are six fixed

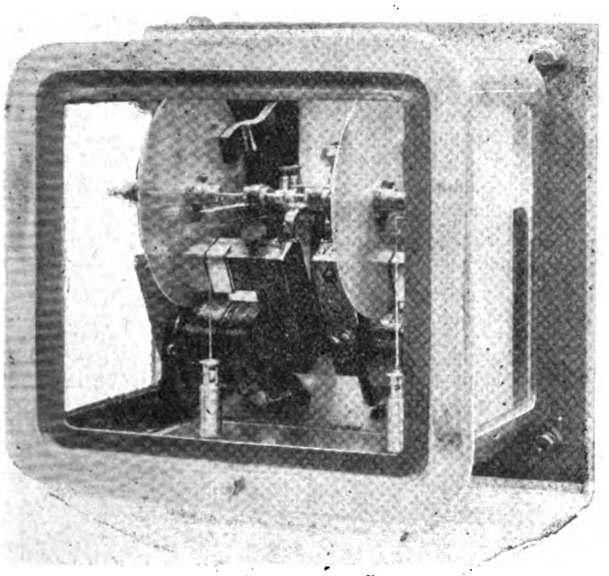

FIG. 9.—Overload Relay, with Adjustable Time Lag.

contacts, and three copper bridging pieces which are moved vertically to make or break circuit. Underneath each pair of contacts will be noticed a small board which moves up and down with the bridging pieces and churns the oil at the moment of make or break, thus minimising the danger from carbonisation of the oil. The writer has tested this type of switch severely at 6,000 volts and found it in every way satisfactory. A similar type of three-phase switch, also made by Messrs. Brown-Boveri, but for a higher voltage, is shown in Fig. 8. The oil-chambers are lowered down showing a six-fold break on each pole; the design of the insulators is especially good. To the left hand of the cover will be noticed the automatic tripping device which opens the switch in connection with an overload relay; the switch is closed by hand.

Overload Relays.—These are usually worked by series transformers in each phase, the secondary current passing through a solenoid, which actuates the tripping device A representative device for obtaining a time-lag in operation is as follows (Fig. 9): The secondary current of the series transformer passes round the windings of a magnet, between the poles of which is a copper disc capable of rotating; on the same spindle as this disc is a small drum to which a weight is connected by a fine cord. Normally the disc is stationary, the tendency to rotate being balanced by the moment of the weight; on an overload, the disc rotates and winds up the weight, which closes an auxiliary circuit and thus opens the main switch. The rate of rotation is proportional to the current flowing in the main circuit, and the time-lag may be adjusted by altering the length of the cord. Such an arrangement is very sensitive and works well.

Reverse-Current Relays.—Such devices are actuated by the secondary current of a transformer having two or more primary windings—one in series with a line, the other across two lines. Under normal condition the fluxes produced by these windings are in opposition, that of the potential coil being the stronger, but when the power flows in the reverse direction a current is generated in the secondary circuit which works the relay. Should a generator break down, in the majority of cases the current passing will be the short-circuit current of the machine (great enough to work an overload relay), but at the same time the pressure across the terminals of the alternator (and the transformer) may fall to zero, and the relay not act. For these reasons return-current indicators find more favour than relays; the indicator, usually a coloured lamp, shows which part of the system is at fault, and the switch is operated by the attendant. A very neat reverse-current indicator is that of Mr. Andrews's, described in his paper before the Institution of Electrical Engineers in March, 1903.

Devices which Prevent or Relieve Excessive Pressure Rise.—The causes of pressure rise in a system are set out above. Any device which only acts on the switching on or off of a cable is a partial safeguard, which should not be used if a complete safeguard can be found. For such a purpose as the above, series resistances (liquid) and choking coils have been used and in many cases afterwards discarded. Spark gaps which remain always connected across the cores of each cable meet every rise of pressure, from whatever cause, but

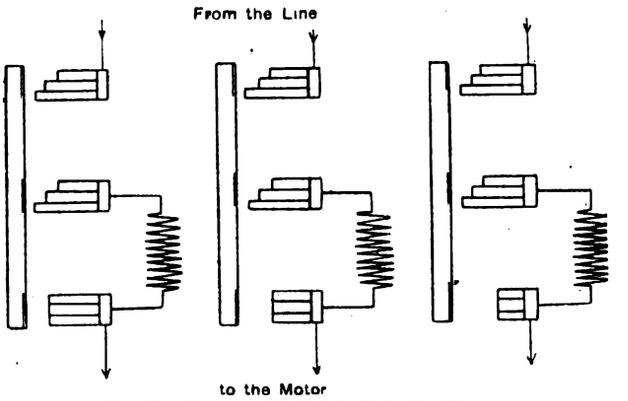

FIG. 10.—Diagram of Switch for Induction Motor.

have disadvantages. The most sensitive spark gap consists of needle points in air, the disruptive voltage being almost independent of humidity and dust, but the passage of a small spark will destroy the points. The horn arrester in which the arc is struck across the lower extremities and rises until it breaks has found extensive use. The Wurts arrester has a number of brass cylinders with knurled or smooth surfaces placed with their axes parallel and with equal gaps between them. In this type the nature and mass of the metal chills the arc which may be formed. A modification of the above consists of two concentric cylinders, the ends of the outer cylinder having conical additions. The arc is chilled as in the Wurts, and blows itself out as in the Siemens type. Series resistances are occasionally used with the idea of minimising the rush of line current which may follow a discharge. The writer has found the Wurts type to be fairly reliable, but when dealing with large rises of pressure and large powers, the discharge localises on the cylinders and forms blisters, sometimes fusing the rollers together. In all the above an arc in air may form with consequent danger to the system, and for this reason the writer has tried the effect of immersing spark gaps in oil. The disruptive strength of some mineral oils is about equal to that of air, so that the distance between the gaps need not be made smaller. The gaps are protected from dust and moisture, and the sparking distance remains constant. The arc is extinguished in the oil as in the oil-break switch, and it is reasonable to suppose that it is extinguished at the instant of zero current. On the disturbance of a system due to a sudden change of current flowing, these gaps must be capable of absorbing a considerable amount of energy, the energy of the surge,

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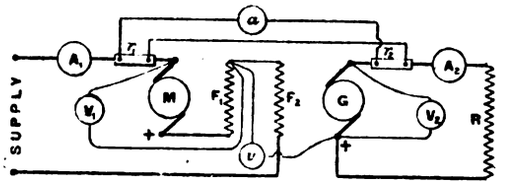
and are therefore liberally proportioned. To test the oil-immersed spark gaps, the following experiments were made. The oil-gaps were set to discharge at 8,000 volts on an inductive circuit and shunted by a pair of needle points set to discharge at 10,000 volts. On the application of 8,000 volts the gaps worked, the arc being extinguished in the oil; the applied voltage was gradually raised to 10,000, but the oil-gaps worked in every case: the needle points never came into action. The test was then repeated with both sets of gaps in air, when the needle points sometimes acted before the horns.

Switching Inductive Apparatus.—On switching on a transformer or induction motor, the full pressure may momentarily exist between adjacent end coils with consequent breakdown; this abnormal stress may be minimised by switching on slowly through a resistance. As an example Fig. 10 shows the arrangement of a switch for use with a three-phase high-tension induction motor. The switch has three extra terminals connected to water resistances; on switching on, these resistances are first put in series with the windings of the motor, then short-circuited, and lastly cut out; on switching off, the reverse operation takes place.

A METHOD FOR FINDING THE EFFICIENCY OF SERIES MOTORS.*

BY ERNEST WILSON, PROFESSOR OF ELECTRICAL ENGINEERING, KING'S COLLEGE, LONDON.

The following method has the advantage of great accuracy, and I have found it work well in practice. The figure gives a diagram of connections, in which M and G are two like machines mechanically coupled together, either through or without gearing, according as it is desired to obtain the efficiency of either machine inclusive or exclusive of gearing. In the test M runs as a motor and delivers its energy to G running as a generator.



The field coils, F_1 F_2, are placed in series with one another and with the motor armature in order that each machine may be conveniently magnetised to the same degree in any test. The input of the motor is measured on the voltmeter V_1 and ammeter A_1. The generator is loaded on a resistance, R, and its output measured on the voltmeter V_2 and the ammeter A_2. Let R_1 and R_2 be the ohmic resistances of the motor and generator armatures respectively, then $V_1 A_1 - V_2 A_2 = X$ are the total watts dissipated in the system, exclusive of the generator field coil F_2. Of these $A_1^2 (F_1 + R_1) + A_2^2 R_2 = Y$ are the ohmic resistance losses in watts, and $X - Y$ are the watts due to brush, bearing, and wind friction, eddy currents, and magnetic hysteresis. The machines are equal, and rotate at the same speed. $\frac{X - Y}{2}$ are the watts which can be debited to each machine when calculating efficiency, it being assumed that the brush contact resistance has the same value as when measured with the machines at rest, and that armature reaction does not produce inequality in the watts dissipated by eddy currents and magnetic hysteresis in the two machines. The expressions for the efficiencies are, for the motor, $\frac{X - Y}{2} + V_2 A_2 + A_2^2 R_2 / V_1 A_1$, and, for the generator, $V_2 A_2 / \frac{X - Y}{2} + A_2^2 R_2 + A_1^2 F_2 + V_2 A_2$

The above, so far, is a well-known method, and has been described by Mr. Field. The extension here described consists in the addition of two low-resistance shunts, r_1 r_2, a milli-voltmeter, a, and a voltmeter, v. By these instruments the differences $A_1 - A_2$ and $V_1 - V_2$ have been measured as direct quantities. It is easy to show that greater accuracy can be obtained by measuring A_1 and a and using the value $A_1 - a$ instead of A_2, and measuring V_1 and v and using the value $V_1 - v$ instead of V_2. For instance, let $V_1 = 500$, $A_1 = 50$, $V_2 = 450$, $A_2 = 42$, $R_1 = R_2 = F_1 = F_2 = 0{\cdot}5$ ohm, and let there be a liability for error of 1 per cent. in reading the instruments. Then the possible error in the value of $X - Y$, when V_1 V_2 A_1 A_2 are the measured quantities, is 31·9 per cent., whereas it is 1·9 per cent. when V_1 v A_1 a are the measured quantities.

* Paper read at the British Association, Southport, 1903.

THE BRITISH ASSOCIATION.

Address to the Mathematical and Physical Section.

BY CHARLES VERNON BOYS, F.R.S., PRESIDENT OF THE SECTION.

The first duty of every occupant of this chair is a sad one. Year by year the record grows of those who have devoted their lives to the development of mathematical and physical science, of those who have completed their work. The past year has added many names to the record—more, it seems, than its fair share. The names include some of the most brilliant and active of our race, of those to whom this association is deeply indebted, and also of our fellow-workmen in other countries whose loss is no less to be deplored. Lord Salisbury's devotion to the Empire, of which this is not the occasion to speak, left him but little time for those scientific pursuits in which he took so keen an interest. Once, however, as president of this association, he showed our members that, unlike the majority of our statesmen, science was not to him a phantom. His address at Oxford will remain in the memories of all who heard it. The eloquence, the humour, the satire, the subtilty provided an intellectual treat of the rarest kind. Of Sir George Gabriel Stokes and his work it is not possible for me to speak. Any attempt on my part to appreciate or gauge the value of the work of such a giant would be an impertinence. This can only fitly be done by one of our leaders, and Lord Kelvin has paid a fitting tribute in the pages of *Nature*. I can only record the fact that Stokes was for seven years secretary and twice president of this section, and in 1869 was president of the association. Dr. Gladstone, for 53 years a member of this association, was not only an unfailing attendant at our meetings, but an active member whose steady stream of original communications on subjects connecting physics and chemistry earned for him the designation of creator of physical chemistry. His investigations on spectroscopy, refractivity, and electrolytics are known to every student of physics. His researches upon early metallurgical history, while of less importance to the progress of science, are none the less interesting. An ardent apostle of education, he was for 21 years a member of the London School Board, and three years vice-chairman. Dr. Gladstone was the first president of the Physical Society. He has been president of the Chemical Society, and at the last meeting of the British Association at Southport—as also in 1872—he was president of the Chemical Section. So long ago, he said, in urging the importance of science as a factor in education, that the so-called educated classes were not only ignorant of science, but had not arrived at the knowledge of their own ignorance. It is not possible to pass on without paying a tribute, in which all who knew Dr. Gladstone will share, to his character no less than to his genius.

Sir William Roberts-Austen was probably one of the most active members that this association has known. Not only had he for many years made the subject of metals and alloys his own, but he had worked for the association in many ways. At three meetings have audiences been charmed by his fascinating and brilliant evening lectures, all relating to metals. He was president of the Chemical Section at the Cardiff meeting in 1891, and not only did he perform these duties, but he accepted the more laborious and more thankless task, for which his unfailing courtesy and tact so well fitted him, of acting as our general secretary for four years. His labours in the important field of research which he tilled were appreciated by numerous technical societies and institutions of which he was an honorary member, or had been president or vice-president. Many branches of public service had the advantage of his skill and experience, which received the official reward in 1899. Dr. Common's skill as a designer and constructor of instruments was well known. His instinct or judgment in producing planes and figured concave mirrors of great dimensions was rare, for this is an art almost unknown in the laboratory. His generosity and his valuable advice have been appreciated by many besides myself. Rev. H. W. Watson, Second Wrangler and Smith's Prizeman in 1850, was a vice-president of the British Association in 1886. Mathematical physicists are familiar with the joint work of himself and Burbury on "Generalised Co-ordinates," and with his mathematical articles. In Otto Hilger, the brother of the late Adam Hilger, who between them brought to this

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country German thoroughness and French skill in instrument manufacture, we have lost one of our first and most valuable constructors. Noted for the high class of all the optical work turned out by the firm, Otto Hilger was not afraid of attacking the problem of manufacturing the Michelson echelon grating. This little bundle of glass plates requires for its success perfection and precision commensurable only with the genius of the inventor. This Otto Hilger supplied.

Dean Farrar, a life member of the British Association, whose activity lay in another direction, showed his appreciation of the value of science in education by appointing the first science master at Marlborough when he became headmaster in the year 1870. As I was a boy at the school at that time, I can speak of the incredulity with which such an announcement was at first received, and of the general feeling that such an action was akin to a joke. I was, however, by no means the only boy who hailed the news with delight. We devoured the feast of chemistry and physics put before us by Rodwell and the books which at once became available. Out of gratitude to the late Dean of Canterbury I recall this episode. James Wimshurst, the inventor of the influence machine which has carried his name into every corner of the scientific world, was not a member of this association, but he fostered and encouraged the scientific spirit in young men who by good fortune came to know him. I do not think I have heard anyone spoken of with such gratitude and appreciation as Wimshurst by men who in their younger days were allowed the run of his well-equipped workshop. James Glaisher, best known as a balloonist in the sixties, has died at the great age of 93. The balloon ascent with Coxwell on Sept. 5, 1862, when they attained the altitude of 37,000ft., will long remain in the popular imagination, not on account simply of the great altitude, but by reason of the sensational account of their having been paralysed with cold, and of their being able to stop the ever-increasing ascent only by the presence of mind of Coxwell, who, with his limbs frozen, seized the valve rope with his teeth, and so let out the gas. While this event remains in everyone's mind, the more prosaic work of Glaisher in astronomy, meteorology, and photography, when most of us were children, and many yet unborn, led to his being elected president of various learned societies. He gave one of the evening lectures of the British Association in 1863, the subject being balloon ascents. A. F. Osler, the inventor of the self-recording direction and pressure anemometer and rain-gauge, whose active meteorological work was carried out in the first half of the last century, when he contributed papers to the British Association and the Literary and Philosophical Society of Birmingham, has died at the still greater age of 95. He was vice-president of the British Association in 1865.

Of other countries, America has lost Prof. J. Willard Gibbs, a mathematical physicist whose very learned and original contributions to the knowledge of the world on the thermodynamical properties of bodies, on vectors, the kinetic theory of gases, and other abstruse subjects, have received the highest recognition that the learned societies of this country can bestow. Prof. Harkness, the astronomer, and Prof. Rood, the skilled experimental physicist of Troy, have also maintained the high standard that we now look for in American science. Germany has lost Prof. Deichmüller, professor of astronomy at Bonn, at an early age. Sweden has lost Prof. Bjerknes, whose hydrodynamical experiments showing attraction and repulsion were so much admired when he performed them at a meeting of the Physical Society some 25 years ago. Switzerland has lost Prof. C. Dufour, the astronomer; and Italy has lost Prof. Luigi Cremona, a foreign member of this association, principal of the engineering school in Rome, whose contributions to pure geometry and to its applications have made him famous.

Of the events of the last year, one stands out beyond all others, not only for its intrinsic importance and revolutionary possibilities, but for the excitement that it has raised among the general public. The discovery by Prof. and Madame Curie of what seems to be the everlasting production of heat in easily measurable quantity by a minute amount of a radium compound is so amazing that, even now that many of us have had the opportunity of seeing with our own eyes the heated thermometer, we hardly are able to believe what we see. This, which can barely be distinguished from the discovery of perpetual motion, which it is an axiom of science to call impossible, has left every chemist and physicist in a state of bewilderment. Added to this, Sir William Crookes has devised an experiment (characteristic of him, if I may say so) in which a particle of radium keeps a screen bombarded for ever, so it seems, each collision producing a microscopic flash of light, the dancing and multitude of which forcibly compel the imagination to follow the reasoning faculties, and realise the existence of atomic tumult. Thanks to the industry and genius of J. J. Thomson, Rutherford and Soddy, Sir William and Lady Huggins, Dewar and Ramsay, and others in this country, besides Prof. and Madame Curie and a host of others abroad, this mystery is being attacked, and theories are being invented to account for the marvellous results of observation; but the theories themselves would a few years ago have seemed more wonderful and incredible than the facts, as we believe them to be, do to-day. An atom of radium can constantly produce an emanation—that is, something like a gas—which escapes and carries with it wonderful properties; but the atom, the thing which cannot be divided, remains, and retains its weight. The emanation is truly wonderful. It is self-luminous; it is condensed by extreme cold and vaporises again; it can be watched as it oozes through stop-cocks or hurries through tubes, but in amount it is so small that it has not yet been weighed. Sir William Ramsay has treated it with a chemical cruelty that would well nigh have annihilated the most refractory or permanent known element; but this evanescent emanation comes out of the ordeal undimmed and undiminished. Not content with manufacturing so remarkable a substance, the radium atom sends out three kinds of rays, one kind being much the same as Röntgen rays, but wholly different in ionising power, according to the experiments of Strutt. Each of these consists of particles which are shot out, but they have different penetrative power. They are differently deflected by magnets and also by electricity, and the quantity of electricity in relation to the weight is different, and yet the atom—the same atom—remains unchanged and unchangeable. Not only this, but radium, or its emanation or its rays, must gradually create other bodies different from radium, and thus, so we are told, one at least of those new gases, which but yesterday were discovered, has its origin.

Then, again, just as these gases have no chemical properties, so the radium which produces them in some respects behaves in a manner contrary to that of all proper chemicals. It does not lose its power of creating heat even at the extreme cold of liquid air, while at the greater degree of cold of liquid hydrogen its activity is found by Prof. Dewar to be actually greater. Unlike old-fashioned chemicals which, when they are formed, have all their properties properly developed, radium and its salts take a month before they have acquired their full power (so Dewar tells us), and then, for anything we know to the contrary, proceed to manufacture heat, emanations, three kinds of rays, electricity, and gases for ever. For ever; well, perhaps not for ever, but for so long a time that the loss of weight in a year calculated, I suppose, rather than observed, is next to nothing. Prof. Rutherford believes that thorium or uranium, which act in the same kind of way, but with far less vigour, would last a million years before there was nothing left, or at least before they were worn out; while the radium, preferring a short life and a merry one, could not expect to exist for more than a few thousand years. In this time 1 grm. of radium would evolve one thousand million heat units, sufficient, if converted into work, to raise 500 tons a mile high; whereas a gramme of hydrogen, our best fuel, burned in oxygen, only yields thirty-four thousand heat units, or one thirty-thousandth part of the output of radium. I believe that this is no exaggeration of what we are told and of what is believed to be experimentally proved with regard to radium; but if the half of it is true, the term "the mystery of radium" is inadequate; the miracle of radium is the only expression that can be employed.

With all this mystery before us, which I must confess myself wholly unable to follow, I feel sure that members of the association who are interested in the work of this section will welcome the discussion, for which our secretaries have been able to arrange, and hear from the lips of Prof. Rutherford the conclusions to which his researches have at present brought him. No one is more fitted than Prof. Rutherford to open such a discussion, for no one has attacked the theoretical side with such originality and daring, or with such ingenuity of experiment. As an example of the activity of mind and of research to which the activity of radium has given rise, I may mention the fact that the last number of the *Proceedings* of the Royal Society is wholly concerned with radium, there being four papers, all of the first importance, dealing with entirely different phenomena.

It is not my purpose to review these or the subject of radium generally; I am in no way fitted to do so. But I cannot well let the present opportunity pass of referring to another mystery of which a conspicuous example is now leaving us. I refer to the mystery of the comet and its tails. What is a comet? of what does its tail consist? Gravitational astronomy has told us for many years past that, compared with the planets or their satellites, a comet does not weigh anything. It weighs pounds or, perhaps, hundreds, thousands, or millions of tons; but in comparison with inconspicuous satellites it weighs nothing. Yet some of them as they approach the sun from remote regions begin to shoot out streamers, which pour away as though repelled by the sun, not being left as a trail behind the comet, as is so often supposed. These streamers, ejected towards the sun, bend round and pour away at speeds which are enormous compared with that of the comet itself, thus producing the tail. Now, these streams separate very often, and give rise to comets with two or three tails. Let me read one paragraph from "The History of Astronomy," by Miss Clerke: "The amount of tail curvature he (Olbers) pointed out depends in each case upon the proportion borne by the velocity of the ascending particles

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to that of the comet in its orbit; the swifter the outrush the straighter the approaching tail. But the velocity of the ascending particles varies with the energy of their repulsion by the sun, and this again, it may be presumed, by their quality. Thus multiple tails are developed when the same comet throws off, as it approaches perihelion, specifically distinct substances. The long straight ray which proceeded from the comet of 1807, for example, was doubtless made up of particles subject to a much more vigorous solar repulsion than these formed into the shorter curved emanation issuing from it nearly in the same direction. In the comet of 1811 he calculated that the particles expelled from the head travelled to the remote extremity of the tail in 11 minutes, indicating by this enormous rapidity of movement (comparable to that of the transmission of light) the action of a force much more powerful than the opposing one of gravity. The not uncommon phenomena of multiple envelopes, on the other hand, he explained, are due to the varying amounts of repulsion exercised by the nucleus itself on the different kinds of matter developed from it." It is impossible not to be struck by the similarity both of phenomenon described and of language used in this paragraph and in almost any of the papers on radium. I know this mere superficial similarity is worth very little, if anything; but for centuries the sky has shown us a phenomenon still not entirely understood, and the inability to remove all difficulty by the aid of radium or similar material is no reason for dismissing the idea of connection without further thought.

The comet's tail is still a mystery. Let me take the most recent explanation, which was set forth only three months ago in the *Atrophysical Journal* in the United States. Those admirable experimentalists, Nichols and Hull, have for some years been investigating the back pressure exerted by the action of light upon bodies on which it falls. In this they have followed the Russian physicist, Lebedew, but in minuteness and delicacy of measurement, and in their successful elimination of disturbances, their results are unequalled. It is sufficient to say that, difficult and minute as the experiment is, their success is such that the discrepancy between the calculated force and that which they have found is under 1 per cent. Perhaps I may express some satisfaction that in this measurement use was made of the quartz fibre. Having now definite and accurate confirmation of the existence of the force produced by the action of light, or rather radiation, Nichols and Hull proceed to examine the question as to how far such repulsion may be competent to overcome the gravitative attraction of the sun and drive away the matter which pours out from the comet. It is interesting to note here that Kepler put forward this very idea, and that Newton, the inventor of the corpuscular theory of light, looked upon the suggestion with some favour.

Coming now to this recent paper of Nichols and Hull, we find first the consideration of the relation of the attraction by gravitation, and the repulsion by light upon particles of different sizes and densities. Density has no influence on the action of light, while it is favourable to gravitation, and therefore unfavourable to tail formation. Size is favourable to both, but more to gravitation than to light, for if the diameter of a particle be doubled, one is increased eightfold and the other only four. So size favours gravitational attraction. Conversely, of course, smallness favours repulsion by light, which relatively should get greater and greater as the particles diminish in size. At last, then, a a degree of smallness may be reached in which the repulsion by light will actually be equal to the attraction by gravitation, and such a particle would remain in space, its motion unaffected by our sun. Let the diminution of size continue, and then the repulsion will be in excess, and if the law were to continue it would with sufficient diminution become relatively as large as we please. The law, however, does not continue. Schwarschild has shown that when the particles are small enough, light does not act upon them in the same way. Owing to diffraction, the effect of light is unduly great for a certain very small size of particle, while it fails almost entirely when the particle is made much smaller. Thus it is that the indefinite increase in the repulsion by light as compared with the attraction by gravitation with diminution of size of particle is checked, and when, according to theory, with a particular density of particle, the light pressure is about 20 times as great as gravitational attraction, further diminution of size ceases to favour the action of light, and it begins to fall off again. The distance of the particle from the sun has no influence upon the relation between the two kinds of forces, for they rise and fall together. Nichols and Hull, therefore, while not denying that other causes may operate, believe that light pressure is adequate to account for the phenomena, and that where the material coming from the head or comet proper is of two or three kinds, whether of density or of size of particle, the separation of the two or three tails should naturally follow. This theory presupposes that the nucleus of a comet will be able, owing to the evolution of gas under the sun's heat, to send out enormous quantities of dust, the finer and lighter the better, so long as it is not unduly small with respect to a wave-length of light. Such dust would account for any reflected solar light that the spectroscope may show, but it is not easy to see how the spectrum of hydrocarbons, of sodium, and of other metal, should be produced for lack of temperature. It is not easy to see why fortuitous dust should be graded of such sizes as to give well separated and defined tails; it is not easy to see how the dust could be produced in sufficient quantity to provide visible illumination to millions of millions of cubic miles of space through which it may be passing at ultra-planetary velocity, even though in looking through a million miles or so one grain of dust in a hundred miles might suffice to supply the light.

Other theories of the comet's tail require an electrified sun, the existence of which is explained by Arrhenius as being caused by the emission by the sun of negatively charged electrons which, picking up condensing gases as Aitkins's dust picks up moisture from the atmosphere, are driven away by the light pressure. Arrhenius believes that these acting on the matter in the tail would give rise to the bright line spectra which have been observed. The result of all this escape of negative electricity is a positively charged sun, but what limits the charge in the sun it is difficult to see, as it is, why the electrostatic attraction helped by gravitation does not ultimately stop the action. I may be displaying my ignorance, of which I am sufficiently sensible, but I am not aware of any evidence for the existence of the stream of electrified grains or drops imagined by Arrhenius. Nichols and Hull, while calling to their aid the researches of Schwarzschild to give them a repulsive force some 20 times as great as gravitative attraction, do not seem to have given due weight to the extremely small range of size of particle for which this high effect is available. The maximum effect for any wave-length according to Schwarzschild is produced when the size is such that a wave-length will just reach round it—that is, with ordinary light when the diameter is between one hundred thousandth and one hundred and fifty thousandth of an inch. If the diameter is $2\frac{1}{2}$ times the wave-length the action of light is only equal to gravity with a material of the density of water; or, again, if it is reduced to one-eighth of a wave-length it again becomes equal, and in these two cases there is no resultant action. With either larger or smaller particles gravity rapidly gets the better of light, while the high advantage of light over gravity is confined to very narrow limits. What the sifting process can be that will give rise to such a quantity of this microscopic dust we can hardly expect to be told, nor why even if the material should in some mysterious way be graded; the ungraded wave-lengths of the solar spectrum should allow of the marked separation in some instances of comets' tails. One thing, however, they do assert, and that is the light pressure can have no action on a gas, so that if what we see is considered to be gaseous, the light pressure theory must be thrown over for some other.

I cannot leave this excursion of Nichols and Hull into a speculative domain of science without expressing my admiration of the experimental work which they have accomplished, or of my appreciation of the ingenuity and daring with which they have attempted the hitherto unheard-of feat of making a comet. While the theory just referred to may be the most recent, it must not on that account be supposed to displace all that has gone before; the authors themselves do not suggest this—it is the last thing that would occur to them. They have referred to the researches of Bredechin that occupy so large a proportion of the annals of the Observatory of Moscow. It is impossible to read even a tithe of these without feeling that the subject of comets and their tails is one which Bredechin, by his amazing industry, has made his own property, and that any stranger casually passing by and taking a random shot should receive the severe penalty awarded to poachers in this country. Bredechin has dealt unmercifully—I do not say unjustly—with the author of at least one such random theory.

It is, therefore, with the greater diffidence and more urgent plea for forbearance that I venture to draw certain parallels and hazard certain suggestions which I admit freely have not reached a stage at which detailed comparisons with known comets are possible. It does not seem possible now to contemplate the phenomena of the comet, of the divided tails, of their tenuity and transparency, of the pale luminosity, partly reflected solar light, partly light as from a glowing gas; of the gradual wearing out and disappearance of those comets which constantly pay visits to solar regions, with all the mysteries of radium now so much in evidence without tracing the features in which they resemble one another. By radium, of course, I mean any material with the remarkable radioactive properties that radium exhibits with such pre-eminent splendour, whether known in the laboratory or not. How many physicists have been peering at comets through radium spectacles, or how many astronomers detect the sparkle of radium in the fairy tresses of their hirsute stars I know not. One writer, however (T. C. Chamberlin) so long ago as July, 1901, looked upon a connection between radioactive materials such as were then known and comets as at least worth considering. Chamberlin's paper in the *Astrophysical Journal* was mainly on the tidal disruption of gravitating bodies and the possible evolution of comets,

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nebulæ, and meteorites, and he did not pursue this consideration in any detail; indeed, the enormous accumulation of new properties of radium was not then available.

Whatever may be imagined as to the constitution of a comet, difficulties still remain. All I suggest now is that the curious properties of radium and of similar bodies should be kept in mind. Radium at least supplies the means by which, if the increasing warmth or the tidal action of the sun should awaken its activity, Rutherford's α-rays should be shot out at the speed that he has measured of a thousand million inches a second—*i.e.*, one-twelfth the velocity of light. These α-rays, according to Rutherford, consist of helium; they weigh each twice as much as a hydrogen atom, and so the same weight of comet matter that would make one of Nicholl's and Hull's best particles—*i.e.*, one that would be just visible with a microscope—would be sufficient for about 400 millions of Rutherford's α-ray particles, an advantage surely where diffuseness seems so miraculous. These particles, shot out at a velocity one-twelfth that of light, go so fast that, if they were to start horizontally on the surface of the earth, the gravitative attraction of the earth would curve their path to the infinitesimal extent of a curve with a radius of forty thousand million miles. Yet so great is the electric charge they carry that a visible curvature can be imposed upon them in a practicable electrostatic field. Now imagine these transferred into space at a distance from the sun, for instance, equal to that of Venus. Gravity there due to the sun is only one-thousandth of what it is here, so gravity there would be, to the same extent, less able to impose visible curvature on their paths. But their electric charges are still available, and unless I have made an arithmetical blunder of a considerable order, it would require no heavy electrification of the sun to bend these rays round in a curve with a radius of 1,000 miles. An electrostatic field of under two ten-thousandths of a unit should be sufficient, a field which would be produced if the sun were only charged with a surface density of one electrostatic unit on every three square centimetres. Whether these figures are correct or not—and I know the risk of getting just thirty thousand million times too large or too small a result—does not much matter. An electrified sun, which after all others besides Arrhenius have postulated, would be sufficient to turn the rays and send them away at rapidly increasing speed so as to form the tail. The speed would in a short time reach the velocity of light if it were not for the change in properties of matter which supervenes when any such velocity is nearly reached. Thus, according to the ratio of charge to mass, particles such as Rutherford's α-rays would be sent away each with its limiting velocity, giving rise to streaks more or less well defined, and double, triple, or multiple according to the number of kinds of rays which the various radioactive materials were able to generate. Not only should streaks pointing away from the sun be formed, but any negatively charged rays such as radium is said to give out should form a tail directed towards the sun. Perhaps this might be expected to be general, but while not common, one was described by Hind in the comet of 1823-4, and three or four more have been observed. The head or coma would be the envelope of all the independent orbits, leaving the nucleus in all directions—orbits which while their velocities are still of the Rutherford order, would be hyperbolas convex to the sun. If this should not appear to be absolute nonsense, it would seem as if another difficulty should become less than it has been. I refer to the visibility, luminosity, and spectral character.

Lodge, as an interpreter of Larmor, tells us that an electrified ion subject to acceleration, whether transverse or in the line of motion, radiates energy. The streamers from the nucleus subject to the greatest acceleration may be bright almost as the nucleus itself. Then, as they have become dissipated into regions where far less acceleration becomes possible, the radiation falls off and the tail is lost in space. The observations made last month by Sir William and Lady Huggins of the spectrum given by a piece of radium in the air may have some bearing upon the luminosity of the comet. It is possible that the internal motions set up by the separate parts, each pursuing its individual orbit, may produce collisions numerous and violent enough to account for all the light that is seen, and for temperature sufficient to bring out the spectral lines that have been identified. Whether this is so or not, radioactive bodies and their emanations can produce light independently of such action; and now these observers have found that in the case of radium in air this light gives the spectrum, line by line, of nitrogen. Is it possible that the enveloping nitrogen has had its atoms so harried by the activity of the radium as to give a response hitherto only awakened by electric discharge? The ability to obtain such a response opens up a new possible interpretation of these spectra, which hitherto have been assumed, with our laboratory experience only to guide us, to have required for their production temperature above a red heat. If further observation should confirm this, the hydrogen, the hydrocarbon, and possibly even the sodium or iron spectrum that has been observed may have come from cold atoms; and it is not even quite beyond the limits of imagination to picture, not from the comet matter itself, but from loose residual and highly attenuated matter through which the comet is passing. There is one other feature of this remarkable observation of equal interest. The lines of the spectrum were not exactly in their proper place, but were all shifted towards the red end of the spectrum about twice the distance between the D lines. If only one or two lines had been so observed, a different origin might well have been suspected; but when the whole series are faithfully reproduced it is reasonable to look upon the spectrum as modified to that extent as though the works of the nitrogen atom had not only been set in movement, but had been loaded with the radium emanations.

Before dismissing these random speculations on the possible connection between radioactivity and comets I would ask your leave to refer once more to Bredechin's conclusions. He has found that it is merely necessary to postulate three kinds of matter, issuing from the nucleus with three initial velocities, and subject to repulsion from the sun with three sets of forces of repulsion—*i.e.*, as compared with ordinary gravitative attraction—for the whole of the phenomena of all sorts of comets to be very completely accounted for. His highest initial velocity is only about five miles a second, and his lowest about a quarter of a mile a second. His highest repulsion, after deducting gravitative attraction, is only 11 times gravity, and his lowest only a fifth of gravity. If, then, with such velocities and forces the phenomena can be exactly accounted for, it would seem futile to consider the possibility of initial velocities from 4,000 to 80,000 times as great and effective repulsions of a corresponding order being able to produce effects with anything in common. This is not necessarily the case, for with the comparatively slow separation of the atoms of Bredechin's matter from the nucleus, each one describing its own hyperbola convex to the sun, the tail at any moment represents the then position of any number of atoms which left the nucleus for some distance back, whereas with the enormous velocities and effective forces now discussed, the comet moves so slowly in comparison that the tail would practically represent the path at the time. It has taken me far longer to throw out this not very luminous ray than I had expected or than it is worth. I fear that it is a sort of ray in which the ratio of its dead weight to its vitalising charge is too small to enable it to penetrate the lightest screen of examination. These are the days of rays, and now before we have quite become familiar with the rays of radioactive bodies, Blondlot has presented us with N-rays, which, issuing from the mantle of an incandescent gas burner, penetrate wood or aluminium, and then increase the light without increasing the heat of hot bodies on which they fall.

Passing now from the amusement of speculation to more serious duties, I find myself confronted with the difficulties that prevent us in this country from succeeding as we used to do in the international struggle—a struggle the issue of which is daily becoming more and more a question of brains, of education, of skill and enterprise in manufacture—and finally of that great virtue extolled by the President of the United States, strenuousness. It is the duty of everyone who see the way in which we are being outstripped in the race to do what in him lies to scrape off the rust which is clogging our educational machinery. I now refer to the defects which hamper the intellectual progress of the majority of our youth. I believe the public school mathematics in this country stands on a level of its own, well below that of any other. In England, owing to our complicated system of weights and measures, which our Ministers and our Parliament dare not abolish for our own good, the scanty hours allowed for mathematics are devoted to the learning of tables which should never have to be learned at all, to compound reductions designed merely to puzzle but not to lead to any new step; and, even if our present system were not futile enough, to learning lists of antique values which serve the useful purpose of giving the boys something to do. The result is that beyond having time to acquire a few elementary algebraical rules the boy is never introduced to algebra proper; he has no idea of algebraical reasoning; his trigonometry often does not exist, and the very sound or suggestion of co-ordinate geometry or of the differential calculus, which might be well within his reach, produces a shiver of dismay. Geometry is presented for the first time in the form of Euclid, a form as repulsive to most boys as it well could be. I must confess to having been attracted and not repelled by Euclid; but the boy does not care for time. Now that I look at Euclid again I have also to confess that any lingering regard for an old friend vanishes before the archaic language and the unnecessary circumlocution. If Euclid must be retained, let it be translated into English, the English that any parent would use in explaining the ideas to his son; let it be illustrated by constant reference to real things, so as to appeal to the boy who does not revel in the abstract. Let the ideas and the terms first be presented in the form of experiments and of measurements with instruments. Let the schoolmaster dare to throw over the intolerable conservatism which prevents our doing anything ten times as well unless some item should prove to be a trifle worse; in fact, let us take some heed of the possibly

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extreme, but none the less genuine and valuable, preaching of Prof. Perry. I have so far referred only to the miserable use that is made of the odd hours gradually given to what is called mathematics. Is it any use to repeat the long-standing complaint of the way in which the schoolmaster insists upon overdoing his Latin and Greek under the belief that they are at least essential to intellectual development, if, indeed, they do not supply the only stimulus? As society is constituted, they are essential to education as an extensive knowledge of Confucius is essential to an educated Chinaman, so that we may mix one with another, appreciate the works of our great authors, understand the same allusions, and have the same kind of knowledge of the development of our civilisation. Few men of science, perhaps none, wish to see all of this, some of which is essential to a general education, abolished; all that we ask is that the schoolmaster shall not continue to impose upon the community the unbalanced learning which corresponds to mathematics and science without letters. The time given to classics is exorbitant; more must be reserved for those pursuits which draw out the habit of independent thought, creation, and originality. It would be well if every schoolmaster could read an admirable article by James Swinburne on the two types of mind fostered by the two complementary types of education, but this is buried away in an inaccessible number of the *Westminster Review*.

The classic is unfortunately still in possession, and where, as is still often the case, he is innocent of any appreciation of the educational value of post-Newtonian studies, it is not surprising that he thrusts into odd moments the subjects he does not understand, and which he therefore despises, and that the boys committed to his charge and living in such an atmosphere are half ashamed of showing any interest in the scanty science which is within their reach. It is almost impossible to believe that such can be the case, but I have referred to the impression to which the appointment of the first science master at my own school gave rise. I now refer to the contribution to a discussion on education but a year or two ago by that experienced teacher, Principal Griffiths. Fortunately our public schools are not the only ones in the country. Smaller and less fashionable schools pay more attention to education and suffer less from what, in defiance of all rule, I can only call didactatorial method. I am not aware that the result of this almost total exclusion of tabooed subjects in favour of Latin and Greek is producing a standard of classical attainment in our youth greatly in advance of that to be found in other countries, but it is certain that in history, modern languages, mathematics, and science the product of our public schools is sadly deficient.

There is another point related to our deficient general scientific training on which I wish to offer some remarks, and that is in relation to manfacture. It is the fashion among some of our scientific people to talk of our manfacturers as if they were a very ignorant lot, and to suppose that one word from some professor who has never seen outside a laboratory would be sufficient to put them right. Now, in my somewhat varied experience I have had occasion to become acquainted with corners of our great manufacturing areas, and, while my experience is small and not enough to generalise upon, it is, nevertheless, several times as great as that of some who are ready to adopt the superior attitude, but have none. The loss of one industry after another is only too patent. In so far as this may be due to want of enterprise in our men of business, we are not concerned with the cause in this section; in so far as it may be due to want of that little assistance which the fiscal arrangements in other countries make possible for our rivals, again we are not concerned in this section; in so far as our patent laws are unique among those of manufacturing nations in allowing the foreigner to manufacture in his own country under the protection of our patent law, so that the most valuable school we possess—the manufactory—as well as the manufacture, is conducted to the advantage of our rivals—a point which I suppose it is unnecessary to commend to the notice of Mr. Chamberlain—with this, too, we have no concern in this section; but in so far as this, or the want of enterprise or of foresight that leads to it, is due to ignorance and to want of appreciation of scientific advance, we are very much concerned with it. If I may refer to my own limited experience, there is a lamentable contrast in the manner in which a great number of our countrymen look at any proposition put before them and that in which the alert American does. It is useless to explain that which would be self-evident to a man with a moderate knowledge of chemistry and physics such as our schools ought to supply, or for which they should at least lay the foundation, for the words have no means; they are merely words. He distrusts anything new; he has heard of a new process before that did not work out well; experience on the Continent to him is no experience at all, for he believes the inhabitants in such distant parts of the earth are not capable of knowing as well as the enlightened Englishman whether a thing is properly done or not, and so he goes on as he did before, perfectly content. This attitude would not be possible with the most elementary understanding of common principles.

But there is another side to this picture. Anyone who has discussed any scheme with the board of directors, the manager, the engineer, and the chemist of one of our great manufactories must have been struck with the concentrated ability there found in harness. It has often seemed to me that it is a great misfortune that our professors of mechanics, of physics, and of chemistry, are in so many instances precluded from a better acquaintance with the working of these great machines—a misfortune not for the works, at least directly, but for the professors, and more especially for their pupils. Nowhere are scientific problems of greater complexity constantly having to be solved than in a great manufactory; nowhere is such concentrated talent necessary as in a works organised and carried on in competition with all the world. I look upon these as our most valuable schools, and the closer the touch between them and those whose province it is to teach, the better for the teacher and the pupil.

It is, perhaps, hardly desirable to mention any one where there are so many. I am tempted to dwell upon the problem which has been at last successfully solved by Parsons, this being the joint product of the school and of the works; but there is one picture—a contrast, I will not say of light and shade, but of colour and colour—to which I must refer. I remember in my early days, in the surroundings of a classical atmosphere, the general feeling of contempt for the manufacturer, the intellectually inferior creature who only made money, but who knew nothing of τυπτω or τέτυμμαι. I am not sure that some such feeling does not still exist among those whose horizon is limited to the Latin and Greek that they have learned—or should I say limited *by* instead of *to*? This recollection came back to me when not long ago I was visiting one of the best organised and most skilfully conducted works in the country—I mean Willans and Robinson—when I remembered that another great manufactory, conducted on American lines, was near by, and when across the road I saw the walls of one of our most famous English schools. I pictured the old contrast. On the one hand, the conviction impressed upon me when a boy that there is something intellectually superior in the struggle with a paragraph of Xenophon or a page of Homer, while manufacture is merely mechanical, sordid, and base, with what I believe to be the reality on the other. I wondered in what spirit the erection of these works was viewed at the school, and to what extent the high intellectual attainment there so essential and so evident is properly appreciated. Of the last of the three headings, Strenuousness, we have plenty, but at school it is most apparent in cricket and football, and in after life in various expensive ways of murdering defenceless animals. However, a change is already beginning to be felt. The public schools no longer withhold the elements of chemistry and physics, and those who have benefited, even in small degree, are taking responsible places vacated by those who had no such opportunity. The numerous polytechnics are providing more serious instruction to thousands of our young men, and it may be hoped that in time even the official—I mean the mere official whose only conception of activity is centred in obstructing progress and enlightenment—will have some appreciation of things as well as of words.

ON THE NATURE OF THE EMANATIONS FROM RADIOACTIVE SUBSTANCES.

The discussion on the above interesting subject was opened on Thursday, the 10th, in Section A, by Prof. E. Rutherford, F.R.S.

Prof. RUTHERFORD commented on the fact that the subject of radioactivity was a comparatively new one, having been under investigation only seven or eight years. He proposed to confine himself to the nature of the rays and emanations from thorium and radium. It was first discovered that the activity of thorium was very varied and depended on air currents. It was then proved that there was a continual emission, but that the rate of emanation depended on local circumstances. It was found that the radioactivity of the emanations fell off with time. For instance, the activity was reduced to one-half after one minute, and to one-quarter after two minutes. Later experiments on radium revealed a similar action, although in this case the radioactivity was a million times more powerful. With the radium emanation the rate of decay reduced the activity by one-half in four days. The question then arose as to what were these emanations. It was clear that they were not dust, because they did not form centres of condensation of moisture. Their size had been approximately determined by the diffusion into gases, and from these experiments it was apparent that

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they were roughly 100 times the hydrogen atom. They acted like a gas, in that they do not pass through mica. An experiment with 20 milligrammes of radium bromide went to show that the rate of production of the emanation was constant under all conditions, and that they could be separated from the radium suddenly by dropping the radium bromide into water or by heating it. The action was as though the emanations were occluded in the substance as a gas would be, and then given off by heat or water. In the same way tubes of celluloid through which the emanations were passed seemed to occlude them. If the emanations were passed into a tube surrounded by liquid air, they seem to be condensed and remained in the tube. They were given off again when the temperature was raised to – 150deg. C. for the radium emanations and – 120deg. C. for the emanations from thorium. This action could be watched by the eye owing to the light given off by the radioactivity of the emanations. In order to prove if the emanations had any chemical properties, they had been passed through solutions which would stop any known gas. It followed, therefore, that, if a gas, they could only belong to the inert argon family. From these emanations positively charged bodies were thrown off which were atomic in size with a velocity equal to one-tenth that of light. The mass of these bodies was twice that of the hydrogen atom, and they possessed, therefore, enormous kinetic energy. For equal mass they had about 16 hundred million times the energy of an ordinary rifle bullet mass for mass. Through the interesting experiment of Sir William Crookes, the impact of these bodies on a screen had been rendered visible. The effect was that of small spots of light like the stars in the heavens, and he believed that it was the first time that what seemed to be the action of single atoms of matter had been rendered visible. It would seem, therefore, that these emanations which behaved like a gas threw off matter at very high velocity. The most reasonable explanation of this was to suppose that the rotational atomic velocity had suddenly been set free to move off at a tangent at enormous speed. It was curious that the emanations from 14 to 15 milligrammes of radium bromide, although they gave from 2 c p. to 3 c.p., could not be collected in sufficient quantities to be either weighed or seen. It was also found that if the emanations were passed through a tube or over a body, the tube or body became radioactive. This activity also decays, and it was found that the excited radioactivity from thorium was reduced to one-half in 11 hours, and that from radium was reduced to one-half in about half an hour. This excited radioactive substance could be dissolved by certain acids, but not by all, and if the solution is evaporated the active matter remains. The law of the rate of decay of radioactivity was found to be a geometrical progression in all cases, and in spite of the influence of any known physical condition. Alterations in temperature or concentration had no effect on it. In fact, the rate of decay seemed to depend on the number of atoms thrown off, and this was only dependent on the number of atoms present. As temperature had no effect whatever, the action was not likely to be chemical. The question arose as to what became of the residue after the positive discharges had been thrown off. He believed that the residue was responsible for the deposited activity on the tubes. It would seem as though the bulk of the radium atoms were stable, and that only one or two became unstable at a time. The process of breaking up of the atom then seemed to take place in four stages. First, there was the radium; secondly, the emanation which is radioactive; thirdly, the other matter carried over with the emanation which has the power of exciting radioactivity in other substances, and is associated with the emission of particles or rays of a very penetrating kind analogous to the Röntgen rays; and, fourthly, the final break up of the atom, which seems to result in the production of helium. This production of helium seems to be a matter of time, as the tube which contains the residue does not give the helium spectrum at first. After being kept for some days the helium spectrum is easily obtained.

Sir OLIVER LODGE said he was pleased to take part in the discussion on the most interesting information which had been given by Prof. Rutherford. He considered that he clearly put forward a theory as to the breaking up of the atom which was distinctly a working hypothesis, as it covered the facts without any forcing. It had now been ascertained that the radioactive emanations thrown off by radium left behind radioactive material. We seem to be seeing substances in transition stages, and the theory put forward as to the disintegration of atoms agreed with the ideas expressed by Dr. Larmor seven years ago. Without doubt the chemist would say that if the radium atom breaks down and throws off helium, it would be correct to say that it is not an atom breaking down, but a compound breaking up. There was, however, a very strong argument against the action being due to chemical action. It was not affected by temperature. Sir Oliver Lodge then read a communication from Lord Kelvin on the subject, in which considerable doubt was thrown on parts of Prof. Rutherford's theory. Lord Kelvin considered that the continuous emission of heat pointed to energy being supplied from without by etheric waves. As a physical example of a similar action, he instanced two glasses of water, in the one of which was a piece of white cloth and in the other a piece of black cloth. If these two glasses were placed in sunlight, the one with the black cloth would get hotter that the other. He suggested that the experiment as to heat emission from radium should be repeated inside a heavy lead vessel.

Prof. H. E. ARMSTRONG, speaking as a chemist, was astonished by the imagination of the physicists. They had had no opportunity of making thorough chemical investigation into properties of radium, owing to its scarcity. He would say, however, that in the whole range of chemical knowledge there was absolutely no evidence of atomic disintegration taking place under earthly physical conditions. He looked upon radium rather as a new kind of screen for picking up radiations.

Mr. W. F. SODDY said he had been privileged to work with Prof. Rutherford in his experimental researches, and as regarded the theory put forward, it was an exceedingly simple one that covered all the facts. The properties of radium had been fully investigated by Madame Curie, who found its atomic weight to be 225, and that its properties were exceedingly like those of barium. It would seem from their experimental evidence that in the mass of radium as a whole the change was so slow as to be inappreciable, but that individual atoms were liable to a sudden change. Prof. Armstrong in a recent paper on the subject had explained that all such exothermic changes were usually explosive: that was so because such changes were usually accelerated by change of temperature. He thought that Prof. Armstrong was wrong when he said that the chemists had no evidence of atomic disintegration. When experimenting with pitchblende Madame Curie had discovered, by means of its radioactivity, the presence of such a small quantity of a substance that could not be determined by ordinary chemical means. She then succeeded in isolating the radium compound, which had distinct chemical properties. He looked upon the means by which this discovery had been made as similar to spectroscopic analysis, which was now fully recognised as a weapon of the chemist in the same way. The revealing of the presence of exceedingly small quantities of materials by their radioactive properties could justly be termed chemical evidence.

Prof. DEWAR described in detail an interesting experiment he had made on the sample of radium bromide which Monsieur and Madame Curie had used in their Royal Institution lecture. He had placed it in liquid hydrogen, which was contained in a vacuum-jacketed vessel, the whole being surrounded by liquid hydrogen. In this way the evaporation of the liquid hydrogen in the inner vessel gave a calorimetrical determination of the evolution of heat from the substance. It clearly proved that the emission of heat was independent of the temperature of the surrounding media. Indirectly, it also showed that any sample of radium bromide after being prepared took some time to make its maximum rate of heat emission as the constant, for the sample in question was considerably below that for older samples in the possession of the Curies.

There were other speakers on the subject, whom we regret we have not space to report.

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CO-OPERATION IN SCIENCE.

The Southport meeting of the British Association has now been concluded, and it is interesting to read the various opinions in the daily Press as to its success or otherwise. Unfortunately, these opinions are frequently influenced quite as much by the livers of the writers as by the actual transactions of the various sections of the association. As far as numbers are concerned, the meeting shows a distinct advance over that held last year in Belfast, but the total number of tickets issued was below that for the previous meeting at Southport some twenty years ago. It is not, however, to the numerical strength only which one must look for success in such an association, as the meeting together of the leading members of the scientific world is the real object to be attained. In this respect it seems to us that the 1903 meeting is quite equal to any of its predecessors of recent times. Quite a large number of the papers were contributed by foreign scientists, and this was particularly the case in the meteorological division of Section A. The discussion "On the Nature of the Emanations from Radioactive Substances" attracted, perhaps, more general interest than any other purely scientific subject during the meeting, and it was very unfortunate that a larger room could not have been obtained for the purpose. As it was, the room allotted to Section A was overcrowded for three and a-half hours on Thursday, the 10th, and those who listened throughout to Prof. Vernon Boys's presidential address and to the discussion on radium suffered from emanations from other than radioactive substances. It speaks volumes for the interest displayed in the subject that hardly anyone in the large audience left the room, in spite of the discomfort caused by the want of ventilation. The discussion in question was introduced by Prof. E. Rutherford, F.R.S, who came from Montreal to lay before the meeting the results of his original investigations on the properties of radium and other kindred substances. Not content with giving concisely the results of his investigations, Prof. Rutherford went further, and propounded a theory which covered the facts in question. This theory will be found in the report of the discussion reproduced elsewhere in this issue. Speaking generally, it accounts for the extraordinary properties of the radium emanations, on the supposition that an actual breaking up of individual atoms is taking place. It would seem that this is a step-by-step process, and that experiments already made enable these steps to be distinguished the one from the other. The theory also involves the production of other elements during the breaking up of the radium atom. Thus spectroscopic analysis reveals the fact that the radium emanations in some way produce helium in course of time. The vast amount of energy which is evolved from radium is accounted for by the setting free internal kinetic energy of the atoms. It will be seen from the above that Dr. Rutherford's theory is a far-reaching one, and that if supported by further experiments it will lead us in the direction of the alchemist's dream—*i.e.*, the transmutation of matter. As was to be expected, any new theory of this kind meets with considerable opposition on its introduction, and there was no exception to this in the discussion at Southport. Lord Kelvin, who unfortunately was unable to be present, forwarded a contribution on the subject, in which he suggested that the energy radiated from radium might be obtained by that substance from unknown external sources, such as etheric waves yet to be discovered. Prof. Armstrong, as an expert in chemistry, stated his opinion that there was no chemical evidence whatever of the disintegration of atoms under the physical conditions available on the earth. To this Mr. Soddy, who has

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worked with Prof. Rutherford on the subject, properly replied that the investigations of Madame Curie in the isolation of very small quantities of radium from pitch-blende might properly be classed as chemical research, as radioactivity was evidence which could be used in the same way as spectroscopic analysis was by chemists. In Section G the contributions were more numerous than usual, and a number of them were most valuable. The feature of the meeting was perhaps the very great interest shown in the comparatively young section devoted to education. This section, which by order of organisation is called the "L" Section, filled at times the Cambridge Hall. On Tuesday last this room had, however, to be given up to the Economic Section for the debate on the fiscal question. This debate was very interesting, but it would have been much more useful if it could have been deferred until after the policy of the Government had been announced. As a whole the Southport meeting was, in our opinion, a great success, and it must have been most profitable to its members.

RETURN-CURRENT TROUBLES ON THE HAMBURG TRAMWAY SYSTEM AND THEIR PREVENTION.*

The return circuit on this system consisted practically entirely of the rails, bundles of bare copper wires being connected to them at various points near the supply station. Only very few distant return feeders were in use, and these carried a negligible proportion of the whole current.

Trouble with the gas-pipes first occurred in 1898, about a year after the principal part of the system came into use. The escape of gas became evident through the dying of several avenue trees through the escape of gas. Investigation showed that most of the streets in which trouble occurred had wrought-iron piping crossing the tramway track. In Fig. 1, which shows the profile of one of these

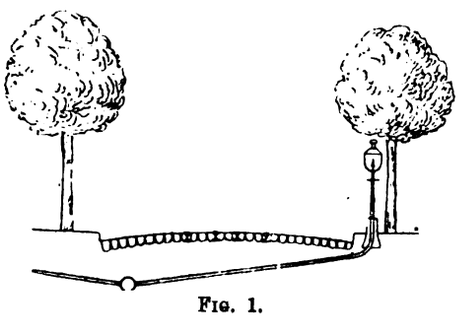

Fig. 1.

streets and is applicable to most of the others, it will be seen that the main cast-iron gas-pipe lies near to one curb, and from this main wrought-iron pipes branch off in both directions to the street lamps and houses on both sides of the road. It is only in recent years that the introduction of cement conduits carrying gas-mains on both sides of the road has enabled the wrought-iron cross pipes, which used to run at a depth of about ·7m., to be dispensed with. The powerful electrolytic action was only noticeable on those wrought-iron pipes which crossed the rails, and only at the parts under the rails. In the more dangerous neighbourhood, near the station, a few of the leaden water-mains, which also crossed the rails, but at a depth of 1·5m., showed a more advanced oxidation under the rails than at other parts, but no holes. Cast-iron pipes which crossed the rails were found to be unaffected, the older ones being protected throughout their length by a covering of oxide, which, if not entirely stopping the current, would at least greatly diminish it.

The insertion of a layer of concrete under the rails in one street to a depth of 20cm., and extending to a distance of ½m. beyond the rails on each side, had no effect in preventing electrolytic action. New tubes became appreciably attacked within six months in the worst district.

The electrolytic action was probably aided by the presence of a considerable quantity of salt in the fairly dry sandy subsoil. This salt had penetrated the soil after use on the surface for snow-melting purposes. Experiments carried out with a view to stopping the electrical action showed that tarred pipes gave more satisfaction than those covered with pitch. The pitch was applied in the form of a pitched tape wound on the pipe spirally, and the pipe became attacked spirally at the overlapping point. The current discovered badly-covered spots, and so damaged the pipes even more quickly than when they were bare, owing to the higher current densities attained. In spite of the rapid electrolisation occurring at certain points, the number of such points discovered was comparatively small, so that only a small proportion of the full tramway current, amounting to over 3,000 amperes, could have been leaking into the pipes. This was borne out by the fact that when one of the cast-iron 100mm. diameter mains in the principal street was cut for experimental purposes, a current of only about four amperes was found to pass through it.

After some further experiments, it was decided to protect the pipes by the employment of insulated returns to about the same extent as the feeders to the overhead trolley line. These returns were carried in cable troughs, and were connected to the rails at intervals by bare copper conductors embedded in asphalt in wooden troughs. For the purposes of calculation, it was found necessary to obtain some reliable figures as to rail and bond resistances, and some careful measurements of voltage drop with constant current were made on the standard steel rails in use. These were 10m. long, and had a cross-section of 6,464 square millimetres (10 square inches), and the average result obtained was ·00003 ohm per 1m. of rail without joints at a temperature of 29deg. C. Bonds between rails were made, as in practice, by means of two 8mm. diameter copper wires, and the measurements were then repeated across the bonds, but no noticeable difference from the plain rail could be noticed.

In order to obtain a record of the current distribution in the different return feeders, measurements of the potential difference existing between different feeding points were made by means of pilot wires and a voltmeter. The measurements were made during working hours, and each reading occupied one minute; the greatest deflection in each direction, or the greatest and least deflections in one direction, if all the deflections were to one side, were noted. On the strength of these measurements resistances were inserted into certain of the return feeders, and in this way considerable reductions in E.M.F. between neighbouring return feeder points were effected.

After the introduction of these return feeders and their adjustment by means of resistances, all trouble through electrolysis of pipes disappeared.

* Translation in abstract of a paper read by Freiherr V. Gaisberg at the eleventh annual meeting of the Verband Deutscher Elektrotechniker in Mannheim.

PERSONAL.

The lectureship in electrical engineering at the Hull Municipal Technical School has been filled by the appointment of Mr. G. W. Osborn Howe, M.Sc., of London. Mr. Howe has had a distinguished college career, and in 1900 was successful in obtaining the Senior Whitworth Scholarship. He graduated at the University of Durham with honours in engineering and physics. His practical experience includes six years in the shops, 18 months in designing and estimating cable work, and nine months in the calculation and design of electrical machinery, all with Messrs. Siemens Bros. and Co., Limited, London. He has further had two years of experience, chiefly in polyphase work, with Messrs. Siemens and Halske, Charlottenburg.

The salary of the electric engineer at Ayr (Mr. Marshall) has been fixed at £300. The salary of the assistant engineer (Mr. M. Henderson) has been raised from £2. 5s. to £3 a week.

Mr. Keenan, the assistant engineer at Taunton, has left, he having obtained an appointment at Torquay.

We are informed that Mr. A. Brandon, commercial manager of the Lahmeyer Electrical Company, Limited, has rejoined the staff of Messrs. Johnson and Phillips, with whom he was previously associated for about 12 years.

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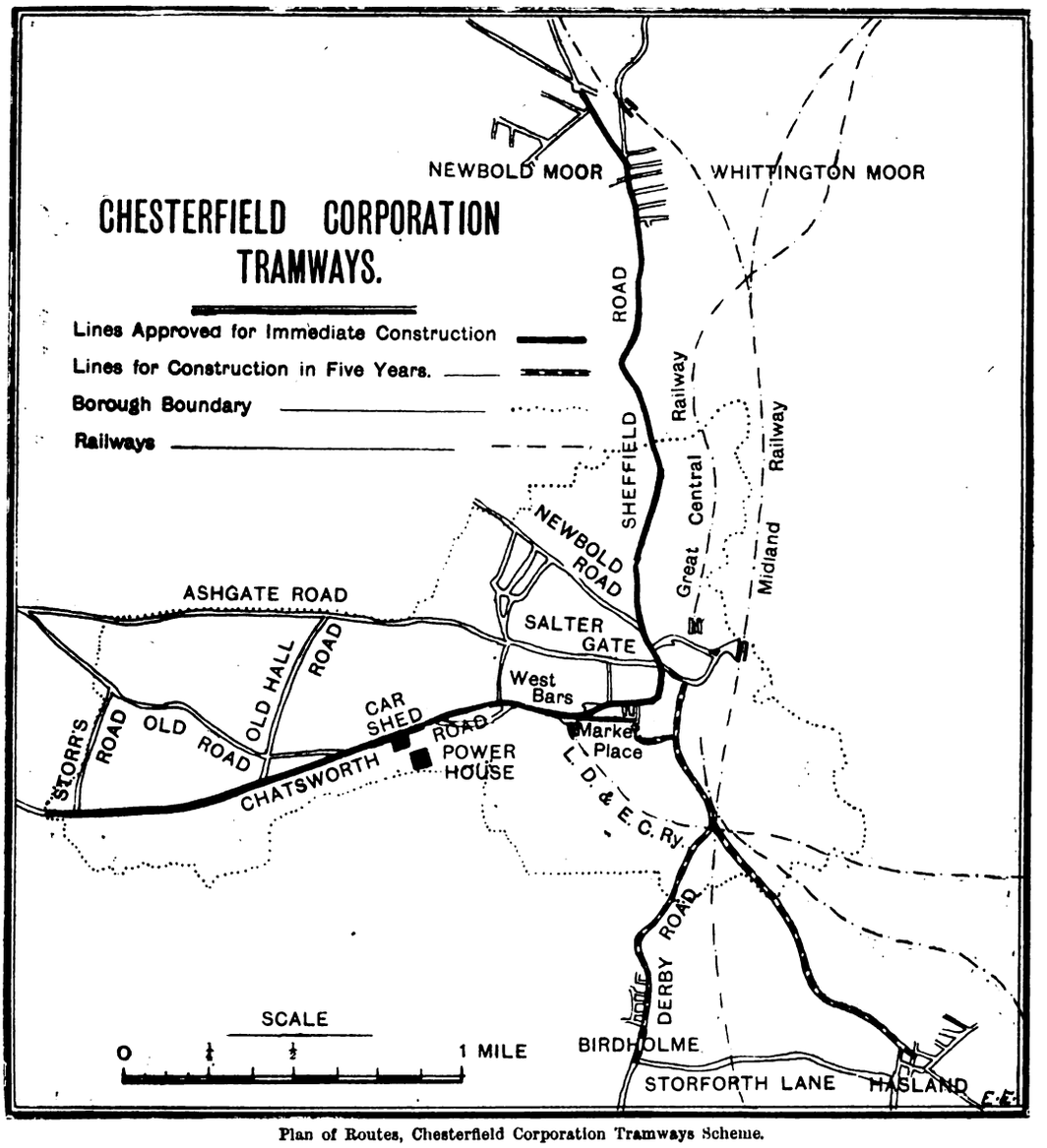
CHESTERFIELD CORPORATION TRAMWAYS SCHEME.

We are indebted to Mr. R. L. Acland, borough electrical engineer, Chesterfield, for the accompanying plan, showing the routes of the tramways which the Council have just decided to construct. The total estimated cost of these tramways, including the necessary equipment, is £86,808, of which sum £55,714 is required for the lines approved for immediate construction.



Plan of Routes, Chesterfield Corporation Tramways Scheme.

ON THE USE OF CAPACITIES AS MULTIPLIERS IN CONNECTION WITH ELECTROSTATIC VOLTMETERS ON ALTERNATING-CURRENT CIRCUITS.*

BY PROF. E. W. MARCHANT, D.SC., AND G. W. WORRALL, B.SC., LIVERPOOL UNIVERSITY.

The measurement of high potential differences necessitates the use of voltmeters more or less cumbrous and expensive, since in all electrostatic instruments there is a liability to sparking between the plates. High P.D.'s may, however, be measured by lower reading voltmeters in several ways. The only methods hitherto adopted have been by the use of non-inductive resistances connected in series with the voltmeter, either shunted or unshunted, and by the use of transformers. The first method becomes quite impracticable with high pressures on account of the large waste of power involved, while the latter method becomes equally cumbrous on account of the difficulties of insulation and the length of wire required in winding the apparatus. The experiments described below have been directed to the construction of a simple and easily made apparatus by which low-reading electrostatic voltmeters may be employed on circuits of much higher tension. The voltmeters used were of the Kelvin multicellular and Ayrton and Mather electrostatic types. The method of combining the voltmeter with the capacities is to connect a capacity in series with the voltmeter across the mains and shunt another capacity across the terminals of the voltmeter, the latter capacity being large compared with the capacity of the voltmeter. Fig. 1 is a diagram of the connections.

Consider two capacities connected in series across the mains.

Let C_1 and C_2 be the values of the capacities in farads;
R_1 and R_2 be their respective insulation resistances;
V_1 and V_2 be the respective P.D.'s between the terminals of the capacities;
E be the total P.D. between the mains;
I_R be the resistance current between the mains;
I_C be the capacity current between the mains;
I be the total current between the mains;
p be 2π (frequency per second).

$$\text{Total current in capacity 1} = V_1\sqrt{\left(\frac{1}{R_1}\right)^2 + (C_1 p)^2}$$

$$\text{Total current capacity in 2} = V_2\sqrt{\left(\frac{1}{R_2}\right)^2 + (C_2 p)^2}$$

These two currents being one and the same,

$$V_1\sqrt{\left(\frac{1}{R_1}\right)^2 + (C_1 p)^2} = V_2\sqrt{\left(\frac{1}{R_2}\right)^2 + (C_2 p)^2} = I.$$

* Paper read before the British Association, Southport meeting.

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Now, $$E = \frac{I_C}{\frac{C_1 C_2}{C_1 + C_2} p} = I_R (R_1 + R_2).$$

Hence, $$I_C = E \frac{C_1 C_2}{C_1 + C_2} p, \text{ and } I_R = \frac{E}{R_1 + R_2}.$$

Now, $$I = \sqrt{I_C^2 + I_R^2} = E \sqrt{\left(\frac{C_1 C_2 p}{C_1 + C_2}\right)^2 + \left(\frac{1}{R_1 + R_2}\right)^2}$$

$$= V_2 \sqrt{\left(\frac{1}{R_2}\right)^2 + (C_2 p)^2}.$$

Hence, $$\frac{V_2}{E} = \frac{\sqrt{\left(\frac{C_1 C_2 p}{C_1 + C_2}\right)^2 + \left(\frac{1}{R_1 + R_2}\right)^2}}{\sqrt{(C_2 p)^2 + \left(\frac{1}{R_2}\right)^2}}.$$

Let $R_1 = \frac{x_1}{C_1 p}$, and $R_2 = \frac{x_2}{C_2 p}$. Then

$$\frac{V_2}{E} = \frac{\sqrt{\left(\frac{C_1 C_2 p}{C_1 + C_2}\right)^2 + \left(\frac{1}{\frac{x_1}{C_1 p} + \frac{x_2}{C_2 p}}\right)^2}}{\sqrt{(C_2 p)^2 + \left(\frac{C_2 p}{x_2}\right)^2}}$$

$$= \frac{\sqrt{\left(\frac{C_1 C_2 p}{C_1 + C_2}\right)^2 + \left(\frac{C_1 C_2 p}{x_1 C_2 + x_2 C_1}\right)^2}}{\sqrt{(C_2 p)^2 + \left(\frac{C_2 p}{x_2}\right)^2}}$$

$$= \frac{C_1}{C_1 + C_2} \frac{\sqrt{1 + \left(\frac{C_1 + C_2}{x_1 C_2 + x_2 C_1}\right)^2}}{\sqrt{1 + \left(\frac{1}{x_2}\right)^2}}$$

Expanding and neglecting higher terms—

$$\frac{V_2}{E} = \frac{C_1}{C_1 + C_2} \left\{1 + \tfrac{1}{2} \left(\frac{C_1 + C_2}{x_1 C_2 + x_2 C_1}\right)^2 - \tfrac{1}{2} \left(\frac{1}{x_2}\right)^2 + \ldots\right\} (1)$$

If x_1 and x_2 are very large—that is, if the insulation resistances of the condensers are high—then

$$\frac{V_2}{E} = \frac{C_1}{C_1 + C_2}.$$

From equation (1) it will also be seen that if $x_1 = x_2$, that is if

$$\frac{R_1}{R_2} = \frac{C_2}{C_1}; \text{ then } \frac{V_2}{E} = \frac{C_1}{C_1 + C_2}.$$

This will most probably be the case if the plates of both capacities are of the same size and the sheets of dielectric

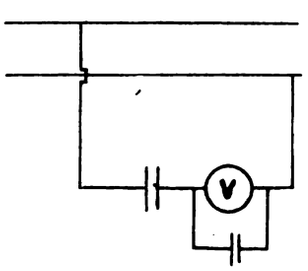

Fig. 1

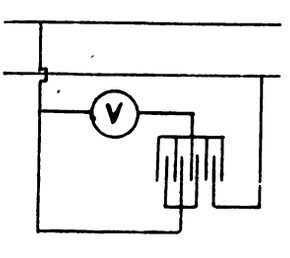

Fig. 2

of the same material, size, and thickness, the difference in the values of the capacities being produced by using different numbers of sheets, since, then, both leakage currents through the material and those over the surface of the dielectric will be proportional to the number of plates forming the condensers. If an electrostatic voltmeter, therefore, be connected across the capacity 2, its reading bears a constant ratio to the P.D. between the mains, and by varying C_1 and C_2 any desired ratio may be obtained. Several advantages, such as compactness and saving of material, are gained by forming the two capacities into a condenser, in which one of the two sets of plates is itself divided into two groups, each group connected to its own related main, one group to the voltmeter, and the voltmeter again to the undivided set, as in Fig. 2.

Two instruments have been constructed up to the present on the principles described. One suitable for measuring P.D.'s up to 300 volts on a 150-volt instrument and having a ratio of $\frac{1}{2}$, and the other suitable for P.D.'s up to 10,000 volts having a ratio of $\frac{1}{40}$. Fig. 3 is an illustration of these instruments. Fig. 4 is a diagram showing the arrangement of the low-tension instrument. This is formed of alternate sheets of mica and tinfoil of equal

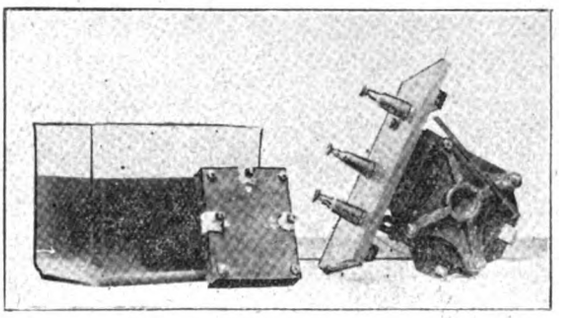

Fig. 3.

dimensions respectively, held together between strong plates of ebonite. Fig. 5 is a diagram showing the arrangement of the high-tension instrument. This is similarly formed, except that copper-foil is substituted for tinfoil, the dielectric varies in thickness directly with the tension, and the whole is clamped between brass plates. The dielectric plates in the higher-tension portion are made larger than those in the lower-tension portion to avoid sparking over the surface, and the entire instrument is suspended in oil for the same reason. The accuracy of the apparatus made has been tested by careful experiments. The measuring instruments used were calibrated at the time of the experiments by comparison with a Kelvin standard balance, and the P.D.'s for the high-tension instrument were obtained by means of a transformer of known ratio. This ratio was determined at a low P.D., and found to be 55·42 and assumed constant; thus the actual voltage

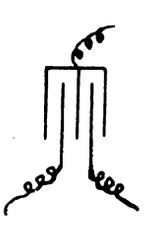

Fig. 4

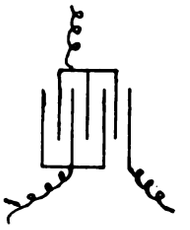

Fig. 5

in all cases given below is that measured on the primary multiplied by 55·42.

RESULTS OF EXPERIMENTS.

Low-Tension Instrument.

Total P.D. between mains. E	Reading of voltmeter. V_2	Ratio $\frac{E}{V_2}$
139·9	73·4	1·906
149·3	77·7	1·921
162·4	85·1	1·908
174·7	91·0	1·920
185·9	97·2	1·912
196·0	102·5	1·913
204·1	107·8	1·893

High-Tension Instrument.

Total P.D. between mains. E	Reading of voltmeter. V_2	Ratio $\frac{E}{V_2}$
6,761	174	39·48
7,426	186	39·92
7,980	204	39·12
8,534	213	40·09
9,089	231	39·34
9,643	243	39·68
10,197	259	39·75
10,751	268	40·11
11,305	283	39·94

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The ratios given above in all cases differ by less than 1 per cent. from their mean value, and in most cases agree much more closely. Any variations that exist are well within the limits of experimental error. It is hoped that this device may be of considerable practical utility, not only in simplifying the construction of high-tension voltmeters, but in laboratory and experimental work, where it frequently happens that measurements of potential have to be made with voltmeters, the best parts of whose scales are too low. The invention has been provisionally protected.

RADIUM AND OTHER RADIOACTIVE SUBSTANCES WITH A CONSIDERATION OF PHOSPHORESCENT AND FLUORESCENT SUBSTANCES. THE PROPERTIES AND APPLICATIONS OF SELENIUM AND THE TREATMENT OF DISEASE BY THE ULTRA-VIOLET LIGHT.*

BY WILLIAM J. HAMMER.

(Continued from page 357.)

With the relay it is placed in the bottom of the buoy and arranged to be absolutely waterproof. When I was in Berlin last August, one of these buoys had been in operation since the previous October, turning the light on and off every night and morning; and Mr. Ruhmer has recently written me that it is still operating successfully, as are others which he has placed near Hamburg and in the Baltic Sea. Mr. Ruhmer has also constructed an apparatus employing the selenium cell to which he has given the name "photographophone," which is one of the most remarkable pieces of scientific apparatus that it has ever been my pleasure to see. Figs. 25, 26, and 27 illustrate the general construction of the apparatus, which I shall further illustrate by accompanying lantern slides. In Fig. 28 the apparatus is shown diagrammatically, and in Fig. 27 the inventor is shown listening to the photographophone reproducing speech and music. It consists of a box containing a gelatine or celluloid film, such as employed in moving picture machines, which is driven at high speed by means of an electric motor. In the front face of the box is set a cylindrical lens about the size of one's little finger. A short distance away from the box is placed an arc lamp and a telephone. Words spoken or sung into the telephone superimpose the waves in the telephone circuit upon the current flowing in the arc light circuit, and cause a corresponding variation in the light of the arc. The rays from the arc lamp pass through the cylindrical lens already referred to, and are caused to fall in sharp white lines on the moving sensitive film. This film, upon being taken out of the box and developed, shows a series of perpendicular striations parallel to one another, which are really a photographic record of the sound waves originally entering the telephone transmitter. Where the striations are fine and close together, the pitch is high, but where they are broader and farther apart the pitch is low. Strips of the films or photograms are shown in Fig. 29. The developed film is next placed back into the box, and the motor again started. The arc lamp remains in its original position, but burns steadily as the telephone is not operated. The rays from the arc lamp passing through the lens are therefore quite uniform, and the moving gelatine strip acts as a screen to cut off these rays, allowing the light intermittently to fall upon the selenium cell at the back of the box, producing a variation in its resistance and a corresponding effect in the telephone receivers connected thereto. A battery is also interpolated in the circuit with the selenium cells and the telephones. By holding these telephones to the ear, the reproduction of the sound is perfect, as I can vouch for from personal experience with the apparatus. Mr. Ruhmer contemplates utilising this photographophone as a receiving instrument with its wireless telephone system, in which he employs a beam of light, as already described. Mr. Shelford Bidwell has also made a device for producing pictures or writing at a distance by combining the properties of selenium with the chemical telegraph.

Various inventors have endeavoured to solve the problem of seeing what goes on at a distance by employing selenium. Among these are Perosino, Senlecq, De Paiva, Cary, Sawyer, Larroque, Nipkow, Gemmill, Liesegang, Heinzerling, Edison, Stern, Jan Szczepanik, Dussaud, Otto von Bronk, Von St. Schneider, Ayrton and Perry, Korn, and others, who have proposed various methods employing images thrown on ground glass or through a photograph negative, or upon mirrors swinging synchronously, by or using revolving perforated screens, for cutting off the

FIG. 27.—Mr. Ernest Ruhmer Listening to his Photographophone.

beams of light, multiple selenium cells which would be affected by high lights and low lights of the original picture, etc., these devices affecting some method of illumination at the receiving end or producing an electro-chemical action such as is produced by the usual chemical telegraph system, or controlling an electro-pantograph system such as Gray's telautograph. These various inventions have been termed the telescope, telephote, telectroscope, and the telephotograph. But these devices have thus far reached little further than descriptive matter, drawings, and crude experiments. Various people have suggested the use of selenium cells for photometric purposes, and it is interesting to note that Mr. Latimer Clark suggested this application the evening in

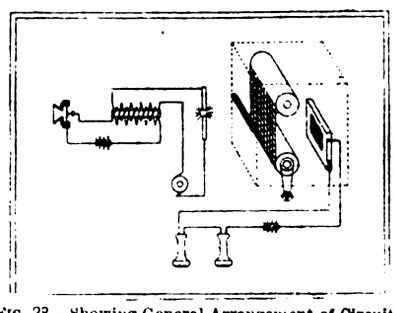

FIG. 28.—Showing General Arrangement of Circuits of Ruhmer's Photographophone

which Mr. Willoughby-Smith first brought to public notice the phenomena of variation in resistance of selenium when exposed to light, to which I have already referred. Mr. Fritts has suggested making a form of photometer which would be sensitive to lights of different colour, as well as of varying candle-power, by employing as a film on the surface of his cell a gold foil which transmits green rays, a silver foil the blue rays, and so on, and suggests that a solid transparent conducting film which would transmit all of the rays would be far better and thus remove the colour stumbling block in photometric work. Sir William Crookes has constructed an exceedingly interesting type of radiometer, in which he has coated the revolving vanes on one side with selenium, and on the other with chromic acid. He found that the white light from a sperm candle repelled

* A lecture delivered at a meeting of the American Institute of Electrical Engineers and the American Electrochemical Society, New York, April 17, 1903.

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the selenium, while the yellower light of the wax candle repelled the chrome, thus indicating the relative absorptive powers of the different substances for rays of different refrangibility, resulting in mechanical motion; just as the same selective capacity operates in photography as

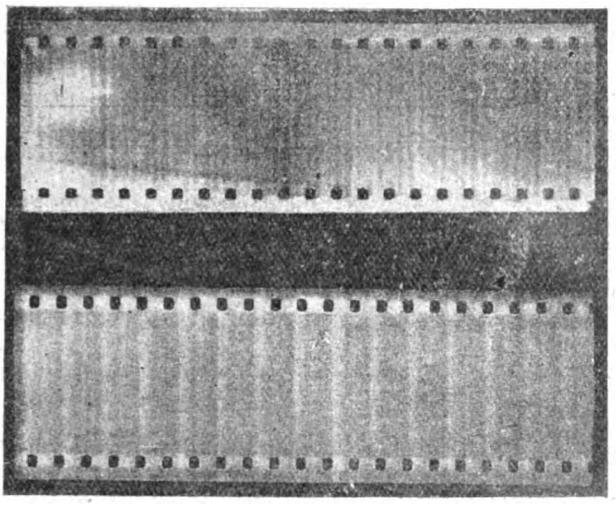


FIG. 29.—Photogram as used in Ruhmer's Photographophone (High-Pitch Tones above, Low-Pitch below).

chemical action. In 1891 Prof. Barnard, of Lick Observatory, employed a selenium cell as a device for automatically detecting comets, and Minchin has employed the selenium cell quite extensively in his astronomical investigations. In Fig. 30 is shown a curve which Mr. Ruhmer recently sent me which shows some

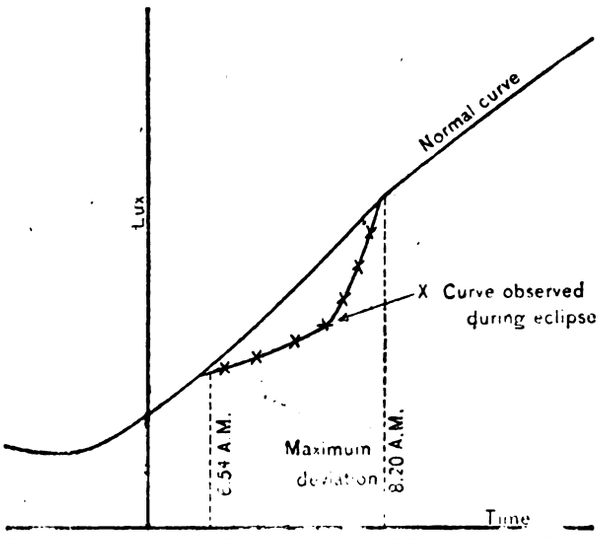
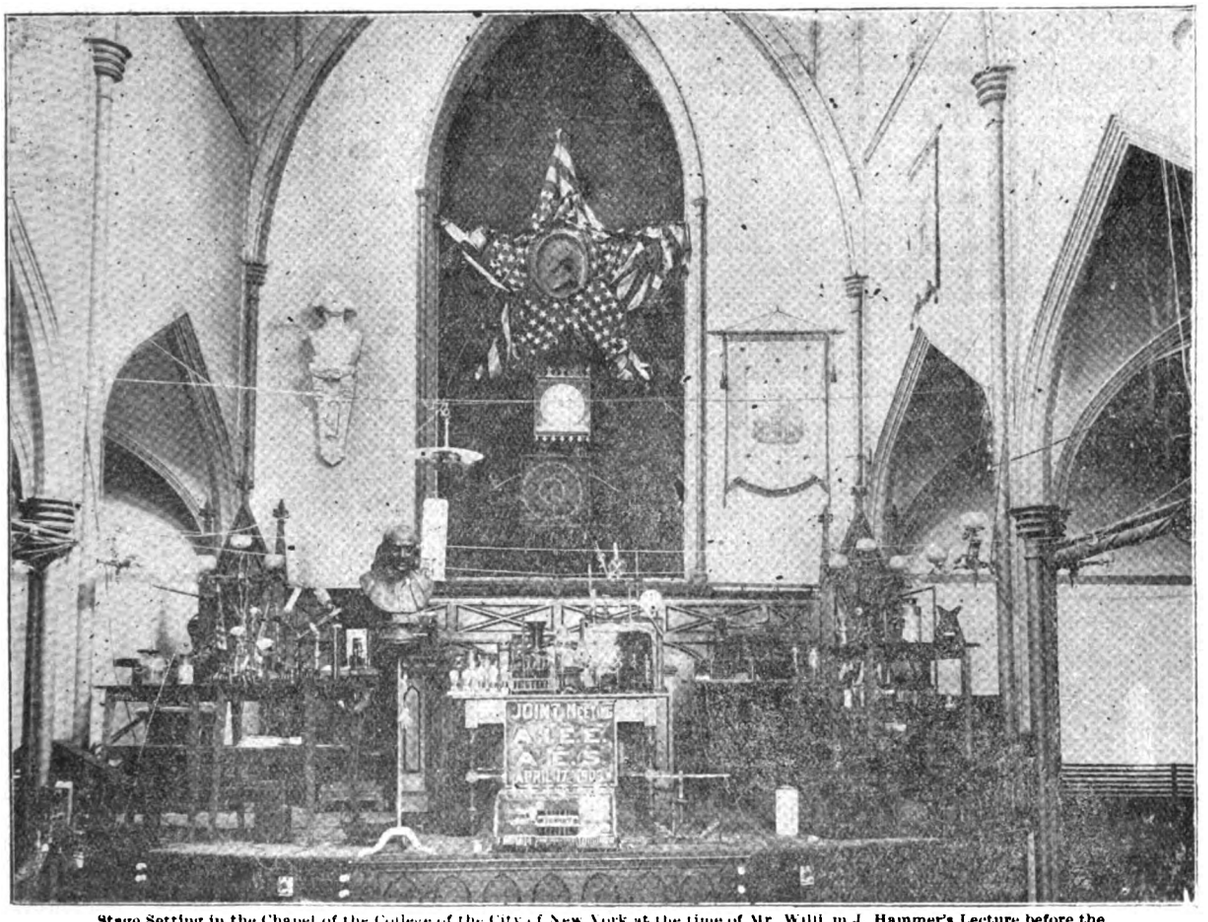


FIG. 30.—Curve taken with Ruhmer Cell during Eclipse, Oct. 31, 1902.

observations made by means of his selenium cell during an eclipse, these being the only observations which anyone was enabled to make at that time on account of stormy weather. Mr. Ruhmer has prepared an interesting paper bearing on this and other applications of the selenium cell to meteorology. He made his observations on Oct. 31, 1902.

Selenium is found in Vesuvian lava, and in natural sulphur as a sulphur selenide in the Lispari Islands. It is also found in Norway and other iron pyrites. It occurs in meteoric iron and in such rare metals as eucarite as a selenide of silver and copper in Sweden and Chili; crookesite, a selenide of copper and thallium with a little silver, from Norway; as clausthalite, a selenide of lead in the Hartz Mountains, from Zinken and Clausthal, in Inverg, Rheinberg, Saxony, Rio Tinto, Spain, Mendoza, South America; as riolite at Culebras, Mexico; as Lehrbachite, a selenide of mercury and lead from the Hartz Mountains; as zorgite, a selenide of copper and lead from Glasbach in the Hartz Mountains. Selenium, although widely distributed over the globe, occurs only in small quantities and in some instances is found in native state. Selenium is placed among the rare metals. Chemically pure crystalline selenium costs about 1dol. per gramme; and the ordinary commercial article about 10 cents per gramme. The



Stage Setting in the Chapel of the College of the City of New York at the time of Mr. William J. Hammer's Lecture before the American Institute of Electrical Engineers and the American Electrochemical Society.

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bibliography of selenium is quite extensive. Those interested in the subject will find an excellent paper by Mr. A. P Saunders in the *Journal of Chemistry* for June, 1900. The paper contains many references, and is entitled "Allotropic Forms of Selenium."

(To be continued.)

PRODUCTION OF CHLORINE AND CAUSTIC ALKALI.

Most of the larger paper and pulp mills have begun to instal in recent years electrolytic plants for the production of bleaching powders for their own use. All of them use diaphragm processes, but the construction of the cell varies in different plants. A patent for a new diaphragm has been granted in the States to A. B. Larihar, and assigned to the Penobscot Fibre Company, which has conducted a number of experiments with the process. The special feature of this new cell, as described in the *Electrical World*, is the cathode, which is of peculiar construction. It consists of a grating forming a complete enclosure, constituting the side walls of the cell. This grating is in sections, forming the four sides of a parallelogram and secured together at the corners by posts of angle iron. The polygonal enclosure thus formed serves not merely as the cathode, but possesses sufficient rigidity to act as the wall of the cell, supporting itself and the diaphragm which is stretched upon it, and also the cover of the cell from which the anodes depend. The grating which composes the cathode consists of a series of vertical bars or slats of soft steel. The slats are spaced uniformly apart, so that a lamellar cathode is formed which divides the solution into a great number of films which pass from the diaphragm out through the cathode into the receptacle which surrounds the cathode. The floor of the cell is formed of Portland cement. The diaphragm consists of asbestos paper, several thicknesses of which are placed around the walls of the cell so as to break joint with each other, each layer forming a lap-joint with itself. The anodes consist of a series of graphitised carbon slabs. Brine is supplied to the anterior of the cell, which represents the anodic compartment. The caustic soda solution escapes from the outside reservoir through an overflow pipe, which is adjustable, so that the surface level of the liquid in the outside reservoir may be changed at will. By maintaining the inside level (anode compartment) slightly above the outside level, it is possible to counteract the tendency of the O H ions to come over from the cathodic into the anodic compartment and there cause trouble. In this the inventor applies the old method used by Le Sueur in his early pioneer work.

APPOINTMENTS VACANT.

Junior Engineer, Dundee Town Council.

Shift Engineer, Taunton Corporation, £100, 28th inst.

Assistant Resident Engineer, Middlesex Hospital, W., 23s., 21st inst.

Chief Tramways Officer, London County Council, £1,500, 28th inst.

NEW COMPANIES REGISTERED.

British Electric Calibrated Fuse Company, Limited.—Capital, £3,000. Objects: to adopt a certain agreement, and to carry on the business of manufacturers of and dealers in electrical accessories and appliances, electricians, electrical engineers and contractors, manufacturers of rubber and rubber goods, etc.

Electro Post Railway Company, Limited (78,489).—Capital, £100. Objects: to construct, repair, maintain, and operate installations, cables, wires, and other works of every kind for the generation, supply, distribution, and employment of electricity for motive power, lighting, heating, or other purposes.

Glasgow Electric Crane and Hoist Company, Limited.—Capital, £100,000. Objects: to acquire patents and patent rights for Great Britain and Ireland granted to the Benrather Maschinenfabrik Actien-Gesellschaft, and the exclusive right for a period of 10 years to sell in Germany machinery in accordance with these patents, and to carry on in the United Kingdom, Germany, and elsewhere the business of, makers of, and dealers in electrical and hydraulic cranes, hoists, lifts, etc.

QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any questions should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

619. How can the pressure and vacuum gauges be calibrated in the station without the use of standard instruments?—W. F. F.

620. With a shunt-wound motor it is found that the no-volt release on the starting switch takes an appreciable time to act after the current is broken to motor. If the motor is heavily loaded when current is broken, it has stopped running before the switch arm is released. But if main current is left on, and circuit broken at field shunt connection or starter, the no-volt release immediately releases switch arm, but the motor takes much longer to stop than when main current was broken. Explain this fully.—C. W. G.

ANSWERS.

Question No. 611.—Two 300-kw. alternators running in parallel and fully loaded, when a short-circuit occurs on one of the high-tension feeders. After the feeder is made dead, the two machines are put in parallel again on the 'bus bars (with no load). Would it be safe to switch in the remaining (say six feeders one by one?

Answer to No. 611 (*awarded* 7*s.* 6*d.*).—If the load consists of lighting and small motors, no harm could be done by switching in the feeders one by one. If, however, there are several large motors with starting resistances in circuit, and the switches had not been taken out or the resistances put back into circuit at the time the current was switched off at the station, it would be risky, as you would possibly blow the fuses of these motors. If the fuses were not the proper size—*i.e.*, too large—then you might do other damage. It must be remembered that there is no automatic release on alternating-current starting switches. Also (in any case) if there is likely to be a weak spot in the insulation of transformers or cables, the sudden high pressure when inserting the switches might find the weak spot.

Your machines should easily stand the load brought on by each feeder, although care should be taken, together with a little forethought. What I should do would be to first take out all feeder switches, then parallel the two machines and switch on to the 'bus bars. You have some idea of the load on each feeder, therefore put in as many switches one by one that will give No. 1 machine its load, then put in the remaining switches one by one, varying your exciting current with the increased load in both cases.

If there was a 1,000-kw., or even an 800-kw. set in the station and plenty of boiler power at the time, I should use this set, in which case you could have all your feeder switches in, including your machine switch, run your engine up to speed and gradually bring on your load with the exciting current. By doing this, your motors, as mentioned above, would start with the load without fear of doing any harm. Afterwards you could run your two 300-kw. sets in parallel with the 1,000-kw. set and give the two former their load, taking out the latter after doing so.—J. W. W.

Answer to No. 611 (*awarded* 7*s.* 6*d.*).—We assume from the question that the short-circuit occurring on the high-tension feeder blows the fuses of the two alternators, but is not sufficient to blow its own fuse, because "P. C. S." refers to the feeder being made dead after. Suppose the supply at the works was generated at a pressure of 2,000 volts, and delivered into sub-stations for transforming purposes by seven feeders, each feeder being connected

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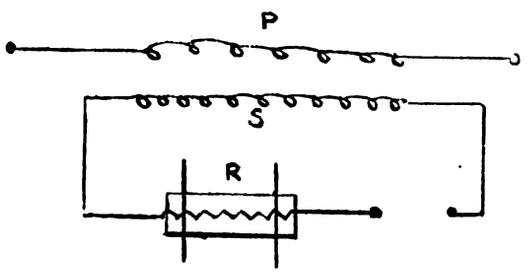
to distinct and separate networks, the two alternators would be producing at this pressure a total of 300 amperes, and the average load on the feeders would be about 44 amperes. No. 6 feeder produces a short-circuit, and the rush of current is sufficient to blow the machine fuses, which have already been carrying their full working current. The switches are now taken out and the machines re-fused and then paralleled in. Now the feeder switches can be closed one by one (except No. 6), but an interval of about 15 seconds should be allowed between each, as the rush of current due to self-induction on the insertion of each feeder would have time to die down. Care should be taken to keep the machine pressure considerably above the normal—say by 50 volts—before closing one of these circuits, and although this would not cure the "blinking" of the lights, it would prevent them from going down too low. Under the conditions stated, the total current would now be about 256 amperes, and this would give the machines more margin for taking the strain imposed upon them, especially when inserting the last two switches. But the feeders should be fused, so as to blow as soon as anything like a short occurs along their length. As it is important under ordinary conditions to get the consumers on as quickly as possible, it would be preferable to place one machine across the "dead" 'bus bars, close, say, three feeder switches, and then parallel in the second machine, after which the remaining feeders could be dealt with. By this means a part at least of the customers would only be in darkness for a short time.

With a good governing engine and a well-built alternator, and a cool head on the part of the switchboard operator, this could be done quite safely and without much loss of time.—MUNDY.

Answer to No. 611 (*awarded* 7*s.* 6*d.*).—The question in itself is very incomplete, no idea being given of the circumstances of working voltages and load. Under ordinary conditions the fuses on the short-circuited feeder should go first, but we will consider the latter part of the question only. It appears that the ordinary practice is that of running up on the feeders, and several conditions have to be known to give an answer which may be applicable to the system.

With high-tension alternating-current cables the type plays a large part, a concentric cable, for instance, having a far higher self-induction than a three-core cable; and again, the voltage has such a large effect, for with anything over about 3,000 the resonance of the cable has to be considered. The resonance of the feeder depends upon its length, and within certain limits—*i.e.*, a few miles, which distance, of course, depends upon the kind of cable used—nothing is felt, but beyond that the curve of resonance rises very sharp to a maximum, from whence it falls gradually as the cable lengthens, therefore giving two points of length on which inside lengths suffer from the resonance. The effect of this will be that when suddenly switched on it will cause an abnormal rise in voltage for the instant, which may prove very detrimental to the cable's insulation.



However, another very important factor is that of the nature of the load. This is generally, and should be, known to the person who would switch on, and a load consisting of induction motor, transformers, etc., which would, if left switched on, cause a large self-induction, would not allow of being suddenly switched on. Several good methods are employed to overcome this self-induction on such circuits and prevent distortion by heavy loads, and one used on a high tension network system may be mentioned. A primary transformer winding is connected by switching in first in the main circuit, which allows a small current only to flow, a secondary winding, S, is in circuit with a water resistance, R, which is gradually cut out, when the secondary coil gradually overcomes the self-induction in the primary, and raising the primary current until its maximum is reached, when it is short-circuited, and the feeder is directly connected.—S. F. RICKETTS.

Answer to No. 611 (*awarded* 5*s.*).—This question resolves itself into a consideration of the advisability of switching the feeders in circuit, as indicated, under various conditions, as regards the machines and apparatus in use at the time, which obtain their required energy from the alternators in parallel. Also, in the question there will be involved a counter-action or series of counter-actions in the alternators themselves which will require consideration. In order to deal with this subject in a complete and proper manner, and with entirety, it will be the best course of action to generalise each case, which under ordinary conditions might exist, as complete in itself. In the first place, if, on the immediate cut-off of the supply from the feeders, and therefore from the consumers' premises, the switches of every motor are opened so as to isolate them and disconnect them entirely, then, in the event of an immediate re-supply, whatever the type of motor and which feeder supplies them with energy, it will be perfectly safe to switch in the feeders one by one in circuit. In the case of incandescent lamps, whether the lamps are switched out of circuit or otherwise, we have a case which stands alone—different entirely to motors—and if the feeders supplied energy to lamps of the above character and not to motors, then no disastrous effects would ensue from switching the feeders in circuit. That the above is the case can easily be seen, since both examples taken are only every-day examples; the first producing no effect, the second, being that of the lamps, having the full pressure applied at the terminals immediately on the resumption of the supply—a case occurring every time an incandescent lamp is used. In the following cases, however, different conditions exist which require consideration. The case of the asynchronous motor will be taken first. It might happen that the attendant of any such motor, fed from the mains, might fail to switch off such a motor from the system. The effect of switching an induction motor with short-circuited rotor straight on to the mains is well known, especially if the motor be of a large output in proportion to the capacity of the generators. What would really occur in the case of induction motors, whether the rotors be of the short-circuited or wound type, is somewhat analogous to the above. At the instant of resumption of supply, if the motors are not switched off, a large overdraft of current takes place in the system. This will lower, for the time being, the power factor, and produce a lag in the current, and the effect of such upon the alternator coils might be unlooked for, and it might produce a tendency to unequally divide the work between the two alternators. It will also disarrange the whole system supplied by the two alternators, and produce objectionable effects in the working thereof. The motors in themselves might suffer very little damage. With synchronous motors a different set of conditions exist. As is well known, motors of such a type will not start without some auxiliary device is brought into action, and so in this particular case no start would be obtained from the motor, and it would have the winding of its armature placed across the mains, subject to the force of the full pressure, without any back pressure generated by motor reacting.

In the above discussion it has been assumed the effect of any of the above actions on the transformers used is negligible, since a static transformer is an automatically-regulated machine, self-regulating the current traversing its coils according to the demand for energy. If rotary converters or motor-generators be in use at different points of the system, and are fed by the mentioned feeders, their case may be similar to either of the above cases dealing with motors, according to the type used. Reviewing the above, it will be seen that safety lies in the knowledge of the reliability of the attendants, and also to the extent of the experience of the attendants.—G. W. B.

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Question No. 612.—Are shunt motors of the same brake horse-power ever wound to give different starting torques? If so, what is the practical maximum torque per brake horse-power in pounds-feet that can be obtained?

Best Answer to No. 612 (*awarded* 10*s.*).—The starting torque per brake horse-power of a shunt motor is inversely proportional to the speed for which the machine is designed. The starting torque may be taken as equal to the normal running torque (assuming no increase of current at starting), and since the power developed by a motor is simply proportional to the product of its torque by its speed, the starting torque per brake horse-power is inversely proportional to the speed. By increasing the dimensions of the motor, and so reducing its speed for a given brake horse-power, the torque per brake horse-power can be increased indefinitely. Thus, a 1,000-revolution motor will develop $\frac{33{,}000}{2 \times \pi \times 1{,}000} = 5\,24$ pound-feet (or pounds pull exerted at a diameter of 2ft.) per brake horse-power, whilst a motor running at 100 revolutions will develop 10 times as much torque.

Looking at the matter in another way, the torque of a motor may be considered as proportional to the product of flux × conductors on armature × current in armature, and as a motor designed for a given voltage carries a fixed current per brake horse-power in its armature (neglecting small differences in efficiency), the torque per brake horse-power depends simply on the product of flux × conductors. As the value of this product is inversely proportional to the speed of the motor, it is clear that the torque per brake horse-power is inversely proportional to the speed for which the machine is designed. Of course, by allowing the current at starting to increase, the total starting torque can be increased considerably, and, in a way, this may be considered as increasing the starting torque per "brake horse-power of rated load." An increase of at least 100 per cent. can usually be obtained in this way before the armature reaction becomes great enough to overpower the shunt excitation.—Q.

Answer to No. 612 (*awarded* 5*s.*).—Shunt motors vary considerably in the torque, or turning moment of their armatures. A cheaply-made machine running at a high speed will necessarily have a smaller torque than a heavily-built one, of equal horse-power, running at a lower speed. The torque, or turning moment, should be carefully distinguished from the pull given by the conductors on the armature.

$$\text{Torque} = \frac{C \times N \times W}{(8\,5 \times 10^8)};$$

where C = current in amperes through armature;
N = total number of lines through field;
W = total number of conductors on periphery (or in slots) of core;
$(8{\cdot}5 \times 10^8)$ = a constant to give the torque in pounds-feet.

The torque is the whole effort of the conductors on the armature multiplied by the radius of the armature; if answer is required in pounds-feet, radius must also be taken in feet. There are then, by the equation, three methods by which the torque at starting may be increased. By allowing more current to flow; this is usually limited by the starting arrangements to the full-load current, so that alteration in the winding under these circumstances will not affect the question. By increasing the number of lines of force through the armature; this may be done to a certain extent by saturating the magnets above the most economical limit, or by increasing the size of the machine. The third method of increasing the number of conductors on the armature generally means a larger and more expensive motor. For shunt motors of from 5 h.p. to 15 h.p. a starting torque with full-load current of from four to six pounds-feet per horse-power is a fair average. Where shunt motors are in use it is very often the practice to put in heavy fuses, and thus get a large current when starting. A much better way, though not generally done, is to have a cumulative series winding that may be cut out when the motor has attained its full speed. With this arrangement we get the advantage of the greater torque of the series motor at starting and afterwards the regulating properties of the shunt machine.—M. M.

Answer to No. 612 (*awarded* 5*s.*).—Shunt-wound motors of the same brake horse-power only give different starting torques when they are wound for various speeds. Let $C_a \times E_a$ (total useful watts) represent the useful available power at the pulley of motor—*i.e.*, C × E = watts—supplied to motor minus losses in armature and shunt circuit due to eddy currents, hysteresis, and friction. Then $C_a \times E_a$ is the brake horse-power or useful power at the pulley.

Let T = torque or force in pounds-feet.

$$\therefore \frac{C_a \times E_a \times 33{,}000}{N \times 2\,\pi \times 746} = T,$$

where 33,000 = unit of power, and $N \times 2\,\pi$ = circular velocity, and 746 = the electrical horse-power.

Example.—$C_a = 10$, $E_a = 500$, $N = 500$.

Then $$T = \frac{10 \times 500 \times 33{,}000}{500 \times 2\,\pi \times 746} = 70{\cdot}4 \text{ pounds-feet.}$$

Then $$\text{B.H.P.} = \frac{T \times 2\,\pi \times N}{33{,}000}.$$

Had the speed been 1,000 revolutions at the same brake horse-power, the turning power would have been less by half, or the one at 500 revolutions would have twice the turning power than the one at 1,000 revolutions. The slow-speed motors, having a higher starting torque, must necessarily be much larger in construction, and involves increased electrical losses which reduces the efficiency. The increase in size also increases the cost of manufacture. It will therefore be seen that there is no fixed constant for the practical maximum torque per brake horse-power for motors of the same brake horse-power, since the torque various with the speed.—J. W. W.

OLDHAM ELECTRICITY UNDERTAKING.

The report of Mr. Arthur Andrew, the superintendent, on the work of the above undertaking for the year ended March 25 last shows the following results:

The expenditure on capital account during the year has amounted to £108,573. 6s. 10d.

The gross revenue for the year amounts to	£26,278	15	2
And the gross expenditure to.....	13,666	13	8
The balance carried to net revenue account being	12,612	1	6
The interest on loans amounts to £4,295. 12s. 2d., and sinking fund instalments to £2 987. 17s. 2d.....	7,283	9	4
The net profit for the year being	5,328	12	2
The credit balance brought forward from the previous year was.....	832	7	2
Leaving a credit balance to carry forward to next year's account of	6,160	19	4

The receipts for energy supplied for ordinary purposes are £538. 1s. more than in the previous year. The amount received for current supplied for tramway traction is £14,741. 7s. 3d., against £2,641. 10s. 9d. in the previous year. The amount received for rental of meters and indicators also shows an increase of £25. 15s 6d. The amount of interest accrued to the reserve fund during the year is £190. 7s. 3d. The total amount standing to the credit of this fund on March 25 was £4,968. 10s. 3d. The amount of energy generated has been 3,189,849 units, of which 2,869,312 units have been sold, being increases over the previous year of 1,947,279 units and 1,827,257 units respectively. The number of lights supplied on March 25 last, equivalent to 8 c.p., was 54,154, being an increase during the year of 8,765. The number of consumers added has been 80, and additional meters fixed, 80, the number of consumers on March 25 being 638, and the total number of meters fixed 692. The number of demand indicators fixed on consumers' premises on March 25 was 389. The maximum demand (exclusive of traction) was on Dec. 19, 1902, the load at the station being indicated at 768 kw., as compared with 765 kw. in the previous year, showing an increase of 3 kw. The greatest quantity supplied in 24 hours for lighting was on Jan. 10, 1903—viz., 5,817 units, against 5,207 units last year, an increase of 610 units. The greatest quantity supplied in 24 hours for traction was on March 14—viz., 10,341 units, as compared with 1,840 units last year, an increase of 8,501 units. The supply mains have been extended a distance of 2,286 yards during the year. The total length of mains laid on March 25 last was 22,154 yards. An alteration in the price charged to large and long-hour consumers was made from Dec. 24 last, by which the minimum charge was reduced from 2d. to 1½d. per unit. The price charged for traction purposes was reduced from 2d. to 1⅜d. per unit from June 25, 1902, and further reduced to 1½d. per unit from Dec. 24 last. The erection of the new station at Greenhill was so far completed as to permit of the plant being brought into use in August, 1902. The engines and dynamos installed in this station comprise two of 600 h.p. each and four of 1,200 h.p. each, and the steam power is provided by eight dry-back marine and three Climax boilers, having a total evaporative capacity of 167,000lb. of water per hour. The generating capacity of the Gas-street station remains the same as last year—viz., 2,480 h.p.

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TRADE NOTICES AND NOVELTIES.

Motors and Generators.

We have received from the Rhodes Electrical Manufacturing Company, 70 and 71, Bishopsgate-street Within, London, E.C., a copy of their latest catalogue of motors and generators. This firm claim to supply a high-class article at a reasonable price, and since they devote their attention exclusively to the manufacture of one type of machine, the claim should be justified. Some excellent designs of motors are illustrated in the catalogue, ranging in capacity from ½ b.h.p. to 40 b.h.p. for standard voltages of 115, 230, and 460, and generators ranging in output from 1 kw. to 24 kw. Prices and particulars, including a full specification of the construction, are given. With reference to the latter, some points are noteworthy. For example, the firm have a special and exclusive design of brush rocker, provided with an arm which extends over to the centre of the commutator, thereby enabling the use of a radial spindle for supporting the brush-holder, the latter being exceptionally rigid, whereby all vibration on the brush is eliminated. In general appearance and finish these machines leave nothing to be desired.

Switchgear.

From Messrs. Bray, Markham, and Reiss, Limited, Blackhorse-lane, Walthamstow, N.E., we have recently received a copy of their new price-list. The firm make a speciality of electrical switchgear, and the list in question contains illustrations and descriptions of some very serviceable-looking B.M.R. double-pole switches and ratchet type motor starters.

New Hack Saw.

Messrs. Beanland, Perkin, and Co., School Close Works, Leeds, have just introduced a new type of double hack saw. This saw is constructed on novel lines, having two saws working alternate strokes, and reducing by one-half the time required for cutting through girders, etc. The price of the machine, including six blades, is £15.

G.E.C. Manufactures.

"Witton" continuous-current dynamos are dealt with in list (No. P, 1,039) just issued by the General Electric Company, Limited, 71, Queen Victoria-street, London, E.C. This is a "sister" list to the "Witton" continuous-current motor catalogue published some little time back. It includes a very clear concise specification of the firm's dynamos, of which they make two types—viz., the open protected pattern for small outputs and the open multipolar pattern for large outputs. These machines have been standardised in a large variety of sizes for 110, 220, and 440 volts, and also for 140 volts in connection with accumulator charging. The tables of which this list largely consists are a model of lucidity. Considerable trouble has been taken to set out in detail weights, shipping dimensions, and linear dimensions of the various sizes. A table of spare parts and accessories is included. Another list (No. E. 1,042) issued by the same firm contains some useful information with regard to the arc lamp carbons manufactured at Witton. These carbons are claimed to be equal, if not superior, to the best Continental makes. It appears from the list that three qualities are supplied—viz., a "standard" quality, a "special" quality, and a third quality specially recommended for enclosed arc lamps.

From the General Electric Company, Limited, we have also a copy of their new pamphlet dealing with the Aron electricity meter. This meter has been passed by the Board of Trade for use on both continuous and alternating current circuits, and one of the principal advantages claimed is that it is a true watt-hour meter, and records direct in Board of Trade units. Lastly, a copy of their leaflet No. M. 1,041, which gives particulars of Milner's patent speed indicator. This indicator is so made as to be capable of running accurately in either direction without any additional adjustment. Extreme simplicity is the principal feature of its design.

Fuller-Macleod Specialities.

We have received from Messrs. Fuller, Macleod, and Co., Limited, 9, Red Lion-court, Cannon-street, London, E.C., a budget of their new lists. The principal of these deals with telephones, telephone switchboards, and accessories. A noteworthy feature in connection with this list is the general excellence of the illustrations. Each piece of apparatus shown has a reference number, the corresponding number being set opposite a concise description and the price of the apparatus in the index. Another of the lists includes particulars and prices of "Lux" incandescent lamps. List S is devoted to plain, fancy, and cut-glass shades for incandescent lamps; while a line in ceiling roses, small motors for direct and alternating current, and continuous-current electric motors for power transmission are dealt with respectively in the remaining lists. Three types of machine are included in the last-mentioned—viz., semi-enclosed, enclosed ventilated, and enclosed. A full specification of their construction is given, also tabulated data for the different machines.

LEGAL INTELLIGENCE.

MARCONI'S WIRELESS TELEGRAPH.

On Wednesday in the Vacation Court Mr. Justice Bucknill heard a motion *in re* Marconi's Wireless Telegraph Company, Limited.

Mr. Gover, for the company, said this was an application for an order of the Court granting leave to rectify an omission to comply with Section 7 of the Companies Act of 1900. It was a case in which, through inadvertence, there had been a failure to file a memorandum of agreement to transfer shares in the Marconi Company. In order that the requirements of the Acts of 1867 and 1900 might be complied with, it was necessary that notice of the agreement should be given within a month to the registrar so that it might be filed. In March last the company agreed to transfer to a Mr. Saunders a certain number of fully-paid shares in the Marconi Company in return for shares which Mr. Saunders was to transfer in the Marconi International Marine Communication Company, Limited. The agreement was verbal, the transfers were duly executed, and the shares allotted. The difficulty had arisen owing to the requirements of the Act having been overlooked through inadvertence both by the secretary of the Company and by Mr. Saunders.

His Lordship made the order asked.

ANGLO-AMERICAN ALUMINIUM COMPANY.

In the Vacation Court on Wednesday before Mr. Justice Bucknill, **Mr. G. Campbell,** for the company, moved that an order made by Mr. Justice Walton last week in the case of Hamilton *v.* the Anglo-American Aluminium Company, Limited, appointing a Mr. Nelson receiver on the part of debenture holders, should be rescinded, and that, instead of Mr. Nelson, Mr. Newitt should be appointed.

His Lordship asked to have further affidavits delivered to him during the week, and said that he would give judgment on Wednesday next.

COMPANIES' MEETINGS AND REPORTS.

SIR HIRAM MAXIM ELECTRICAL AND ENGINEERING.

The annual meeting of the shareholders in this Company was held at 44, Gillingham-street, Pimlico, on Monday, under the presidency of Mr. Jules De Merry.

The **Chairman,** in moving the adoption of the report, said that since he presided over their meeting about a year ago the Company had passed through many hard struggles, and had encountered, but he was glad to say had surmounted, many great difficulties. All differences, however, were now at an end, and the days of litigation with the lamp company were over. As to the volume of the business done, in 1900 they had only £14,636 to report, and in 1901 the figures were £35,097. From the date of the last balance-sheet up to that day the contracting department alone showed that they had taken over £105,000 worth of contracts. The field of operations was practically unlimited. They began about three years ago by taking from contractors small orders in connection with the latter's contracts. This was followed by making a speciality of all steam accessories for electrical power stations, the Company taking big contracts themselves in this special line of business. They had made arrangements which enabled them to contract for the whole of the erection and complete equipment of electrical power stations. Lately they had extended the scope of their civil engineering and contracting department. They had been entrusted by the Chiswick Council with their new sewerage scheme, and by the Corporation of Chatham with the extension of their pier and landing stage. At Manchester their men were divided into three shifts, each working eight hours a day. The Company's part of the contract was finished at the time, and the chairman of the Lighting Committee thanked them for their work, while Prof. Kennedy acknowledged their energy by recommending the Company for many other contracts which had since been given to them. They had a similar experience at Grove-road power station in London. Lately they were entrusted by the Westinghouse Company with part of their contract for the Naval Cadet College in the Isle of Wight, and the work was finished exactly at the time required. They were also on the point of starting a boiler department. They had become contractors to the Admiralty, the War Office, the India Office, and the Crown Agents to the Colonies, and an important share of the supply to these various services could be relied upon. In addition to their incandescent lamp, they had successfully turned their attention to a new arc lamp. Sir Hiram Maxim was devoted to their interests, and he was now spending large sums to perfect a certain invention from which the Company would probably derive the greatest benefit. All things considered, he thought that their prospects were exceedingly bright. He sympathised with the shareholders in the fact that there was no dividend, but the Company had had to lay the foundation of and to create a growing concern.

Sir Hiram Maxim seconded the motion, and said: Now that my health has improved, I hope to remain in England 10 months in the year. In regard to the new work which you have in hand, you can look at my past. On several occasions I have thought out very important inventions that had a lot of money in them, and various parties at different times, in America and in England, have made large sums of money from these. I have thought out another invention—something that perhaps has more direct money in it than anything else I have ever done, not excepting the automatic gun. I found, on speaking to my friends about this invention, that if I

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wanted any money to exploit it any amount would be given me; but I am not accepting a single penny. I am putting in every penny myself to prove the invention, and when it is proved I propose to make arrangements—I have already made a proposition to the Company. I am bringing out this invention very largely to put this Company on a paying basis. and, as a proof of my belief in this invention, I am putting thousands of pounds of my own money in it, and one of the considerations of the agreement is that I have a right within a few years after this invention is brought out of buying a large block of the Company's shares at par. That is the consideration I get. I think that in this way I shall get a very fair return, because the invention I am working on at the present time will bring in a very considerable amount of money. The nature of the invention is such that I cannot speak of it at the present moment. I am advised to say nothing about it until the patents are secured everywhere, because when it is once known, there will be hundreds of others who will try to get round your patents. I advise you all, no matter how much you have been discouraged in the past, to stick to the shares, or if you wish to sell them, perhaps I shall be able to buy all you have got within a few months.

The motion was adopted, and a resolution was also passed for increasing the capital to £190,000 by the creation of 15,000 ordinary hares of £1 each.

CHLORIDE ELECTRICAL STORAGE.

The report of the directors for the year ending June 30, 1903, states that the balance-sheet shows a trading profit for the financial year of £20,756. 12s. 10d. After deducting directors' and auditors' fees (to June, 1902), debenture interest, depreciation, provision for bad debts, and interim dividend on preference shares, the available balance for the year is £6,030. 4s. 4d., to which must be added £5 802. 4s 8d. brought forward from last year, making a disposable balance of £11,832. 9s. The directors propose the payment of a dividend of 6 per cent. on the preference shares for the financial year, less interim dividend already paid, and a dividend of 8 per cent. on the ordinary shares, free of income tax, together amounting to £4,520, and to carry forward the balance, £7.312. 9s. During the year under review the Electric Storage Battery Company of Philadelphia, U.S.A., with which the Company has always maintained close relations, acquired, by purchase of shares, a very large interest in the Company. The directors accordingly elected Mr. Herbert Lloyd (president of the Electric Storage Battery Company), Mr. John R. Williams, Mr. Robert E. Lloyd, and Mr. J. De Berniere Smith as directors to fill the vacant places on the Board, in order that this interest might be adequately represented. Under the circumstances it is advisable that its reconstitution be reviewed and determined by the shareholders.

CONTRACTS FOR ELECTRICAL SUPPLIES.

Macao.—The Colonial Office at Lisbon invite tenders for the electric lighting of Macao. Tenders by Oct. 21.

Lisbon.—The Public Works Department require tenders for the public electric lighting of Macao. Tenders by Oct. 21.

Paris.—The Posts and Telegraph Department, 103 Rue de Grenelle, require tenders for two lots of electric wire. Tenders by Oct. 1.

Bucharest.—The Government Railways require tenders for the installation of electric lighting and plant for their workshops. Tenders by Oct. 10.

Pietermaritzburg.—Tenders are invited by the Natal Government Railways Electrical Department for additional plant for the power station at Pietermaritzburg.

Transvaal Colony.—The Chairman of the Tender Board, Pretoria, requires tenders for installing and working the electric lighting of Potchefstrom for about five years. Tenders by Oct. 30.

Dublin.—The Port and Docks Board invite tenders for the supply of a 100-ton electric crane. Specification can be obtained at the office of the engineer to the Board, Mr. John P. Griffith, M.I.C.E., Eastwall, Dublin. Tenders by Oct. 5.

Blackpool.—The Corporation invite tenders for the supply of arc lamp carbons for the ensuing year. Specification, etc., may be obtained on application to Mr. Charles Furness, borough electrical and tramway engineer, Electricity Works, Blackpool.

Shanghai.—The French Colony propose to instal motor-propelled tramways. Tenders may be sent by Oct. 31, 1903, to Secrétariat de la Municipalité Française de Shanghai. Particulars may be obtained from l'Office National du Commerce Extérieur, Rue Feydeau, 3, Paris.

East Barnet.—The Urban District Council will receive proposals for carrying out the provisions of their electric lighting order within the Council's district. Further particulars upon application to Mr. Henry York, the Council's surveyor, Council Offices, Station-road, New Barnet.

Rochdale.—The Guardians invite tenders for certain new underground cables and switchboard alterations and additions required at the workhouse, Dearnley. Specifications, etc., may be obtained from Messrs. Shepherd and Watney, Greek-street-chambers, Leeds. Tenders by 26th inst.

Russia.—The Russian Minister of the Interior has sanctioned a plan for the reconstruction of three lines of municipal tramways—namely, those in Newsky, Sadovaïa, and Wassiliostrow districts. Each car is to provide for two classes of travellers, and will accommodate 52 persons.

Utrecht.—The Town Council will receive tenders for supply and erection of a central electric establishment for lighting, power supply, and working tramways. Contract, conditions, etc., to be obtained at the "Gemeente Secretaire" of Utrecht, on payment of 5fl. (8s. 4d.). Tenders by Oct. 1.

Swindon.—The Corporation invite tenders for erection at Swindon, Wilts, of car depot stores, repair shops, etc. Specifications, etc., may be seen at the office of Messrs. Lacey and Sillar, 2, Queen Anne's-gate, Westminster. Tenders to Mr. Robert Hilton, town clerk, Town Hall, Swindon, by 23rd inst.

Brighton.—The Town Council invite tenders for the (1) supply of steel girder tramrails, fishplates, etc.; (2) tramcars; (3) points and crossings and other fittings. Specifications, etc., may be obtained from Mr. Francis J. Tillstone, town clerk, Town Hall, Brighton Tenders by 10.30 a.m. on Oct. 5.

London, W.—The Commissioners of H.M. Works and Public Buildings invite tenders for alterations and additions to Ealing telephone exchange. Drawings, etc., may be seen on application to Mr. J. Wager. Tenders to the Secretary, H.M. Office of Works, etc., Storey's-gate, London, S.W., before 12 noon on 29th inst.

Johannesburg.—The Municipality require tenders for gas generating plant or for steam generating plant and for gas motors or steam motors, with electric generators and accessories. Particulars may be obtained from the Town Clerk, Johannesburg, or from Messrs. Mordey and Dawbarn, 82, Victoria-street. Tenders by Oct. 19.

Launceston (Tasmania).—The Mayor and Aldermen invite tenders for the supply of 500 or more electric meters. Particulars may be obtained on application to Mr. William Corin, city electrical engineer, Launceston, Tasmania, or to Messrs. John Terry and Co., 7, Great Winchester-street, London, E.C. Tenders by Sept. 28.

Bootle.—The Corporation invite tenders for the extension of the boiler-house at the electric light station, Pine-grove. Plans, etc., may be seen at the office of Mr. B. J. Wolfenden, A.M.I.C.E., borough engineer, on and after the 18th inst. Tenders to the Chairman of the Electric Power and Lighting Committee by the 30th inst.

Cienfuegos (Cuba).—The Municipal Authorities require tenders for the installation and working of electric lighting. They will pay an annual subsidy of 24,000 piastres for 150 arc lamps of 1,500 c.p. each and 350 incandescent lamps of 50 to 100 c.p. each for street lighting, and 16 to 25 lamps in public buildings. Tenders by 1 p.m. on Sept. 28.

Dundee.—The Town Council invite tenders for the relaying of distribution mains in the central area of the town. Specification, etc., may be had on application to Mr. H. Richardson, A.M.I.E.E., city electrical and tramways engineer, Dudhope-crescent-road, Dundee. Tenders to Mr. W. H. Blyth Martin, clerk to the Council, City Chambers, Dundee, not later than Sept. 30.

London, S.E.—The London County Council invite tenders for the supply, delivery, and erection in the electricity generating station to be established by the Council at Greenwich of four 5,000-h.p. vertical-horizontal steam-engines, each suitable for driving a three-phase generator. Particulars, etc., may be obtained at the County Hall, Spring-gardens, S.W. Tenders by 10 a.m. on Oct. 6.

Birkenhead.—The Corporation invite tenders for cleaning and painting the poles and bracket arms in connection with the Corporation electric tramways. Specification, etc., may be obtained at the office of Mr. William Bates, A.M.I.C.E., borough electrical engineer, Craven-street Works, Birkenhead. Tenders to Mr. Alfred Gill, town clerk, Town Hall, Birkenhead, by 5 p.m. on 22nd inst.

Bradford.—The Corporation invite tenders for the construction of about 13 miles of light railways and tramways in connection with the Angram storage reservoir works. Plans may be seen and specifications, etc., obtained at the office of Mr. James Watson, M.I.C.E., waterworks engineer, Town Hall, Bradford. Tenders to Mr. Frederick Stevens, town clerk, Town Hall, Bradford, by 10 a.m. on Oct. 1.

Oldham.—The Electricity Committee invite tenders for arc and incandescent lighting and power circuits in Greenhill station, comprised in specification No. 9. Copies of the specification, etc., can be obtained from the Resident Engineer. Specifications can be seen at the offices of Messrs. Kennedy and Jenkin, 17, Victoria-street, Westminster, S.W. Tenders to be sent to the resident engineer, Mr. S. Wilmott Newington, by Oct. 6.

Bermondsey.—The Borough Council invite tenders for (Contract No. 12) the construction, supply, and erection of two dust-destructor cells, with furnaces, flues, etc., and storage bins, one water-tube boiler and brickwork settings, one water storage tank, with supports for same, and extensions to the steam, feed, and exhaust piping system; (13) the construction, supply, and erection of two 300-kw. steam generators, two 20-kw. feeder boosters, one 15-kw. motor-balancer, and sundry switchgear and connecting cables. Specifications can be obtained from Mr. Fredk. Ryall, town clerk, and may also be inspected (but not obtained) at the offices of the engineers, Messrs. Kincaid, Waller, Manville, and Dawson, 29, Great George-street, Westminster. Tenders by Sept. 21. See advertisement.

London, E.C.—Tenders will be received until noon on Sept. 28 (a for the supply of Swedish, Norwegian, or Finland red fir telegraph poles, to be delivered in London, at Northumberland Dock (River Tyne), West Hartlepool, Hull, or Grimsby, at Leven, Fifeshire, and at Swansea, Cardiff, or Newport; and (b) for creosoting the poles with 10lb. or 12lb. of creosote to the cubic foot, as may be directed. The poles to be felled during the winter of 1903-4, and to be delivered during the following summer at the port at which the creosoting is to be performed. Butt sections, 2in. thick, stamped with the shipper's mark, from not less than three poles, to show the quality of timber offered, must precede or accompany the tender of any person who has not already supplied the Postmaster-General with poles. Forms of tender may be obtained from Mr. S. C. Hoolley, controller of stores, Stores Department, 17-19, Bedford-street, London, W.C.

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RESULTS OF TENDERS.

Pietermaritzburg.—The tender of Callender's Cable Company for £3,141. 10s. 5d. has been accepted.

Grimsby.—The Corporation have accepted the tender of Messrs. Hewins and Goodband, for building a fan-house, etc., at the electricity works, Doughty-road, Grimsby, at £589.

Huddersfield.—The Town Council have accepted the tender of the Manns Patent Steam Cart and Wagon Company, Limited, for the supply, at the price of £540, of a steam motor wagon.

Newcastle.—The Corporation have accepted the tender of the Lorain Steel Company at £1,894 for crossings, etc., in connection with the tramway extension from Westgate-road to Scotswood-road.

Aston Manor.—The Town Council have accepted the tender of Mr. George Trentham, 38, John Bright-street, Birmingham (Contract No. 1), at £46,739. 13s. for Scheme No. 1, and £47,920 for Scheme No. 2 of their tramways, for which Mr. Robert Green, A.M.I C.E., is the engineer.

Johannesburg.—With regard to the result of tenders noted in our last issue we cull from *South African Exports* the following details: "The recommendations agreed to were as follows: (a) That the tender of the Brush Electrical Engineering Company to supply steel grooved rails and fishplates in accordance with Sections A and B of tramway specification No. 1, at the price of £63,686. 0s. 6d., f.o.r. Johannesburg, be accepted. (b) That the tender of the Brush Electrical Engineering Company to supply steel Vignoles rails and fishplates, in accordance with Sections C and D of the tramway specification No. 1, at the price of £10,863. 4s. 6d. f.o r. Johannesburg, be accepted. (c) That the tender of the Hadfield Steel-foundry Company, Ltd., Sheffield, to supply points and crossings (with manganese steel tongues and crossings) and lay-out work, in accordance with Section E of tramway specification No. 1, at the price of £5,355. 8s. 7d. f.o.b. British port, be accepted, and that an additional sum of £885. 12s. 6d. be sanctioned for the cost of the delivery of the material included in this tender. (d) That the tender of the Brush Electrical Engineering Company to supply tie-bars, sole-joists, etc., in accordance with Section F of tramway specification No. 1, at the price of £5,708. 19s. 8d. f o r. Johannesburg, be accepted. (e) That the consulting engineers be authorised to order such extras as may be required from the successful tenderers up to an amount not exceeding £8,000. At the outset of the debate an amendment was moved that the main tender for grooved rails and plates should be given to British manufacturers. The Council was going to British financiers, it was pointed out, for the loan, and it was questionable whether they would be encouraged to lend when they knew that the money was to be spent in foreign countries. Reference was also made to the position in the East, and in case of war, it was asked, would British cruisers protect Flemish tramway rails? On the opposite side the facts of the case were pointed out, emphasis being laid on the fact that the shipping ring had offered a special rate of 18s. 6d. to Durban and 20s. to Delagoa, whereas the rate for foreign rails worked out at 10s. 6d. per ton. The amendment was defeated by the casting vote of the chairman."

BUSINESS NOTES.

TRACTION.

King's Norton.—The Urban District Council have accepted a tender of £16,892 for the construction of tramways.

Brighton.—The Corporation are experimenting with a motor fire-engine which is easily capable of a speed of 20 miles an hour.

Dublin.—A public meeting of the residents of Finglas has approved the scheme of the proposed electric tramway between Dublin and Slane.

Ilkeston.—The receipts for the first three months of the working of the tramways have amounted to £2,802; the working expenses were £1,846.

Halifax.—The Corporation have yielded to the temptation of the chance of making £1,000 a year by means of advertisements in the tramcars.

Bradford.—By one vote the Town Council have decided not to have advertisements on the tramway cars. The loss will be equal to a 1d. rate.

Chesterfield.—The Town Council have adopted a scheme for electrifying and extending the present tramway system at an estimated outlay of some £87,000.

Crewe.—The Mayor has been asked to call a town's meeting for the purpose of discussing the various light railway proposals that are or may be before the Town Council.

Warwick.—The British Electric Traction Company have submitted plans of the proposed routes for electric tramways. The Council will consider the proposals at an early meeting.

Burton.—Following on the *plébiscit* of the town, which resulted in favour of the Sunday running of the electric cars, the committee have decided on a service on Sundays from 2 to 9.30 p.m.

Hayes.—The Parish Council have been informed by the Board of Trade that they have granted the tramways company an extension to April 9 in which to complete their line to Uxbridge.

Driffield.—The Urban Council have decided to approach the North-Eastern Railway Company with a view to securing a service of motor 'buses between Driffield and the villages between that town and Beeford inclusive.

Wrexham.—The extension of the Wrexham tramway line from Johnstown to the bottom of Hill-street, Rhos, has just been completed, and it will be opened as soon as the Board of Trade authorities have inspected the line.

Dewsbury.—Formal application is to be made to the Board of Trade for power to construct tramways along Wakefield-road, so as to communicate with Soothill Nether, *via* Earlsheaton, and Ossett, and along Leeds-road and Crackenedge-lane, to serve Soothill Upper.

Wolverhampton.—On Friday the Tramways Committee decided to purchase the 11 miles of track from the Lorain Steel Company for £22,000, on condition that the company supply 5,000 new contact boxes. This decision has yet to be confirmed by the Council.

Northampton.—The Corporation have received the sanction of the Board of Trade to their borrowing the sum of £85,000 for tramway purposes as follows: £55,400, permanent way, buildings, and contingencies; £19,600, electric equipment and machinery; £10,000, cars.

Paisley.—The Glasgow tramway connection with this place will be opened in about a month's time. Probably the first part of the electric tramway system in Paisley will be completed by March next, and the whole system is expected to be in working order in June next year.

Flint.—It has been decided by the County Council to inform Messrs. Rowcliffe and Co., Manchester, solicitors to the promoters of a scheme for laying down a system of tramways over a circular route in the county, that the project would be favourably considered when submitted in the form of a Bill.

Devonport.—The new tramway extensions on the system leased by the Devonport and District Tramways Company, which were completed recently, have now been opened for traffic. Colonel von Donop, Board of Trade inspector, visited the new routes, and his sanction to their opening was obtained a fortnight ago.

Wigan.—At a meeting of the Corporation Tramways Committee on Tuesday the action of the manager in discharging a number of men was confirmed. A letter from the secretary of the tramway men's union asking for an interview with reference to the discharged men and other matters was considered. The committee unanimously refused to see him on any matter affecting the tramway management.

Leeds.—The inequalities of the existing fare system on the city tramways were discussed by the Traffic Sub-Committee at their last meeting. The sub-committtee agreed to recommend to the full committee that the first 1d. stage outward from the city should be universally fixed at two miles, and Mr. J. B. Hamilton (the general manager) was instructed to report on the practicability of the scheme.

Rotherham.—Two Corporation tramcars came into collision on a single line in Westgate, about 30 yards from the loop at the bottom of that thoroughfare. A dense fog prevailed at the time. None of the passengers were injured, but No. 17 car was badly damaged, the platform being broken. No. 16 car escaped with less damage to the platform and a broken plate-glass window. Both cars were put out of use.

Guildford.—A proposal by the West Surrey Light Railways Company to lay down a system of electric tramways in Guildford and the district is at present under consideration. The scheme includes the connection of Stoughton, Merrow, Stoke, and Shalford with the town. This would be a great boon to the inhabitants, as the villages at present possess very inadequate means of communication with Guildford.

Electric Signalling.—The North-Eastern Railway Company are reported to be experimenting at York with a system of electric signalling similar to that in operation on the London and North-Western Railway at Crewe. The work is now almost complete, and the system will be given a trial on Sunday, the 20th inst. It is being installed by the Railway Signalling Company, Limited, of Fazakerley, Liverpool.

London County Council.—The traffic returns of the London County Council tramways for the week ending Sept. 5 show that the receipts amounted to £10,731, against £8,144 in the corresponding week of 1902. The number of passengers carried was 2,716,294. The aggregate receipts this year to date are over £228,000, against £194,000 at the same period of last year, but the total mileage open is now 39¼ miles against 26⅝.

Bolton.—A sub-committee has been appointed to confer with Lord Bradford's agent with respect to land for additional car-sheds on Manchester-road. The engineer has been instructed to report as to the extension of the Chorley Old-road tramlines to Doffcocker Mill and Bobs Smithy, and as to the population of the district. A sub-committee has also been instructed to consider the question of the general management of the tramways and report.

Scarborough.—The tramways company have replied to the Corporation's request to name a price at which they would be prepared to sell the undertaking, the company stating that they are not desirous of selling at the present time, but that they would be prepared to consider any offer if the Corporation liked to mention the sum which they would be prepared to pay. The Corporation, however, have decided not to proceed further at the present time.

Dundee.—The promoter of the suburban tramway has entered upon the preliminaries necessary for laying his proposals before Parliament. The agreement between the promoter and the municipality has been signed by the parties concerned. The preparation of the plans will now be pushed forward with all dispatch so that they may be ready for lodging with the application for the provisional order, which must be submitted before the end of November.

Cowpen.—At the last meeting of the Council a letter was received from the Tyneside Tramways Company in reply to a communication of enquiry from the public authority pointing out that extensions of

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existing lines in the immediate neighbourhood were being proceeded with, and that probably the directors were wishful to complete these before taking in hand the Blyth scheme. It was further stated that the Blyth tramways scheme would be undertaken without any delay which could be avoided.

Ayr.—At the Town Council meeting on Monday the convener of the Tramways Committee read the report by the manager, Mr. Frederick Coutts, on the year's working. This showed that the distance run by the cars had been 336,049 miles; number of units of electric current used, 335,893; cost per car mile, 1·39d.; passengers carried, 3,201,586; working expenses per car mile, 5·04d.; total expenditure per car mile, 9·01d.; total drawings per car mile, 10·11d.; average fare per passenger, 1·03d. The total working expenses had been £12,621. 17s. 7d., leaving a profit of £1,538. 16s. 1d.

Taff Vale Railway.—The passenger train service between Llantrisant and Aberthaw on the Taff Vale and Cowbridge and Aberthaw Railways has been discontinued, and a motorcar capable of accommodating 50 passengers is now run between the places named. The directors resolved on the alteration in consequence of the small number of passengers who travel from Llantrisant down. Occasionally a train of eight or nine coaches is seen travelling quite empty. The motorcar stops at all stations, and also at all level crossings, where necessary, to put down or pick up passengers. The fare is 1d. per mile or fraction.

Musselburgh.—The Town Council at their monthly meeting received intimation from the promoters that the Royal assent had been given to the local electric tramway order on Aug. 11. The Council was reminded by the clerk that the promoters had undertaken to begin work on the tramways within five weeks of the Royal assent being given to the order, and also that the electric lighting installation would proceed concurrently. The specifications were now out of the hands of the Edinburgh electrical engineer advisers of the company, and were in London, where prices were being got in. Everything was being done to get a start made.

Chester.—The Tramways Committee have resolved that the city surveyor prepare a plan and submit it to the committee, and report whether any and what road widening will be necessary in connection with the proposed tramway extension to Boughton, and that the electrical engineer and tramways manager confer and report as to the best mode of working a service to Boughton. An alternative suggestion was made to run trolley 'buses on the same route as the horse 'buses are now run—viz., Boughton to Bache—and the electrical engineer was requested to obtain information with regard to the cost and working of trolley 'buses and report.

Additional Traffic Returns.—Anglo-Argentine, £1,928 increase; Barcelona Ensanche y Gracia, £214 increase; Barcelona, £4 decrease; Brisbane, £4 increase (month of August, £11,736, increase £294); British Columbia Electric (month of March), gross earnings £10,352, net income £2,658; Buenos Ayres and Belgrano Electric, £252 increase (month of August, £13,431, increase £533); Calcutta, £383 increase; Cape Town (month of August), receipts £15,349, expenditure £8,696; Isle of Thanet Electric, £307 decrease; Mexico Electric (month of August), receipts £48,600; expenses, £27,900; Perth Electric, £127 increase; Port Elizabeth (month of August), receipts £3,875, expenditure £2,305.

South London Tramways.—At Wednesday's meeting of the Camberwell Borough Council a letter from the Board of Trade was submitted stating that, after careful consideration of the points put forward by the Council, the Board had decided to approve of the plans for the construction, by the London County Council, on the underground conduit system of electrical traction, of the following tramways: (*a*) from Camberwell-green *via* Denmark-hill, Champion-park, Grove-lane, Dog Kennel-hill, Grove-vale, and Lordship-lane to near the junction of that thoroughfare with Crystal Palace-road; (*b*) at Denmark-hill, connecting the above line with the existing tramway in Coldharbour-lane.

Batley.—Four of the eight electric cars originally ordered by the Corporation have been delivered at the Frost Hill depôt, Liversedge. Every endeavour is being made by Mr. Jones, the electrical engineer to the Batley Corporation, to be ready so far as the supply of energy is required. The service, however, cannot be inaugurated before the middle of next week at the soonest. The cars are being equipped as expeditiously as possible, with a view to early trial trips on the Batley lines. Much disappointment has been felt among the public at the delay in the delivery of the cars, it being fully expected that Batley Feast would at least see a commencement of the running to Healey and Staincliffe.

Tramway Material for Railways.—The Aberdeen Harbour Board have decided to reconstruct the whole of the numerous railway junctions, etc., running round their docks, and, in doing so, are departing from the usual railway practice of having built-up switches and crossings, but are adopting tramway practice of constructing them in solid castings, adopting Hadfield's manganese steel. The lines take the very heavy traffic from the docks on to the N.B. Railway, who use the new 30-ton long wagons, and it speaks well for the reliability of this material that it has been found suitable for this purpose. The experiment will, no doubt, be watched with interest by other permanent-way engineers.

Lowestoft.—So far the new bogie cars recently put in service by the Tramways Committee have not worked very successfully. There was a discussion on the subject at the last meeting of the Town Council. The manager reported that the bogie cars would not run properly, and the town clerk was directed to inform the Westinghouse Company that the committee have fully considered the matter, and are advised that the cars are incomplete, and are not delivered in accordance with their contract; that damages are accruing under the terms of their contract for non-delivery, and to inform them that the Corporation will enforce the terms of the contract, and request their immediate attention to the matter.

Tramway Standards in the Streets.—At a meeting of the Manchester Trades Council held yesterday the General Railway Workers' Union presented the following resolution: "That having taken into consideration the regulations recently obtained by the Manchester Corporation, which give them strict authority over the centre of certain routes, we urge upon the Tramways Committee the necessity of immediately removing all electric standards to a safe distance inside the kerbstone. The carrying out of this suggestion will assist in securing the safety of the public and will also tend to prevent collisions between tramcars, drays, carts, and other vehicles, which are now of frequent occurrence."

Another "Tube" Breakdown.—Another breakdown on the Central London Railway occurred on Thursday night last week almost in the same place where a mishap took place on the previous Tuesday. The train was being shunted at the cross-over road at the Bank Station when one of the coaches fouled the points, striking the centre or current rail, causing a slight explosion. The current was cut off between the Bank and the British Museum Stations, and the emergency current was turned on to light up the tunnel and intermediate stations. Trains containing nearly 200 passengers stopped near the Bank Station, but they alighted, and without disorder walked along the track to the station and were conveyed to the surface. There was no panic.

Edinburgh and Leith.—A conference has taken place between representatives of Edinburgh Corporation and Leith Town Council with the view of discussing the question of the restoration of a through tramway service between the two towns. The alternatives of carrying the cable which now goes to Pilrig down to the foot of Leith-walk, and of carrying up the electric system which Leith proposes to adopt from Pilrig to St. Andrew-square, were discussed, and ultimately it was agreed that the Leith Committee should have a conference with the Edinburgh tramway lessees to see what they would agree to by way of having the two systems worked by them as one concern. The conference was purely informal, as the representatives had no powers to decide in any direction.

Torquay.—The Dolter Electric Traction Company are promoting a Bill to introduce their system of surface contact in this place. They are offering the Corporation special inducements, as, contrary to the usual practice, they have not mapped out their own routes, but have agreed to adopt those selected by the consulting engineer to the Corporation. They are also offering a very fair price for the electric current, the supply of which would greatly assist the town's electrical undertaking. The company propose to start with a small scheme, embracing the union of the two railway stations and a swift means of communication between St. Marychurch and Torquay. The Dolter Company intend shortly to give a practical exhibition of the working of their system on a temporary piece of line at Castle Circus.

Greenock.—The Corporation have approved the plan of a new car proposed to be used in Greenock, subject to the tramway company reducing the height of the step from 15in. to 11in. It was agreed to communicate with the company and request that the cars and points should be put into proper order, so as to lessen the excessive noise made by the cars. It was stated by the engineer that during the time of the America Cup races a supply of energy had been taken from the trolley wires for lighting a specially illuminated car, and a connection had also been made from the trolley wires in Gourock to illuminate the premises of the yacht club. It was agreed to notify the company that in future the Corporation's consent would have to be obtained and special terms arranged for any supply used for other than tramway purposes.

Competition.—The introduction of electric cars into Manchester has had the effect of reducing the number of licensed 'busmen from 146 to 47, and of cabmen from 762 to 576. Yet there are only 448 electric cars as against 520 of the old horse-cars. The lumbering omnibus has almost disappeared, except for pleasure party traffic. The most astonishing fact recorded in the Board of Trade's annual railway return just issued is that, while the number of third-class railway passengers only increased in 1902, as compared with 1901, by 11,706,000, tramway passengers increased by 196,226,000. Last year the former totalled 1,080,625,000, while the tramway travellers aggregated 1,394,453,000. The total capital of the railways of the kingdom now stands at £1,216,861,000, and their net earnings last year were £41,629,000.

Aston.—The District Council had a special meeting on Monday to consider the report of the Tramways Committee with regard to the electrification of the tramways in the district. The committee had considered two alternative schemes, and recommended that a double line of tramway be constructed along Aston-road from the city boundary, Aston-road North, and Lichfield-road, with a single line under the railway bridge at Aston Station, and a double line of tramway in Victoria-road from the Vine Inn to the Six Ways, the work to be executed by Mr. George Trentham, of Birmingham. The recommendation was agreed to negotiate for loans for the following purposes: purchase of tramways, £70,000; for work agreed upon that evening, £32,500; for overhead equipment, £10,000; and cost of the electric generating station, £62,000.

Newcastle.—At the last meeting of the Tramways Committee it was agreed to instruct Mr. Edge, the city engineer, to go on at once with the tramway extension from the corner of Clayton-street and Westgate-road to join the Scotswood-road section at the cattle market. The contract was let for the providing of crossings, etc., for this work to the Lorain Steel Company for £1,894 on the distinct understanding that they should be ready in six weeks. The question as to the extension of tramways *via* Dean-street to the Quayside was referred to the city engineer to report upon. It was agreed to convene a special meeting for Oct. 9 to take into consideration suggested negotiations with the Tyneside Tramway Company for the proposed interchange of traffic. It was decided to extend the present line of rails from the top of Shields-road to Chillingham-road.

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Berlin.—The Berlin correspondent of the *Standard* says that the Berlin Tramway Company has conceded a rise in wages to all its employés, which involves an additional outlay of 275,000 marks per annum. The intervals fixed for the automatic advance to higher scales of wages have been considerably shortened. Nevertheless, the pay can hardly be described as ample. The drivers and conductors are to receive £4. 15s. a month during the first year of their appointment, and the maximum pay of £6. 5s. in the sixteenth year of their service. It is true that the conductors earn a good deal of money besides their salary through the halfpenny "tips" generally given them, not only by the well-to-do, but also by common people. The drivers get no "tips," but every driver advances to the position of conductor after a certain term of service.

Paris Tube.—A Paris correspondent states that an accident to the motor of one of the trains on the Paris Tube Railway on Tuesday morning caused it to come to a standstill in the Châtelet Station. The passengers had to leave the train, but the service was resumed after a delay of 20 minutes. The opening of the Metropolitan Railway seriously affected the traffic receipts of the Paris Omnibus Company, and some of its services were even abandoned. The nervousness which the recent series of accidents has created among the public has, however, caused the company's receipts to increase considerably, and there are rumours that some of the old lines may be restored, and notably that of the Hôtel de Ville to the Porte Maillot, which was a favourite ride for tourists, since it took them along the Rue de Rivoli by the Tuileries, and then up the Champs Elysées and round the Arc de Triomphe before reaching the fortifications.

Handsworth.—The District Council are anxious to get their tramways questions settled without any delay. They are particularly anxious that the half mile now served by the British Electric Traction Company's steam trams shall be electrically equipped, so that there shall be a through service from the Black Country to the cable trams at Handsworth. The Council have decided to purchase the section from the British Electric Traction Company, and have offered £5,000 for the old lines and tram-sheds, but the company want another £2,000. If the Council's offer is not accepted, the matter will probably be submitted to arbitration, and another tantalising delay caused. Meanwhile plans are being prepared for the electrical equipment of the lines, and as soon as negotiations have been completed the work, which will entail an outlay of £15,000, will be commenced.

Automobile Club Reliability Trials.—The fifth annual reliability trials of motorcars organised by the Automobile Club were begun at the Crystal Palace on Wednesday, and will continue until the 26th inst. There is a record entry of no less than 130 cars, of which considerably over one-half are of British manufacture. A series of brake and dust-raising tests were conducted in the palace grounds on the opening day, and these continued yesterday. For the latter test quantities of flour have been spread out upon the race track, and, as the cars are driven over it, photographs of the cloud which is raised are made by the judges. To-morrow (Saturday) the long-distance runs of from 90 to 150 miles a day will commence, the first run being made to Margate and back. On the following seven days the motors will visit, in succession, Eastbourne, Worthing, Folkestone, Southsea, Bexhill, Winchester, and Brighton. In this way a total distance of over 1,000 miles will be covered by each car.

Tramway Inspection.—There is much that is valuable to be gained by an interchange of courtesies between municipal authorities who have the responsibility for the success of the local tramway undertaking in their own hands. The growing importance attached by outside municipalities to the electric tramway system of Liverpool is shown by the frequent applications made to the Corporation for permission to study the conditions under which it is conducted. On Sunday a body of 28 tramway officials from Leeds visited the city for the purpose of obtaining information as to how Liverpool manages its tramway affairs. They were courteously received by the general manager, Mr. C. B. Bellamy, who, with other officials, took them over various routes and through different generating stations, and fully explained to them the working and equipment of what is now acknowledged to be one of the most up-to-date and successful electric tramway enterprises in the kingdom.

Bury, Rochdale, and Oldham Tramway.—In the report of the directors of the Bury, Rochdale, and Oldham Tramway Company, Limited, for the half-year ended Jan. 31 last it is stated that notices to purchase under the Tramways Act, 1870, have been given by several of the local authorities for certain sections within their respective districts, and Sir Frederick Bramwell, Bart., has been appointed referee by the Board of Trade. An interim working agreement was desired by the local authorities, and a number of clauses, called "Heads of Agreement," were after discussion agreed upon and accepted in writing by both sides. The authorities have since expressed a determination not to be bound by the heads of agreement but the Board are advised that a binding contract had been entered into, and should be carried out, unless an arrangement is mutually come to for modifying or cancelling it. They have taken, and will continue to take, such steps as they deem best to protect the Company's interests, both as regards the working agreement and the arbitration.

Reading.—The following is from the *Berkshire Chronicle*, and we print it for what it is worth: "In consequence of so many axles breaking, it has been decided to use only the outside rail in coming down and going up London-street, so as to avoid the awkward curve of the inner rail at the top of the street. Scarcely a day has passed without at least one car breaking down through the axles giving way, and on some days two have done so. About 10 cars have been in the shed *hors de combat* every day of the week, and the strain is so great that both axles have been removed from some of the broken-down cars and the good one placed on another car. These unfortunate series of accidents emphasise the arguments of those who have urged that more cars are needed. But it must not be forgotten that there is little room for more cars in the shed unless it is enlarged. Another suggestion of the 'experts' is that bogie cars are more suitable for the tramways, as there are so many sharp curves, and that if we had them the breakdowns would not happen. Whether that is so or not is for the real experts to decide."

Ashton.—A motorman, formerly in the employ of the Corporation, was fined 7s. 6d. by the local bench last week under curious circumstances. The charge against him was one of "exposing valuable property to serious injury." It appeared that on Aug. 21 the defendant on taking his car to the depôt at Mossley-road left the controlling handles on, and also left the mechanism controlling the current in such a way that anyone passing and touching the handles would have resulted in the car starting, with no doubt serious injury to property or life. On receiving the report, Mr. Coveney, the tramways manager, directed Inspector Davies to see the defendant and tell him that for his gross neglect of duty he would be reduced for a time to the position of conductor. Davies boarded the car near the Albion Schools, and rode down towards the bowling green. When spoken to the defendant said he had a good mind to chuck up the job. Davies told him it was nonsense, and some little discussion took place, the end of which was that the defendant picked up his basket and walked off, saying Davies could take the car. By this time a number of passengers had got seated in the car. Fortunately Davies was able to take the car up to the depôt, and another motorman was obtained to take the service.

Erith.—The Tramways Committee reported to the last meeting of the District Council that the Tramways and Improvement Bill had become law. The committee had discussed with Mr. Hawtayne the question of proceeding with the construction of the proposed tramways, and had considered the resolution forwarded to the Council by the Erith and District Tradesmen's Association and the memorial signed by a number of ratepayers in support of such resolution. The committee recommended that the whole question of tramways be considered by the General Purposes Committee of the Council. The committee, however, expressed their opinion that if it was the intention of the Council to proceed with the construction of any part of the tramways forthwith, the following routes should be the first constructed—viz.: part of tramway No. 1, commencing in Bexley-road at the boundary of the parish of Crayford at Northumberland Heath by a junction with the Bexley tramway, along Bexley-road to Bexley-road Bridge; tramway No. 2, along Pier-road; part of tramway No. 3 from the corner of Pier-road in a southerly direction along High-street, Crayford-road and South-road to the boundary of the parish of Crayford; and tramway No. 8, along the new road through the Walnut Tree House estate. The report was adopted.

Salford.—The Tramways Committee have prepared their report on the working of the Corporation tramways for the year ended March 31. It shows that the receipts were altogether £141,486. There were covered 3,380,590 car miles, and the cars carried 28,150,675 passengers. The monthly receipts rose steadily from £9,390 in April, 1902, to £13,127 in March, 1903. Whitweek in 1902 gave the highest receipts for any one week—namely, £3,632. In the 11 months before the period mentioned the number of passengers carried was 10,352,675 (or rather more than a third of the year's figures), the receipts £88,639, and the miles run 2,107,868. The earnings per car mile show little alteration, being 10·25d. in 1902-3, against 10·09d. in 1900-1. The total expenditure for the year was £104,969, and this left a gross profit of £39,856. Out of this £26,865 has been applied to interest and sinking fund charges; £2,990 has been set off for reserve and renewals, leaving £10,000 to be contributed in aid of the rates. No special provision has been made for depreciation charges apart from the reserve and renewals fund. On March 31 the Corporation owned 100 cars. The total electrical energy used during the year was 3,370,434 units. On the same date there were 35 miles of track open in and 8½ miles outside the borough. The average fare was 1·2d.

Underground Electrification.—Last week we reproduced from the *Financial Times* an article contributed by a "Railway Expert" commenting upon the working of the Inner Circle by the two owning companies, and contending that an interchange of rolling-stock between the two companies would be quite impracticable because different systems of multiple-unit control have been adopted. That paper has since been informed that this is not the case, and that the Circle traffic will in no wise be affected by this condition. The collector-rail equipment and all the parts of trains and tunnels affecting an interchange of stock will be identical, and not only the electrical trains of both companies, but also their steam trains and those of outside companies will run over the tracks during the period of electrification. As an example of this, the District steam trains are equipped with the Westinghouse automatic air brake and at the present time the Metropolitan steam trains have the vacuum brake, but this does not prevent interchange of stock. In the future the air brake will be used for all electric trains. A further invention of Mr. George Westinghouse, intended for use on railways generally, but more especially for electric railways, consists of an automatic coupling, which in one piece of apparatus takes the place of all the numerous connections required between electric cars—viz., the draw-bar, the buffers, the brake hose, and the several electrical circuits. The simple bringing together of the carriages automatically completes all connections necessary for the running of the train. Thus the time occupied in making up and splitting trains will be greatly reduced, and the risk to the shunter in being compelled to crawl between and under carriages in close vicinity to electric circuits at pressure high enough to give a very severe shock is entirely abolished.

South African Railways.—Mr. Hoy, chief traffic manager on the Central South African Railways, writes as follows on the subject of steam *v.* electricity: "The success with which heavy locomotive engines are now being employed in these colonies, as well as in England, points to the maximum having been nearly, if not actually, reached. A 120-ton locomotive upon an 80lb. rail, on a 3ft. 6in.

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gauge, is what would generally be considered a favourable result. If the locomotive limit has been attained, there are evidences of developments in substituting a newer motive power upon lines where the nature of the traffic to be conveyed renders it possible to utilise electrical or other systems of energy. The employment of the heavy locomotive has its unquestioned economic merits, but it is an important consideration whether freight vehicles may not with advantage be equipped with their own motive power, either for individual or collective haulage The grade will always largely influence the value of the locomotive, but upon sections admirably adapted for the use of electricity, the adhesive power may with advantage be abandoned for the energy attached to the vehicle itself, and thus overcome the resistance common to the present system of haulage. Whether the power to be employed be electricity or a combination of other forces, there can no longer be any doubts that upon short and busy lines steam can be superseded. If any section of railway in South Africa lends itself for advancement in this direction, the Springs-Randfontein length offer an admirable opportunity for the expansion of such scientific energy. The working of so many mines sidings might assure the success of a change in working. There is a further guarantee of sufficient traffic within the section. I assume that electricity will supersede steam for passenger work along what is known as the Rand Tram Section within a measurable space of time. There are excellent opportunities for installing electricity, and of taking early steps not only to cultivate the suburban traffic, but to retain it."

Snowdon.—A local paper gives some interesting information about the scheme which the North Wales Power and Traction Company are promoting for an electric light railway or tramway system in the Snowdon district. The scene of the initial operations is Llyn Llydaw, one of the lakes on the slopes of Snowdon, where the River Glaslyn has its source. Here it is intended that the first generating station shall be situated. Important proposals have already been made by the company to a number of private firms and public authorities in the county, with a view to an extensive supply of electric power and light at low rates throughout the district. Among the more important schemes under consideration are the construction of a light railway from Portmadoc, through Beddgelert to Rhyddu, to join the present narrow-gauge railway, which will then be extended from Dinas to Carnarvon, the whole line to be worked by electricity. This will not only bring Portmadoc and the county town into direct connection but will open up an independent line of communication for North Carnarvonshire with the Cambrian Railway system. It is also proposed to electrify the Snowdon Mountain tramroad to the summit, and to supply electric power to the quarries in the Nanttle Vale, the Gwyrfai district, and Llanberis. A further intention is to make the Carnarvon Corporation an offer which, it is alleged, will be far more advantageous to the borough than those recently negotiated with another company, the new offer, it is said, being calculated to save the town from 40 to 50 per cent. of the now contemplated outlay, while enabling the residents to get a supply of electric light at a much lower rate than was proposed under the other scheme. All the towns of the Menai Straits, including Beaumaris, Bangor, Menai Bridge, Port Dinorwic, and Carnarvon, are embraced within the scope of the contemplated operations, it being argued that if these towns combined in one common scheme for generating electricity by water power, an enormous saving would be effected in each. The supply produced at Llyn Llydaw will, it is alleged, be not only ample for these purposes, but will leave a residue available for working tramways in the future from Carnarvon to Clynnog, Nevin, and Ebenezer, and from Talyfoel, on the Anglesey side of the Straits, to the surrounding villages in that county.

LIGHTING AND GENERAL.

Bo'ness.—The Town Council have acquired a site for a generating station.

West Bromwich.—The Town Council propose to expend £12,000 in electric lighting works.

Grimsby.—Sanction has been received to the borrowing of £7,000 for the electric lighting extension.

Swansea.—About £200 is to be spent in equipping the fever hospital with the electric light.

Swansea.—The Mayor is to be invited to formally declare the telephones open at a date to be fixed shortly.

Walton-le-Dale.—The Urban District Council have decided to apply for an electric lighting provisional order.

Cromer.—The Urban District Council have adopted the Union Electric Company's "Flame" lamp for arc lighting purposes.

Ince.—The Board of Trade will defer consideration of the question of revoking the Council's electric lighting order for 12 months from July 26, 1903.

Dorking.—Messrs. Edmundson's list of the roads in which they propose to lay mains is before the Electric Lighting Committee of the Urban District Council.

Southend.—An enquiry has been held into an application of the Town Council for sanction to borrow a further sum of £20,000 for electric lighting purposes.

Berwick.—The draft of the contract with the Urban Electric Supply Company for the lighting of the streets will come before the next Council meeting for completion.

Direct West India Cable Co.—A further dividend of 3 per cent., making 6 per cent. for the year ended June 30 last, is recommended by the directors in their annual report.

Carlisle.—The engineer reported to the Electricity Committee on Sept. 1 that since the last meeting he had received seven applications for new lights equal to 240 8-c.p. lamps.

Chippenham.—The Town Council have resolved to apply to the General Post Office for a complete telephone service night and day. At present they are cut off to the world after 9 o'clock.

Cowes.—The electric light is to be installed at once in Holy Trinity Church. Instead of driving the organ by gas power, electricity is to be the motive power for supplying the wind.

Removal.—The Berliner Telephone Manufacturing Company, 117, Queen Victoria-street, E.C., has removed to larger and more commodious premises at 200, Upper Thames-street, E.C.

Barry.—The District Council have authorised a deputation to consult with the South Wales Electrical Distribution Company to consider the question of supplying electricity in the district.

Kingswinford.—For the last two seasons the Council have been expecting the Midland Electric Corporation to be ready to supply electricity for public lighting, and they are apparently getting impatient.

Rhyl.—The Council are raising a loan of £1,300 from the Public Works Loan Commissioners for street improvements and in connection with the refuse-destructor works, and £10,098 in connection with the electric light works.

Whitehaven.—The Council have received sanction to borrow £2,500 on account of electric lighting. The original electric lighting loan was for 30 years; the last was for 10 years, and this one being for 25 years, will ease the burthen.

Vienna.—A Laffan's wire states that an incandescent electric lamp trust has been formed by the most important manufacturers of Central Europe. The trust is made for a period of 10 years. A central depôt for the sale of lamps will be opened.

Dorchester.—As a result of an interview with Mr. J. Enright, electrical engineer, the Electric Lighting Committee are of the opinion that without impairing the efficiency of the installation the cost could be considerably reduced on the first estimates.

Wrotham.—At the last Council meeting it was proposed that a small committee be formed for the purpose of helping the Kent Electric Power Company to get a provisional order for the purpose of supplying the district with electric light. No action was taken.

Islington.—The work of excavating for the extension of the electric arc lighting in the Canonbury district has been commenced, the first blow being struck in Petherton-road (Grosvenor-road end) by Mr. Councillor Samuel Lambert, chairman of the Lighting Committee.

New Branch.—The British Westinghouse Electric and Manufacturing Company, Limited, have established a new district office at Central House, New-street, Birmingham, under the management of Mr. G. K. Chambers, formerly contract manager of the British Insulated Wire Company.

Walton.—The Urban District Council are in communication with the Weybridge Electric Supply Company in reference to the lighting of Walton. An Electric Lighting Committee has been appointed to go into the whole question of the policy to be adopted in regard to the provisional order recently obtained.

Cambridge.—Messrs. Handcock and Dykes, of 1, Victoria-street, Westminster, have been retained to advise on the subject of electric lighting at the University Library, where, owing to the value of its contents, very great care has to be taken for the prevention of fire. The Cambridge Electric Supply Company are, we understand, to carry out this contract.

Stock Exchange.—Application has been made to the committee to allow the following securities to be quoted in the official list: Metropolitan District Railway Company's £2,116,666 3 per cent. consolidated rent-charge stock, in lieu (partly) of the 4½ per cent. Ealing rent-charge stock and the 4½ per cent. Fulham rent-charge stock now quoted.

Llandudno.—The statement of the revenue account of the electric lighting undertaking for the year ended March 31 last shows that after making provision for the repayment of loans and interest there was a deficiency on the year's account of £368. This deficiency was, however, provided for out of the balance of £427 which stood to the credit of the undertaking at the commencement of the financial year.

Cardiff.—Mr. Arthur Ellis, electrical engineer and manager, in his last report states that there are 868 private consumers connected with the mains, equivalent to 87,416 8-c.p. lamps, showing an increase of 58 per cent. in the total connections as compared with the same time in the previous year. The estimated revenue in July was: for street lighting £400; private supply, £1,295. 11s. 4d.; and in August: street lighting, £420. 3s. 8d.; private supply, £1,384. 3s.

Coventry.—The Corporation Electric Light Committee have agreed to recommend that from Oct. 1 consumers be allowed the option of paying for current for lighting either according to the present system or at a flat rate of 4½d. per unit, provided that the option is exercised for a period of not less than 12 months. The committee also recommend that from the same date energy for motive purposes be supplied at the present rate of 1¾d. per unit up to a consumption of 2,500 units per quarter, and of 1d. per unit for all consumption beyond that figure.

Carnarvon.—The Council have entered into a provisional agreement with the National Electric Wiring Company for an electric installation at Carnarvon, the Corporation providing capital to the extent of £17,000, and the company undertaking to construct the works and to maintain them for a period of years, repaying the Corporation annual instalments of principal and interest on the loan, together with all profits over and above a specified amount. Since the Corporation made this provisional agreement the North Wales Power and Traction Company, Limited, had made an offer. The enquiry by the Local Government Board has been fixed for Tuesday next.

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Devonport.—The Council have received sanction to loans of £9,650 and £19,272 for the purposes of the electrical undertaking, the former amount being in respect of works already carried out and the latter in respect of proposed new works. Agreements have been concluded for the supply of electricity to the Royal Naval Hospital, Royal Naval Barracks, and Sir John Jackson's works.

Lifts.—The Royal apartments used by H.M. the King last week at Doncaster racecourse have been furnished with an electric passenger lift by Messrs. Archibald Smith and Stevens. The machine is a duplicate of that erected for the King's personal use at Epsom by the same firm, and was during the King's visit under the care of Mr. Major on behalf of the makers and of the Doncaster Race Committee.

Huddersfield.—Negotiations are proceeding between the Golcar Urban District Council and the Electricity Committee of the Town Council for the extension of the electricity mains to that township. A deputation has decided to recommend the District Council to approve similar terms to those arranged between the Corporation and the Linthwaite Council subject to the mains being laid in the principal streets within two years from the commencement of the order.

Peat Coal.—As a consequence of a number of experiments with the treatment of peat by electricity, a demonstration of a new patent process is to be held shortly by Messrs. Johnson and Phillips, Charlton. We are informed that the extraction of moisture is carried out quickly, and can be continued all the year round at comparatively low cost. A demonstration of the process on a large scale has been arranged, and we defer further particulars until after that event.

Glasgow.—The Council have approved a report of Mr. Lewis, stating that 54 lamps would be required to light Victoria Bridge, Main-street and Cathcart-road up to Dixon-avenue with electricity, at an annual charge of £756, with an estimated cost of erection of £1,245, and a probable charge of £324 for electric fittings. The annual charge of the 128 gas lamps in that district was £252. 15s. 5d. The consideration of the matter is to be continued. The estimates, which were before the Corporation a few weeks ago, show a proposed additional expenditure of £3,000 for electric lighting.

Pemberton.—Cables for public lighting and private supply have been laid along a number of streets. The gas lamps have been taken down and pillars planted every 50 yards, as in the other parts of the district, and the whole will be lighted in the course of a few days. The number of applications for current has considerably increased over the previous month, also the services connected, and it has now become necessary to run both the small sets nightly. The Nernst lamps on trial have during the month given very good results, and it is proposed to substitute them for the ordinary lamps along Ormskirk-road.

Royce, Limited.—We are informed that this firm have now completed and started up new works at Trafford Park, Manchester, for the manufacture in quantities of dynamos and motors. The works cover a large area and include a fully-equipped ironfoundry. They are electrically driven throughout, have been expressly designed with a view to promoting rapid and economical production, and are equipped with a splendid selection of the latest automatic and other machine tools and labour-saving devices. The firm state that the resultant economy in the manufacture of their standard lines of machines has been such as to enable them to considerably reduce prices.

Hindley.—A letter from the South Lancashire Tramways Company as to lighting by electricity of the electric standards in Atherton-road and Liverpool-road came before the Council last week. The following queries will be discussed at an interview which is to take place shortly between the Council and the company's engineer: "Will the company fix on the 81 poles electric incandescent lamps, light them, and keep them in repair? Will they make the connection between the cable and the present poles to the lamps complete? Will they make good to the Council's satisfaction the road where they are compelled to cross? Will they light the lamps from one hour before sunset until half an hour before sunrise for the 365 days?"

Finchley.—The electrical engineer in his last report states that the boilers had been under steam, and the brickwork was thoroughly dried. The engines, dynamos, etc., were fixed and completed ready for the official trial, which would take place at an early date. Two sets had already been under steam. The battery had arrived on site, and was erected, and would shortly be ready for charging. Sufficient switchboard apparatus had been delivered to enable the supply to be commenced, but there had been delay owing to difficulty in procuring slate of satisfactory quality. In accordance with instructions, pipes were being laid to the proposed centre poles along the tramway track in the Great North-road. The electrical engineer has been authorised to purchase sleepers for the purpose of making-up a road for cartage over the soft ground round the works at a cost not exceeding £50.

Water Power.—A project has been worked out by Messrs. Charles Gochrich, C. de Lacroix, and E. Zuber to utilise the power of the Rhine between Niffer and Ottmarsheim, near Muelhausen, in Elsass. A canal is to be constructed from the former place to the latter, a distance of 8 km. to 9 km. The fall between the two points is now 8·40m., and is to be increased to 10m., by means of a movable weir constructed of six horizontal iron tubes, each of 3m. diameter and 26·70m. length, fixed into slots so as to be lifted in flood time. The minimum flow of water equals 300 cubic metres, and it is anticipated that 250 cubic metres could be used, and that they would produce 23,000 h.p. It is proposed to distribute this power over 16 sets, composed each of a turbine direct-coupled on its vertical axis to a three-phase dynamo. Half of the output will be conducted to Muelhausen, and the other half will be used for local power and lighting supply.

London Gazette.—The partnership heretofore subsisting between Frank Ashton Clayton and William Turner, carrying on business as electrolier and gasolier manufacturers, art metal workers, and general brassfinishers, at 2, Short-street and 25, City-road, Manchester, under the style or firm of Clayton and Turner, has been dissolved by mutual consent from June 13, 1903. The partnership heretofore subsisting between Henry Rossell and Hugh Rossell, carrying on business as electrical engineers and contractors, at 65, Alfreton-road, Nottingham, under the style or firm of H. Rossell and Sons, has been dissolved from Sept. 8, 1903, by mutual consent. A first meeting in the estate of Edwin Ward (trading as E. Ward and Co.), plumber and electrician, of 38, Osborne-road, lately residing and carrying on business at 108, Bevois-valley and 47, Lodge-road, Southampton, will be held at 3 p.m. on Sept. 21, 1903, at the Official Receiver's Office, 172, High-street, Southampton.

Steam-Turbine Plant for Lighting.—The increasing demand for light and power at the municipal lighting station at Anderson, Indiana, U.S.A., having rendered the present plant (comprising two belted generating units) entirely inadequate, two Westinghouse steam-turbine generating units, each of 400 kw. capacity, are being installed, together with a 20-kw. exciter direct-connected to a Westinghouse standard engine. By the employment of turbines extensions to the power-house itself have been rendered unnecessary, the capacity of the plant at the same time being largely increased. The additions consist of three 310-h.p. Stirling water-tube boilers, equipped with Roney mechanical stokers. They are being arranged to supply saturated steam to the turbines at 150lb. pressure, all condensation being returned to the boilers by a steam loop and Holly gravity system. Surface condensers will be used, and as the exhaust will be free from oil, the condensed water can be delivered direct to the boilers as return feed. Three-phase current will be furnished by the turbo-generators at 2,200 volts pressure, 120 periods.

King's Lynn.—The electrical engineer in his last report stated that since the previous meeting applications for a supply of electricity had been received from two additional consumers for 46 lamps of 8 c.p. or equivalent, making a total of 16,210 from private consumers. He further reported that all the four boilers had undergone their thorough annual inspection by the insurance company, and they report in each case that there are no defects affecting their safety. It was intimated that the wire in the regulation resistance had perished, and that it was being replaced with a wire of another kind. The electrical engineer also reported that the factory inspector required guards to be fixed over the flywheels of the two steam dynamos, and that he was having the work carried out. Messrs. Savage Bros. had written asking the price of one of the gas dynamos converted into a motor. He stated that the machine would give out when run as a motor about 45 h.p., and a new motor this size would cost about £200, and suggested that it should be offered for hire to Messrs. Savage at a rental of £16 per annum. The matter was left in the hands of a small committee. The engineer submitted the following statement: units generated, July, 1903, 18,149 (1902, 13.547); total units sold to private consumers (light and power), 8,638 (6,988); units sold at power rates, 4,919 (2.610); cost of fuel, stores, repaire, and wages at station, £100. 19s. 11d. (£107. 0s. 7d.); cost per unit generated, 1·33d. (1·89d.); wages of lamplighters and outside staff, £19. 15s. 3d. (£21. 6s. 4d.).

Swindon.—On the report of the electrical engineer as to the desirability of erecting a refuse destructor in connection with the electricity station, a sub-committee was appointed last week to report. It was resolved that the electrical engineer be authorised to fix a voltmeter in his private residence, at an estimated cost of 25s., for the purpose of indicating the supply pressure on the electric mains. The electrical engineer was also authorised, in the event of receiving applications for the supply of electricity to a greater distance than 20 yards from the electric mains, to extend the mains on the applicants giving an undertaking, to the satisfaction of the town clerk, to take a supply of electricity for the period of three years, which will give an annual return of 15 per cent. on the cost of the extensions. It was resolved that the scale of charges for recharging portable accumulators be as follows—namely: for recharging a four-volt accumulator, taking up to 20 ampere-hours, 9d.; for recharging a four-volt accumulator, taking between 20 and 40 ampere-hours, 1s.; for every 20 ampere-hours over and above 40 ampere-hours, 3d. The monthly report of the electrical engineer was read as follows: Number of consumers connected, May 30, 40; equivalent in 8-c.p. lamps connected, May 30, 2,727; number of consumers connected, Aug. 26, 75; equivalent in 8-c.p. lamps connected, Aug. 26, 4,280; horse-power of motors connected, Aug. 26, 33½; estimated units sent out (31 days), Aug. 26, 7,693; applications in hand, Aug. 26, 19 consumers, equal to 1,500 8-c.p. lamps.

Morley.—The last statement of accounts of the electricity undertaking shows some improvement upon that for the previous year, for although there has been an increase in the expenditure there has been more than a corresponding increase in the receipts. The expenditure showed the cost of generation of electricity to be £1,092. 11s. 10d., which included £476. 1s. 10d. for coal; £213. 11s 4d. for oil, waste, and engine-room stores; wages at the works, £314. 7s. 9d.; repairs and maintenance of buildings, £21. 17s.; machinery and plant, £66. 13s. 11d. The distribution of electricity cost £146. 19s. 4½d.; public lighting, £49. 1s. 5d.; rents, rates, and taxes, £99. 13s. 4d.; management expenses, £378. 16s. 4d., of which £292. 2s. 8d. was salaries of engineer and assistants; and special charges, £19. 12s. 10d.; the total expenditure amounting to £1,786. 15s. 1½d. The receipts included £1,364. 15s. 5d. by sale of current; £346 from public lighting; £53. 1s. 6d. from meter rentals; £22. 9s. 2d. miscellaneous receipts; and £154. 12s. for supplying steam for heating the baths; a total of £1,940. 18s. 1d., leaving a profit of £154. 1s. 11½d. In addition, however, there has been £1,021. 13s. 8d. paid for interest and £735. 3s. 8d. transferred to the sinking fund. The capital account shows an expenditure on the works and mains to date of £25,31

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8s. 9d., and there is in the sinking fund £3,483. 14s. 2d. Mr. Ellis in his report states that the output of electricity during the four weeks ending July 12 was 5,645 units, against 3,831 units the corresponding period of last year. There had been 195 lamps connected during the month, the number of lamps connected to date being 10,497.

Felixstowe.—Mr. Wilson, the consulting electrical engineer, reported at the last Council meeting on the respective merits of gas or steam plant for the extension of the electrical station. Mr. Wilson said his own view was that, so far as the Council's immediate requirements were concerned, it was not a matter of importance whether gas or steam were used; but if in the future the demand increased to such an extent that they had to put down engines of double size, it became imperative that steam should be used. Mr. Prentice was naturally anxious to reproduce the gas plant, and his reason was very obvious. He had used a gas plant satisfactorily for some time, and his men understood the working of it. But the way in which Mr. Prentice proposed to increase the plant was to his mind a method absolutely impossible from the point of view of the Council. Of course, they were liable to get into difficulties with regard to smoke and vibration if they used the present style of gas-engine. In view of this it was proposed to put in vertical reciprocating engines, but there was no engine on the market which in practice achieved the results guaranteed. It seemed to him, therefore, not right that the Council should go in for something which had not got beyond the experimental stage. Messrs. Fielding and Son, of Gloucester, however, were willing to give every opportunity for testing one of their engines, and if it was not satisfactory they would take it back and let it be used on the hire system for six months. From the Council's point of view that was not satisfactory, because for the purpose of the gas-engine it would be necessary to acquire a gas producer, which could not be returned in the event of the engine proving unsatisfactory, and the Council would be bound to continue the extensions in gas instead of steam. His conclusion was that the capital expended and working expenses would be less in using steam for the extension. If the Council were in agreement with him on this point, he would ask them to instruct him to prepare specifications and obtain tenders for a compound high-pressure 100-kw. (200-h.p.) engine, with all necessary boilers, additional buildings, etc. The shaft would burn smokeless coal and consume its own smoke. The Council decided that steam be the method adopted.

Ayr.—For the first time since the introduction of the electric light, some eight years ago, last year's account closes with a credit balance of £300, which has been placed to the credit of the police rate. With regard to motor charges, it has been agreed that a universal charge of 2d. per unit should be made, with a minimum charge of £2 per annum; supplies in large quantities to be a matter of agreement with each consumer. Consumers will be required to meet the wishes of the Corporation regarding the hours of use during the winter season. The Ailsa Shipbuilding Company, Limited, are to be supplied at the rate of 1¾d. per unit for all units consumed from a minimum of 25,000 up to 40,000 units per annum, and 1½d. per unit for all units consumed if the consumpt exceeds 40,000 units; an agreement is to be entered into for a supply for at least five years. In the event of an agreement with the company being arrived at, the present cable will be extended at a cost of about £350. The annual report of the burgh electrical engineer (Mr. Roland Marshall) states that the total number of consumers connected up to the end of the year was 681, as against a total of 530 last year, thus showing an exceedingly satisfactory increase of 151 for the year, and representing an increase in the number of lamps connected amounting to 4,080, as against 2,746 last year. During the year three motors, equal to a total of 11½ h.p., were connected, bringing the total number connected up to eight, having a total equivalent horse-power of 28·5, and 26 additional arc lamps and six incandescents, making a total of 121 arc and 155 incandescent public lamps. During the year there has been no hitch in the supply of power to the tramways, and they have been supplied with 335,842 units. The following figures were added: Number of units sold—private lighting, 1902-03 253,332, 1901-02 192.553; public lighting, 424,600 (350,560); power (included in private lighting), 14,462; traction, 335,842 (132,405)—total units sold, 1,014,774 (655,518); maximum load, 548 kw. (387 kw.); coal consumed, 7,300 tons (4,963 tons); price paid for same, 7s. (6s. 8d.). In connection with the total units sold, it is interesting to note that the station supplied some 200,000 units more than any other town in Great Britain having the same population. The following was the financial result: capital expended, 1902-03 £83,510, 1901-02 £78,999; revenue from private lighting, £4,864. 3s. 4d. (£2,765. 6s. 4d.); revenue from public lighting, £3,546. 13s. 4d. (£2,147. 10s.); revenue from traction (eight months' run), £1,950 6s. 6d. (£827. 10s. 7d.); revenue from other sources, £249. 7s. 9d. (£233. 9s. 3d.)—total, £10,610. 10s. 11d. (£6,973. 16s. 2d.); total expenditure, £5,884. 2s. 1d. (£4,483. 3s. 9d.); gross surplus, £4,726. 8s. 10d. (£2,490. 12s. 5d.); interest and sinking fund, £4,425. 13s. 9d. (£3,247. 4s. 3d.); £300. 15s. 1d. net profit (£756. 11s. 10d. deficit).

Erith.—With reference to the application of the Council for sanction to the borrowing of the sum of £20,000 for electric lighting purposes, stating that the Local Government Board have decided to comply with the application so far as it related to the borrowing of £19,733, the committee have also considered the report of Mr. Hawtayne, the consulting electrical engineer, upon the advisability of providing additional plant at the electricity works. Included in the further loan of £19,733 sanctioned is the sum of £5,000 for additional plant, made up as follows: one 10,000lb. evaporation boiler, including foundations and brickwork setting, £1,400; one 300-kw. steam alternator, including exciter and foundations, £3,000; pipework for above, £320; switchgear for steam alternator and cable connection, £280. The maximum load at the electricity works up to the present time has been 130 kw., and Messrs. Callender's requirements will bring this load up to about 200 kw. There are, further, some 2,000 8-c.p. lamps waiting to be connected, which will represent another 35 kw. on at one time, so that it is anticipated that the maximum load during this winter will at least reach 250 kw. The capacity of the plant at present installed, not allowing for any spare plant, amounts to 350 kw., or, in other words, if the above load is reached during the winter there will theoretically only be 100 kw. in reserve, but in practice to do the 250 kw. it will be necessary to run the two 150-kw. sets, and if one of these breaks down there will only be 200 kw. available to meet the above requirements. Mr. Hawtayne recommends, in view of the future possibilities of the electricity undertaking, taking into consideration the tramways as well as the lighting and power loads to be anticipated, that additional plant of 500 kw. capacity should be installed in place of the 300 kw. included in the above estimate, the estimated cost of the larger plant, including additional condenser, amounting to £8,230. As the question of the size of the additional plant to be installed is in a large degree dependent on whether the Council will proceed forthwith with their tramway undertaking, the committee recommends that this matter of additional plant be considered by the General Purposes Committee of the Council, when the question as to proceeding with the tramway has been decided. The committee has received a full report from Mr. Hawtayne upon the transformers, particularly as to the causes for the breakdowns which have from time to time taken place. Mr. Hawtayne states that after carefully considering the full history of the case, he does not feel justified in altering his original opinion that the type of transformer as installed at Erith is upon the whole the best obtainable. The supply of current to Messrs. Callender's works was commenced on the 17th ult. The committee recommends that an ornamental iron kiosk be erected for a transformer station on the site of the drinking fountain, and that the surveyor be instructed to submit plans and estimates for such building. The committee have also instructed the resident electrical engineer to proceed with the wiring and fitting of the Erith mortuary for electric lighting, the same to be connected for the present to the public lighting main.

PROVISIONAL PATENTS, 1903.

SEPT. 7.

19200. An automatic lifeguard to be applied to electric tramcars. Harry Lambelle, 5, Grosvenor-terrace, Middlesbrough. (Complete specification.)

19249. Electric controlling apparatus. Carl Ewald Schönfelder, 27, Chancery-lane, London.

19250. Improvements in telephone receiver holders. Arthur Joseph Briggs, Fife House, Kingston-on-Thames. (Date applied for under Patents Act, 1901, Sept. 6, 1902, being date of application in United States.) (Complete specification.)

19251. Improvements relating to electric telegraphy. Sidney George Brown, 45, Southampton-buildings, Chancery-lane, London.

SEPT. 8.

19291. Improvements in the electric extraction of sodium, potassium, and the alkaline metals. Edwin Thornley Parker, Lea-road, Wolverhampton.

19319. A cell recorder for use in electric light stations and other places. Arthur James Abraham, 37, West Nile-street, Glasgow.

19363. Improvements in or relating to electric insulated cables. Henry Robert Garrard, 6, Lord-street, Liverpool.

19366. Process relating to the reducing of metallic compounds and the fusing of metals, in particular of nickel and iron, in the electric furnace. Charles Denton Abel, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Siemens und Halske Aktien-Gesellschaft, Germany.)

19367. An improvement in the insulation of electric conductors. Edward Lawley Pinching and Walter Henry Walton, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

19368. An improvement in the electrode deposition of copper. Harry Parkes, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

SEPT. 9.

19399. Improvements in pipe sockets or couplings, more especially for the purpose of facilitating inspection when used with pipes which contain electric wiring. Ernest White and James Waldron, Prince's-chambers, Wolverhampton. (Complete specification.)

19419. Improvements in high-frequency electrical appliances. Leslie Bradley Miller, 93, Hatton-garden, London.

19427. An improved mechanical electrical switch for use on tramways and light railways, worked on a surface-contact system. Joseph Patrick Trumble and Thomas Meredith Trumble, 540, Romford-road, Forest Gate, London.

19437. Improvements in raising and lowering electric arc lamps. William Anderson Brown, 40, Chancery-lane, London.

19449. Improvements in apparatus for reducing or preventing the production of sparks at the collectors of dynamos and electric motors. Reny Thury, 45, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents Act, 1901, Oct. 16, 1902, being date of application in Switzerland.) (Complete specification.)

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19454. Operating vapour electric lamps from an alternating-current source. Ezechiel Weintraub, 111, Hatton-garden, London. (Date applied for under Patents Act, 1901, Oct. 18, 1902, being date of application in United States.) (Complete specification.)

SEPT. 10.

19491. Improvements in and relating to arc lamps. Charles Edwin Foster, Edwin Rudolp Grote, and Milton Victor Ely, 165, Queen Victoria-street, London.

19492. Improvements in apparatus for controlling and operating the points of electric railways and tramways. John Garside Lees, 8, Quality-court, Chancery-lane, London.

19513. Improvements in and relating to underground current conductors and surface rail contacts for electric street railways. Anton Kuchinka, 72, Cannon-street, London.

19520. Improvements in alternating-current electrical apparatus. Charles Fenton Scott, Westinghouse-building, Norfolk-street, Strand, London. (Date applied for under Patents Act, 1901, Sept. 13, 1902, being date of application in United States.) (Complete specification.)

19521. Improvements in systems of alternating-current distribution for railways. Charles Felton Scott, Westinghouse-building, Norfolk-street, Strand, London. (Date applied for under Patents Act, 1901, Sept. 13, 1902, being date of application in United States. (Complete specification.)

19522. Improvements in rotary electric machines. Henry Chitty, Westinghouse-building, Norfolk-street, Strand, London.

19524. Improvements in manhole terminals for conduit sections. Guy Moore Gest, 40, Chancery-lane, London. (Complete specification.)

19540. Improvements in electrically operated and controlled railway signals. Robert Drury Peters and Hjalmer Andrew Ellingson, 18, Southampton-buildings, Chancery-lane, London. (Complete specification.)

19547. Improvements in or relating to the magnetic excitation of synchronous, alternate, and three-phase current machines. William Phillips Thompson, 322, High Holborn, London (Berliner-Maschinenbau-Actien-Gesellschaft vormals L. Schwartzkopff, Germany.) (Complete specification.)

19533. Improvements in and relating to printing telegraph apparatus. Henry Casevitz, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents Act, 1901, Sept. 11, 1902, being date of application in France. (Complete specification.)

SEPT. 11.

19633. Improvements in apparatus suitable for detecting electric, Hertzian, or similar waves or currents. John Reed Fothergill and Henry Fothergill, 46, Lincoln's-inn-fields, London.

SEPT. 12.

19657. Improvements in and relating to the working of points and plough guides on electric cable tramways or railways. William James Stewart, 96, Buchanan-street, Glasgow.

19705. Improvements in turbines. Willans and Robinson, Limited, and Matthew Henry Phineas Riall Sankey, 24, Southampton-buildings, Chancery-lane, London.

COMPLETE SPECIFICATIONS ACCEPTED.

To be published Oct. 1, 1903.

1902.

19366. Electric cable conductors. Hitch.

19573. Contact shoes for electric railways. Lake. (General Electric Company.)

19579. Process and apparatus for the detection of short-circuits in electric batteries. Beckmann.

20323. Electric switches. Codd.

20556. Electromagnetic valve-controlling apparatus. Waterman.

20656. Switches and connections for testing electric current circuits. Addenbrooke and Robinson.

21267. Secret electrical interrupter. Zay.

21302. Electric lampholders. Chalmers.

22957. Construction of electric switch. Schulz.

23114. Storage and other batteries. Niblett.

23115. Current or charge meters or indicators for use chiefly in connection with storage batteries. Niblett.

23151. Battery installation for submarine boats. Lake.

23560. Trolley gear for electric traction. Bushell.

23940. Electrical influence machines. Eckstein and Coates.

24101. Methods of and apparatus for transforming electric energy. Carolan. (General Electric Company.)

24172. Conduit system of electric traction. Galloway.

24236. Process for obtaining metallic sulphides in electric furnaces. Bronn.

24644. Field magnets of dynamo-electric machines. Burleigh.

24330. Apparatus for the generation and application of electric currents for electrolysis. Elmore.

24711. Magnet coil spools. Carolan. (General Electric Company.)

25442. Secondary electrodes for electrolytic apparatus, more especially intended for use in the manufacture of chlorates. Imhoff and United Alkali Company, Limited.

28523. Electric accumulators. Haddan. (Soc. Française de l'Accumulateur Tudor.)

1903.

7337. Terminals for secondary or electrical storage batteries. Tunbridge.

12301. Electric meters. Compagnie Anonyme Continentale pour la Fabrication des Compteurs à gaz et Autres Appareils. (Date applied for under International Convention, Oct. 4, 1901.)

13983. Induction coils. Splitdorf. (Date applied for under International Convention, April 8, 1903.)

14940. Device for indicating the exceeding of specified speeds on dynamos, motorcars, and the like. Neuberg.

15338. Magneto-electric igniting apparatus for internal-combustion engines. Roos.

15992. Electromagnetic brake for electrically-propelled cars of tramways and street railways. Seggel.

16653. Apparatus for soldering armature leads to commutator bars. Wirth and Beech. (Date applied for under International Convention, Oct. 22, 1902.)

16806. Holding devices for the collecting brushes of electrical machines. Brewer. (Elecktricitäts-Gesellschaft Alioth.)

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.		Last price
Commercial and Industrial.—	£		£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1	..	½-¾ xd
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-126,000	1	..	½-¾
British Insulated and Helsby Cables, Ord., 1-100,000	5	..	6-7 xd
—— 5 per cent. Cum. Pref., 1-100,000	5	..	5½-5¾
—— 4½ per cent. Mortgage Debentures	100	..	102-106
British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red.	100	..	104-106
British Westinghouse Elec. and Manuf., 6 per cent. Pref., 275,001-375,000	5	..	5⅝-5¾
—— 4 per cent. Mortgage Debenture Stock	100	..	100-102
Brush Electrical Engineering, Ordinary, Nos. 1-105,731	2	..	¾-1¼
—— Non. Cum., 5 per cent. Pref.	2	..	1-1¼
—— 4½ per cent. 1st Debenture Stock	100	..	97-100
—— 4½ per cent. 2nd Debenture Stock	100	..	85-90
Callender's Cable, Debentures	100	..	106-110
—— Ordinary	5	..	11½-12¼
—— 5 per cent. Pref.	5	..	5¼-5⅜
Crompton and Co.	3	..	2-2¼
—— 5 per cent. Debentures	100	..	100-104
Edison and Swan United, "A" Shares, 1-99,261	5	..	¼
—— "A" Shares, 01-017,139	5	..	1½-2¼
—— 5 per cent. Debentures	100	..	77-82
—— 4 per cent. Deb. Stock, Red.	100	..	72-77
Electric Construction, Limited, Nos. 1 to 112,100	2	..	1½-1⅝
—— 7 per cent. Cumulative Pref.	2	..	2½-3
—— 4 per cent. Perp. 1st Mort. Deb.	100	..	98-101
Ferranti Limited, 5 per cent. 1st Mort. Deb. Stock, Red.	100	..	90-95
General Electric Company (1900), 5 per cent. Cum. Pref.	10	..	9½-10
—— 4 per cent. 1st Mort. Deb. Stock	100	..	97-100
W. T. Henley's Telegraph Works, Ordinary	5	..	13½-14½
—— 4½ per cent. Preference	5	..	5-5¼
—— 4½ per cent. Debentures	100	..	107-111
India Rubber, Gutta Percha, and Telegraph Works	10	..	18½-19¼
—— 4 per cent. Debentures	100	..	100-103
Parker, Thos., Limited, Ordinary	10	..	14½-15½
Telegraph Construction and Maintenance	12	..	34-37
—— 5 per cent. Bonds	100	..	100-103
Electric Lighting and Supply.—			
Blackheath & Greenwich District Ordinary 1,201-101,200	1	..	⅝-¾
—— 4½ per cent. Deb. Stk. Certs., Red. and Conv.	100	..	118-121
Bournemouth and Poole, Ordinary	10	..	12½-13½
—— 4½ per cent. Cum. Pref., 7,501-15,000	10	..	10-11
—— 6 per cent. Cum. Second Pref., 15,001-22,500	10	..	10½-11½
—— 4½ per cent. Debenture Stock, Red.	100	..	103-106
Bromley (Kent) Electric Light and Power Co., 4½ per cent. 1st Debenture Stock, Red.	100	..	102-105
Brompton and Kensington, Ordinary	5	..	10½-11½
—— 7 per cent. Preference	5	..	10½-10⅝
Calcutta Electric Supply Corp., Ordinary, Nos. 1-40,000	5	..	6½-7⅛
—— Nos. 20,001-30,000	5	..	7-8
Cambridge Electric Supply Company, Ltd., £10 Ord.	8	..	14½
—— " £10 Ord.	6	..	10⅝
Central Electric Supply, Ld., 4 per cent. Guar Deb. Stock	100	..	106-109
Charing Cross and Strand, Nos. 1-70,000	5	..	8-9½
—— 4½ per cent. Cum. Pref.	5	..	5½-6
—— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000	5	..	4½-5
—— 4 per cent. Debenture Stock, Red. (Prov. Certs.)	100	..	104-106
Chelsea Electricity Supply	5	..	5⅞-6¼
—— 4½ per cent. Debentures	100	..	108-111
City of London, Ordinary	10	..	10½-11
—— 6 per cent. Cumulative Pref.	10	..	13-14
—— 5 per cent. Debenture Stock	100	..	122-127
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100	..	102-106
County of London and Brush Provincial, Ordinary	10	..	7½-8¼
—— 5 per cent. Cum. Pref.	10	..	11½-12¼
—— 4½ per cent. Debentures Prov. Certs. All pd. Red.	100	..	109-112
Edmundsons' Electricity Corporation, Ordinary, 1-50,000	5	..	6½-7
—— 6 per cent. Cum. Pref.	5	..	6½-6¾
—— 4½ per cent. First Mort. Deb.	100	..	107-110
Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-30,000	5	..	3½-4¼
—— 5 per cent. Debenture Stock, Red.	100	..	95-98
Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000	5	..	6-6¼
—— 4½ per cent. First Deb. Stock, Red.	100	..	100-103
Hove Electric Lighting, Limited, Ord., 1-13,000	5	..	7⅛-8¼
Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000	5	..	10½-11¼
—— 4 per cent. Debenture Stock Red.	100	..	103-106

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Name.	Amount paid.	Last price.
	£	£
Kensington and Knightsbridge and Notting Hill	100	103-106
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	9½-10½
London Electric, Ordinary	3	2-2½
—— 6 per cent. Pref.	5	5½-6 xd
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	100-102
Metropolitan, Ordinary	10	17½-18½
—— 4½ per cent. First Mortgage Debenture Stock	100	108-112
—— 3½ per cent. Mortgage Debenture, Red.	100	97-100
Newcastle-upon-Tyne Electric Supply, Ordinary	5	98-101
—— Preference	4	100-103
Notting Hill Electric Lighting	10	13-14
—— 4 per cent. First Mort. Debs., Nos. 1-500 (Reg.)	100	99-102
Oxford Electric, Ordinary, 1-96 and 407-14,510	5	5-5½ xd
—— 4 per cent. Debenture Stock	100	98-101
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100	100-102
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5	3½-3¾
—— 4 per cent. Debenture Stock	100	88-90
South London, Ordinary	5	3¾-4¼
St. James's and Pall Mall, Ordinary, 101-20,060	5	15½-16½
—— 7 per cent. Pref.	5	8-9
—— 3½ per cent. Deb.	100	98-101
Urban Electric Supply Co., Ordinary, 8-30,007	5	5-5½
—— 5 per cent. Cumulative Preference, 50,001-80,000	5	5-5½
Westminster, Ordinary	5	13-14
—— 5 per cent. Cum. Pref., 110,101-138,251	5	6-6½

Electric Railways.—

Central London, Ordinary	100	98-101
—— 4 per cent. Pref.	100	100-103
—— ,, deferred	100	100-103
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100	115-118
City and South London, Consolidated Ordinary	100	59 61
—— 4 per cent. Debenture Stock	100	116-119
—— 5 per cent. Pref. Stock '91	100	127-130
—— ,, ,, ,, '96	100	126-129
—— ,, ,, ,, '01	100	125-128
Liverpool Overhead, 5 per cent. Pref.	—	13-13½
—— Ordinary, 1-50,000	—	7⅞-8
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	—	103-104
Waterloo and City, Ordinary	100	95 98

Electric Tramways.—

Anglo-Argentine, 1-260,007	5	4⅛-4¼
—— Permanent 6 per cent. Debenture Stock, 1888	100	125-130
Blackpool and Fleetwood Tramroad	10	13½-14½
Brisbane Tramway Invest., Lim., Ord., 1-75,000	5	2-3
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5	4-4½
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100	101-104
British Columbia Electric Railway Co., Ord., Nos. 1-20,000	100	77-80
—— Non-Cum. 5 per cent. Pref., Nos. 25,001-38,600	100	91-94
—— 4½ per cent. 1st Mt. Debs., Nos. 1-6,250, of £40 each	40	104-106 p.c.

Name.	Amount paid.	Last price
	£	£
British Electric Traction, Ord. 1-300,000 & 60,001-90,000	10	12½-13
—— 6 per cent. Cm. Pf., 30,001-60,000	10	11½-12
—— 5 per cent. Perpetual Debenture Stock	100	122-125
Buenos Ayres and Belgrano Tram., Ord., 1-100,000	5	2½-2¾
—— "A" 6 per cent. Cm. Pf., 1-40,000	5	5-5½
—— "B" 6 per cent. Cm. Pf., 1-27,500	5	4½-5½
—— 5 per cent. Deb. Stock, Red.	100	107-110
—— Prov. Cert., all paid	100	99-102
Cape Electric Tramways, Nos. 1-480,000	1	2½-2¾
City of Birmingham Tramways, 5 per cent. Cum. Pref.	10	5-5½
—— 4 per cent. 1st Mortgage Deb., 1-3,000 (1917)	100	99-102
Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red.	100	102-105
Cork Electric Tramways and Lighting Co., Ordinary	10	13-14
—— 5 per cent. Cum. Pref.	10	11-12
—— Debentures	100	96-99
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10	12½-13½
—— 6 per cent. Pref., Nos. within 1-60,000	10	15-16
—— 5½ per cent. Mort. Debs., 1-3,000, Red.	100	94-97
Imperial Tramways Ordinary	all	22-22½
—— 6 per cent. Cum. Pref.	all	14½-15½
—— 4½ per cent. Deb Stock	100	112-114
Isle of Thanet Electric Tramways and Lighting, 5 per cent. Cum. Pref., Nos. 30,001-60,000	5	3¾-4¼
—— 4 per cent. Debenture Stock	100	92-95
Kidderminster and District Lighting and Traction, Pref.	5	3¾-4
London United Trys. (1901), 5 per cent. Cum. Pref.	10	11½-12½
—— 4 per cent. 1st Mt. Db. Stock, Red.	100	104-106
Metropolitan Electric Trams., Deferred, 1 000 001-1,314,016	1	3/16-5/16
—— 5 per cent. Cum. Pref., 500,001-814,016	1	⅝-1⅛
New General Traction, Ordinary	5	1½
—— 6 per cent. Cum. Pref.	5	2-3
—— 5 per cent. Mortgage Debentures, 1-1,713 (Regd.)	100	88-93
Oldham, Aston, and Hyde Tramway, Ordinary	10	10½-10¾
—— 5 per cent. Cum. Pref.	10	11½-12½
Perth Elec. Tramways (W.A.) 5 per cent. 1 Mort. Deb. Stk.	100	99-102
Potteries Electric Traction, Ordinary, 20,001-40,000	10	9-10
—— 5 per cent. Cum. Pref., 1-20,000	10	9-10
—— 4½ per cent. Debenture Stock	100	103-106
South Lancashire Electric Traction and Power Company—		
—— £250,000 Ordinary	1	1
—— £101,132 6 per cent. Preference	1	1
—— £528,093 4½ per cent. Debenture Stock	100 p.c.	100 p.c.

Telephones.—

National Telephone, Preferred	100	100-102
—— Deferred Stock	100	77-79
—— 6 per cent. Cum. First Pref.	10	13-14
—— 6 per cent. Cum. Second Pref.	10	13-14
—— 5 per cent. Non. Cum. Third Pref.	5	5-5½
—— 3½ per cent. Deb. Stock, Red.	100	94-96
—— 4 per cent. Deb. Stock, Red.	100	101-103
Oriental Telephone and Electric Company	1	13/16-15/16

TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line	Traffic Returns for week			Increase or decrease.		Miles of single track open.		Accounts for past year.						Cost per car mile.
	Ending	1903.	1902.	Week.	Current year.	1903.	1902.	Ending	Total receipts	Passengers carried.	Car miles run.	Receipts per Pas-s'nger	Car mile.	Mile of track.	
		£	£	£	£				£			d.	d.	£	d.
Aberdeen Corporation	Sep. 12	1,255	1,087	+ 167	+ 2,550	19¼	17¼	May 31	37,931	9,099,715	794,641	0·98	13·02	1,970	6·14
Ayr Corporation	,, 5	273	294	− 21	+ 43	8	6	Sept. 25	12,503	2,979,276	290,099	1·00	10·34	1,560	4·7
Birmingham Tramways	,, 13	5,138	5,088	+ 50	+ 8,234	6½	6½	—	—	—	—	—	—	—	—
Blackburn Corporation	,, 11	926	903	+ 23	+ 452	24	24	March 25*a*	40,964	7,234,106	826,558	1·36	11·87	1,705	7·44
Blackpool Corporation	,, 10	1,688	2,183	− 495	− 118	17½	16½	,, 31	211,168	6,169,121	784,443	1·52	10·8	—	—
Blackpool-Fleetwood Tramways	,, 12	1,141	1,495	− 354	− 48	16½	16½	Dec. 31	30,923	2,049,677	584,989	3·62	12·68	1,932	6·99
Bolton Corporation	,, 13	1,827	1,566	+ 261	+ 6,077	38	25	March 31	85,704	17,761,605	1,896,247	1·15	10·75	3,430	5·87
Bournemouth Corporation	,, 10	1,391	—	—	—	10½	—	—	—	—	—	—	—	—	—
Bradford Corporation	,, 13	3,806	3,431	+ 372	+10,885	41	—	—	—	—	—	—	—	—	—
Brighton Corporation	,, 13	1,010	1,039	− 29	+ 5,901	6½	—	,, 31	—	10,432,508	1,031,928	1·00	10·10	—	—
Bristol Tramways Company	,, 11	5,140	5,180	− 40	—	51½	51½	Dec. 31	223,480	41,192,899	5,724,114	1·30	9·38	4,348	—
Burnley Corporation	,, 12	956	764	+ 192	—	—	—	—	—	—	—	—	—	—	—
Burton Corporation	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Cardiff Corporation	,, 12	2,096	1,705	+ 390	—	—	—	—	—	—	—	—	—	—	—
Carlisle Tramways Company	,, 12	214	201	+ 13	+ 494	—	—	,, 31	—	2,216,583	320,129*h*	—	—	—	—
Central London Railway	,, 12	5,537	6,137	− 600	− 2,548*h*	6	—	,, 31	367,225	45,305,110	1,276,971*a*	1·87	66·6*a*	59,076	35·6*a*
City and South London Railway	,, 13	2,632	3,029	− 397	− 3,458	6⅜	—	,, 31	165,003*a*	19,069,319*a*	—	—	—	—	—
Cork E. T. and L. Company	,, 10	653	907	− 254	− 1,800	—	—	—	—	—	—	—	—	—	—
Darwen Corporation	—	—	—	—	—	7·23	—	March 31*g*	12,341	2,360,735	254,279	1·25	11·65	1,707	9·36
Dover Corporation	,, 12	270	286	− 16	+ 49	3	—	—	—	—	—	—	—	—	—
Dublin & Lucan Electric Railway	,, 13	128	123	+ 5	+ 85*h*	—	—	Dec. 31	5,796	364,796	102,087	3·81	13·62	859	7·68
Dublin U. T., electric cars	,, 11	4,081	3,956	+ 115	—	46	46	March 31	126,121	24,553,133	3,429,356	1·23	8·82	2,741	5·06*b*
Dublin S. District, Electric	,, 11	1,041	1,016	+ 25	—	22	22	May 15	35,874	9,081,522	752,814	0·93	11·276	1,630	—
Dundee City Tramways	—	—	—	—	—	10·75	7·52	March 31	25,341	9,971,337	650,224	0·61	9·35	2,357	—
East Ham Corporation	,, 12	710	582	+ 128	+ 5,215	—	—	—	—	—	—	—	—	—	—
Farnworth U.D.C.	,, 9	142	142	—	+ 500	—	—	—	—	—	—	—	—	—	—
Glasgow Corporation	,, 12	14,129	12,700	+1,329	+21,966	124	101	May 31*g*	656,572	177,179,549	14,008,750	0·88	11·25	5,489 *b*	7·40*d*
Halifax Corporation	,, 9	1,456	1,428	+ 28	+ 3,596	30¼	27⅜	—	—	—	—	—	—	—	—
Huddersfield Corporation	—	—	—	—	—	34	35	March 31	56,631*h*	9,738,213	1,218,539	1·4	11·14	1,618	6·38
Hull Corporation, E. S.	,, 12	1,914	1,780	+ 134	+ 2,050	19	19	,, 31	87,707*h*	21,065,999	2,218,696	1·00	9·49	5,004	5·07
Ilkeston Corporation	,, 9	183	—	—	—	—	—	—	—	—	—	—	—	—	—
Kirkcaldy Corporation	,, 5	177	—	—	—	—	—	—	—	—	—	—	—	—	—
Leeds Corporation	,, 12	5,658	5,228	+ 430	+ 7,806	77	—	March 25	262,656	57,239,779	5,773,651	1·11	10·91	3,283	—
Liverpool Corporation	,, 5	10,427	10,673	− 246	+11,627	101	95	Dec. 31	504,304	108,906,472	11,705,425	1·11	10·34	5,000	6·83
Liverpool Overhead Railway	,, 13	1,672	1,522	+ 150	+ 1,088	15½	15½	June 30	79,252	10,466,726	986,185*a*	1·82	19·30*a*	5,110	— *e*
Lowestoft Corporation	,, 12	322	—	—	—	—	—	—	—	—	—	—	—	—	—
Nelson Corporation	,, 12	122	—	—	—	3	—	—	—	—	—	—	—	—	—
Newcastle-on-Tyne Corporation	,, 12	3,507	2,909	+ 598	—	38½	36	March 25*g*	150,334	33,474,122	3,379,119	1·08	10·93	4,175	6·17
Portsmouth Corporation	,, 12	2,113	2,062	+ 51	—	29	29	Sept. 30	47,651	9,168,137	868,157	1·24	13·17	1,643	—
Rochdale Corporation	—	—	—	—	—	4½	—	March 31	5,416	925,281	127,456	1·38	10·27	—	7·66
Rotherham Corporation	,, 10	511	—	—	—	—	—	—	—	—	—	—	—	—	—
Salford Corporation	,, 14	3,836	2,623	+1,213	+28,241	—	—	—	—	—	—	—	—	—	—
Sheffield Corporation	,, 14	4,412	—	—	—	53½	46¼	Mar. 25*g*	216,709	56,812,049	4,926,083	0·904	10·428	7,510	7·0
Southampton Corporation	,, 10	1,205	1,199	+ 6	—	11	11	,, 31	36,874	9,084,522	752,814	0·946	11·436	3,760	—
Sunderland Corporation	,, 13	1,192	1,235	− 43	+ 913	18·48	17·18	,, 31	59,930	13,987,121	1,270,957	1·03	11·3	3,243	6·45
Wallasey U.D.C.	,, 12	747	689	+ 57	+ 2,248	10·5	10·5	,, 31*g*	31,307	5,690,378	654,550	1·32	11·47	2,981	6·97

* Includes maintenance of permanent way and proportion of profits paid to the tramway companies for term of unexpired lease. *a* Train mile.
b Per mile of single track. *c* Include rail and tram. *d* including depreciation. *f* Including one section of horse traction *g* 1903. *h* Half-year's figures.

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NOTES.

Electric Speed Trials.—Further speed trials on the electric railway between Berlin and Zossen are reported by Reuter to have resulted in a speed of nearly 114 miles an hour being attained. This is a great improvement on what has been previously achieved, the highest record having been 100 miles an hour. There seems every prospect of the much-talked-of 120 miles an hour being attained before very long.

The Pacific Cable.—A dispatch from Ottawa states that Lord Strathcona has conferred with Sir W. Mulock, the Dominion Postmaster-General, with regard to the land-line rates between Canada and Australia, which are said to be so high as to militate against the business of the Pacific Cable. Sir W. Mulock was unable to promise relief, as the Government exercise only a nominal control over the rates of the telegraph lines.

London-Paris Telephone.—Further facilities are being offered in connection with this line. Soon it will be possible to use the telephone between London and Paris during the night at half the existing rates. Eight shillings for every three minutes is at present the charge at all times during the day. When the contemplated arrangements are completed it will be possible to telephone between the two capitals during the night for 4s. per "conversation," provided that a monthly subscription is made for a period of not less than six minutes per night.

Telegraph Statistics.—From the "Statistical Year Book" of the German Empire we take the following comparative figures: In 1900 Germany had 24,471 telegraph offices, with 36,000 instruments in operation; Great Britain, 11,512 offices and 38,000 instruments, and the United States, 22,954 offices and 81,000 instruments. The number of telegraphic dispatches transmitted in 1900 was: Great Britain, 92,000,000; United States, 63,000,000; France, 50,000,000; Germany, 46,000,000. In Germany there were 2,411 cities or or towns having public municipal telephone systems, with 305,795 connections. France had 1,199 public telephone plants, with 72,480 connections.

Telephonic Communication with Belgium.—On Oct. 1 the existing telephone service between London and Brussels will be extended, and communication can be obtained by subscribers to the Post Office telephone system between the Central, Western, Victoria, and Putney exchanges in London and Antwerp, Bruges, Charleroi, Ghent, Liège, Louvain, Malines, Mons, Namur, Ostend, Termonde, and Verviers. Communication will at the same time be opened between Birmingham, Brighton, Bristol, Cambridge, Cardiff, Derby, Ipswich, Leicester, Lowestoft, Newport (Mon.), Norwich, Nottingham, Sheffield, Southampton, and Yarmouth, on the one hand, and Brussels and certain of the above-mentioned Belgian towns on the other. In all cases the charge will be 8s. for a conversation of three minutes.

Electro-Harmonic Society.—We have pleasure in announcing the arrangements which have been made by the above society for the ensuing season, which is the eighteenth of its existence. The programme provides for four smoking concerts—on Oct. 9, Dec. 18, Jan. 22, and March 25—and two ladies' nights—on Nov. 13 and Feb. 26 respectively. As was the case last season, the rendezvous will be the Holborn Restaurant, and in anticipation of crowded audiences the two ladies' concerts will be held in the King's Hall. A pleasing echo of the last season is the publication in the society's latest circular of a letter from Mr. J. C. Lamb, C.B., C.M.G., president of the recent International Telegraph Conference, recording the delegates' thanks for the pleasant evening arranged for them on the occasion of the special extra concert on June 5.

Unique Electric Trolley Scheme.—We hear of a scheme which is progressing favourably in the States, and which proposes an unusual example of electric railway construction. The idea is to build a trolley line in the bed of the Morris Canal from Newark to Paterson, a distance of about 12 miles. The result, it is expected, will be an actual saving of thousands of pounds, and, as the canal is at present being worked at a loss, it is in the interests of economy that the scheme should be allowed to proceed. A somewhat parallel case occurred in this country some years ago, when that part of the Gravesend-Strood Canal which ran through tunnel was acquired by the South-Eastern Railway Company. At the present time a considerable part of the railway from Gravesend to Chatham is laid on the bed of the disused canal, and the tunnel, which one time marked the course of a busy barge traffic, is given over to the purposes of a not less active steam railway service.

Incandescent Lamp Combine.—News reaches us from the Continent that the rumoured formation of a syndicate of makers of incandescent electric lamps in Europe is assured. It is stated that the negotiations on the subject have been in progress for a long time past, but the difficulties which have arisen in apportioning the production of each manufacturing company have hitherto prevented the scheme from being brought to a successful conclusion. Now an estimate has been brought forward that the output of the works proposing to form the syndicate amounted to 27,500,000 lamps last year, and it is on the basis of this computation that the constitution of the combination is projected. Among the German, Austrian, and other companies said to be interested are the Allgemeine Elektricitäts-Gesellschaft, of Berlin, the United Electricity Company, of Vienna, the Siemens and Halske Company, of Berlin, Strum and Co., of Vienna, and other factories. The proposed combination is for 10 years, and the anticipation is that its formation will immediately result in a standard of prices being fixed at a considerably higher level than exists at present.

Books Received.—"Conduction of Electricity Through Gases," by J. J. Thomson, D.Sc., LL.D., etc. (Messrs. C. J. Clay and Sons). In this work the author developes the view that the conduction of electricity through gases is due to the presence in the gas of small particles charged with electricity called ions, which, under the influence of electric forces, move from one part of the gas to another. The author declares his object to have been to show how the various phenomena exhibited when electricity passes through gases can be co-ordinated by this conception, rather than to attempt to give a complete account of the very numerous investigations which have been made on the electrical properties of gases. The book contains the subject-matter of lectures given at the Cavendish Laboratory, where a good deal of attention has been paid to the subject, and where a considerable number of physicists are working at it.—"Electricity and Magnetism," by R. T. Glazebrook, M.A., F.R.S. (Messrs. C. J. Clay and Sons); 7s. 6d. As implied by the title, this is a work dealing with elementary electricity. To a large extent it embodies the subject-matter of lectures delivered at one time or another by Dr. Glazebrook, and although originally intended for the benefit of students at the Cavendish Laboratory, the author expresses the hope that it will be found of service outside that immediate sphere.

Ozone Production.—High-frequency resonators, as is known, give rise to an abundant production of ozone. According to Bordier's experiments, this means of pro-

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duction is much preferable to any other method, dark discharges being much more efficient than luminous ones. In the neighbourhood of high-frequency resonators there is thus a field particularly favourable for the transformation of oxygen into ozone, the energy maximum of this field coinciding with the terminals of the secondary. In a note recently read before the French Academy of Science, M. Guillemiot describes an ozoniser which is a particular application of such high-frequency coils. Two coils are connected in parallel and placed in front of one another, being surrounded by a flexible impermeable substance, whereas the external faces are provided with glass plates so as to form an air vessel, the transparent sides of which enable the state of the discharge to be observed from outside. All sorts of devices may, moreover, be easily designed in order to regulate the distance of the coils to change the faces placed in front of one another and to alter the self-induction of the primary coil. Air is then passed through the vessel. The most suitable condition for continuous renewing of the air layers is thus ensured, this condition being favourable to the output of any high-frequency ozonisers. The advantages of the type of coils above described are as follows: first, that they allow of the enormous mutual influence of the resonators being utilised to augment the field, and, second, that they permit of a large discharge surface being obtained between two resonators.

New Form of Mirror Extensometer.—Mirror extensometers have not been much used in this country. They are not self-contained, and to obtain the mean extension of a specimen two sets of readings are necessary. There may be errors due to slight alterations in the positions of the specimen, the telescope, or the scale. Mr. John Morrow, before the engineering section of the British Association, described an experiment in which an attempt has been made to avoid these defects and to obtain the mean extension by a single observation. Its special feature is the use of two mirrors placed side by side, one of which is attached rigidly to the instrument and the other arranged to tilt about a horizontal line when the specimen extends. The tilting mirror is carried on a piece of hardened steel of diamond-shaped section. One edge of this base is pressed against a piece attached to the upper pair of set-screws, and the opposite edge similarly against a piece from the lower screws. The four set-screws serve to attach the instrument to the specimen, and are situated at opposite ends of two parallel diameters of the test piece. Any change in the mean vertical distance between them is thus a measure of the alteration in length of the centre line of the specimen, and is accompanied by a slight tilting of the mirror. A telescope is so placed that the two images of a scale are seen close together, and to measure extensions a convenient mark on the fixed image is taken as an index, and the reading coinciding with it on the other image is noted each time the load is altered. The instrument has proved very satisfactory with a magnification of 1,600, when the extensions can be measured to the nearest $\frac{1}{640000}$ of an inch.

Protection of Wood.—Any device, method, or process which tends to the protection of wood from fire and its preservation from decay should be welcomed by engineers, as opening up a question of supreme importance which has never yet been completely solved. An hour added to the time necessary to render wood inflammable when exposed to fire, as in the case of the recent Paris Tube disaster, represents a real increase in commercial value, and herein lies the importance of a paper on the subject read by Mr. Ferrell before the Engineers' Club of Philadelphia. He describes two recent discoveries which represent a distinct advance in entirely doing away with the steaming process commonly employed for drawing out the sap from timber. The wood to be treated is placed in a cylinder; a piston, with an aperture in its centre, advances against one end and presses the other against a rubber cushion on the closed door of the case, this cushion also having a similar aperture in its centre. Zinc sulphate is then forced in at one end, driving the liquid sap before it and out at the other. The outlet is then closed, and continued pressure forces the zinc sulphate solution, by way of medullary rays, throughout the whole mass towards the surface. The cylinder is then filled with calcium chloride under pressure. This, penetrating far into the wood, reacts on the zinc sulphate to produce the preservative zinc chloride, enveloped and penned in by the almost insoluble calcium sulphate. This double reaction, consisting of the formation of an insoluble guard to prevent loss of the preservative salt, constitutes the chief feature of the process. For fire-proofing aluminium sulphate is used. Exposure to fire causes the disengagement of water and sulphur dioxide, retarding combustion pretty much as it would in the case of ammonium sulphate, but instead of this stage ending the protection, there is a residue of alumina left which has the excellent property of swelling to nearly three times the volume of the dry sulphate, and, being an admirable non-conductor, enables the mass to withstand fire for a prolonged period.

Oil Fuel.—The increasing interest and steady progress in the employment of oil as fuel for various purposes suggested the compilation of a paper, which Mr. A. M. Bell read before the Engineering Section of the British Association at Southport. He showed at the outset how the large discoveries in Californian and Texas have provided enormous supplies of crude oil, and have led to great advances being made in its use in the United States. Owing to the absence of regular supplies progress in this country has not been so rapid. The manufacture of oil gas and carburetted water gas has, however, thrown on the market products of a character only suitable for fuel, and rendered its adoption possible on a limited scale. The different methods of burning oil fuel may be summarised as follows: (1) those wherein it is burned in bulk form; (2) in a sprayed or atomised condition; and (3) consumed as vapour or gas. The first-mentioned procedure has received most application in Russia, whereas the last has enlisted most attention in the United States owing to the lighter character of the oils available. Generally, however, the second or spraying system may be looked upon as the favourite, most generally adopted, and probably the most successful; hence the chief attempts at improvement appear to have been devoted to it. The most effective device is doubtless that requiring the least quantity of the atomising agent (steam or compressed air) for operation, and until recently the attention of workers in this direction has been centred on the burner employed, the construction of the furnace, which is of as much importance for a good result, being somewhat neglected. Further, a due consideration of the admittance, distribution, and temperature of the air for combustion is absolutely essential to success. The latest developments of spraying apparatus point to the employment of oil fuel under pressure, heated to a high temperature, sprayed with dry steam, and the fire fed with heated air for combustion. For furnace work oil fuel offers unique advantages, and many interesting applications have been made to meet the special requirements of annealing, tempering, metal melting, brazing, etc. In glassmaking and enamelling oil fuel has met with considerable adoption, and portable

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furnaces of all kinds are successfully operated with it; in bridge-work, shipbuilding, etc., oil-fired rivet furnaces are to be preferred to any form of solid fuel-heating device. In storage oil fuel has many favourable features. It occupies a minimum of space, does not deteriorate by exposure, and is easier of transportation and distribution. In the Far East and many Oriental countries the importation of oil fuel has now become a regular undertaking, and supplies are guaranteed in many cases where wood has become scarce and imported coal an almost prohibitive article.

Northampton Institute. — Dr. R. Mullineux Walmsley, the principal of the above polytechnic, informs us that the 1903-4 session will open as regards evening courses and classes in engineering, artistic crafts, and other technological subjects on Monday, the 28th inst., and as regards day courses in engineering on Monday, Oct. 5. Many of our readers will be familiar with the excellent work which the Northampton Institute is achieving under the able administration of Dr. Walmsley and the governing body, of which the Marquis of Northampton is the chief private member. A bulky prospectus has reached us setting forth the programme of announcements, educational and social, for the coming session, and we compliment the compilers on its excellent get-up. We are very interested to find that the engineering subjects are chief factors in the courses of instruction. We will, however, confine our attention to the purely electrical engineering branch, with which our readers are concerned more particularly. This department has the inestimable advantage of having Dr. Walmsley himself at its head, with Dr. C. V. Drysdale as chief assistant and senior lecturer. Its work is divided into four branches—*i.e.*, lectures, laboratory work, workshop practice, and special drawing-office work in the design of electrical machinery and apparatus. In glancing through the prospectus one is struck by the large amount of practical instruction which is given in the workshops and laboratories, and this will particularly appeal to the electrical student. Electro-chemistry and electro-metallurgy are taught in conjunction with the electrical engineering department, and only electrical students may attend the classes. The electro-chemical laboratory, on account of the electro-chemical trades carried on in the neighbourhood of the institute, has been fitted up in a very complete manner with current-generating apparatus, secondary batteries, and depositing vats for hot and cold work, in which all the usual processes for the electro-deposition of metals can be carried out on a commercial scale and under ordinary workshop conditions. In view of the present rapid development of the electro-chemical industry, the practical training in the subject should be especially valuable to electrical engineering students.

The Acker Process for Alkali.—Mr. Chas. E. Acker's process for alkali and bleaching powder by the electrolysis of fused common salt has gained the Elliott-Cresson Medal of the Franklin Institute. The committee which examined into the merits of the process has published its report which, while commending the operation as a "commercial practicability," throws out one or two hints for the guidance of the inventor in his future work. The report is not an unqualified approval of Mr. Acker's method; it is in a more critical strain, and, therefore, the more interesting. The details of the process and its operation have been widely published, and the committee is satisfied that the information given to the world is substantially correct; and from the facts submitted to the committee it appears that the business can be operated profitably at present market values of the products and at the cost of power at Niagara Falls. As compared with the wet electrolytic processes the advantages of the Acker system are summarised thus: First, its directness, the salt being decomposed in one room, the whole process being completed in two operations and in a space of about 30ft. A second advantage is the very heavy current sent through each pot—as much through one Acker pot as through 15 Castner cells; a third, the absence of the evaporation of caustic and boiling down to dryness; a fourth, the absence of water solutions, requiring special pumps and a complicated circulating system; and, finally, the absence of the use of mercury. Among its disadvantages are a larger power requirement—6·75 volts in place of 4·5, or some 50 per cent. more; the rapid destruction of the apparatus and of the anodes; and the more arduous work of the potmen. As regards the future advancement of the process, the committee says there are still improvements possible in the working of the plant, particularly regarding the durability of the pots and the simplification and better preservation of the anodes. Their presence and evident capability of improvement give hopes for a still better working of the process. Some calculations made by the committee may be of scientific and practical interest. Of the total energy of the current used, 54 per cent. is usefully applied to the chemical separation of sodium from chlorine, 9 per cent. is utilised in melting the salt used, and 37 per cent. is radiated from the apparatus. As regards the quality of the products, the committee found the bleaching powder to be substantially as given by Mr. Acker's analysis, but that the caustic soda, while of good commercial quality, contained more sodium chloride and carbonate, and less caustic soda than shown by the analysis. In view of this the committee recommend Mr. Acker to exercise more care to prevent carbonation, and particularly the entrance of sodium chloride accidentally into the fused caustic during its collection in the pot-room.

South African Inter-Town Telephones.—For some time past the Post Office Department of the Cape Government has had under consideration the question of inter-town telephonic communication, and developments in this direction are to be shortly expected. Briefly, the scheme is not only to connect up the larger towns in Cape Colony by telephone, but to establish connections with other important centres in South Africa, such as Johannesburg. Sir Somerset French, the Postmaster-General at the Cape, has made a report on the scheme, from which it seems that the department is at present making experiments with a view of determining the minimum weight of copper wire which would be necessary to secure clear telephonic speech during working hours over long distances under the conditions prevailing in South Africa, having regard to the disturbing effect of the powerful electric currents employed on the telegraph lines in connection with Wheatstone automatic telegraph working, and to the inductive effect of the phonopore instruments used for railway signalling. These experiments are being made before any reliable estimate can be formed of the type of line which would be necessary for long-distance telephony. Conditions vary in different countries, and the consulting engineer to the Government, Sir William Preece, has stated that the weight of copper wire to be used can only be decided by practical test. The weight of copper wire ordinarily used varies according to distance from 150lb. to 800lb. a mile, and two wires are required for each line. For long distances Sir William Preece does not advise a lesser weight than 800lb. (or 1,600lb. for each speaking circuit per mile) unless climate and other conditions conclusively show that a lighter gauge would give effective results. It is expected, however, that in South Africa the electrical and climatic

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conditions will prove more favourable than in Europe and America, and that even for the longest distances the weight of copper can, without serious risk of failure, be reduced. Owing to the large number of wires that would be required, and also to avoid interruptions, Sir S. French says that a separate system of poles from the telegraphs would be required. The main trunk line would be between Cape Town and Beaufort West, linking in the intermediate towns of importance, and he estimates that the total cost of this section would be over £200,000. The charges for conversations would necessarily have to be high as compared with telegraph rates, and Sir S. French thinks the annual expenditure for maintenance would be a heavy item. However, the scheme is to await the result of the experiments which are now going on; but, incidentally, parliamentary sanction is about to be sought for the money provision required for the establishment of telephone exchanges at a number of towns in the Colony. Until these are in operation it is not expected that a trunk system could be conveniently used. As soon as is possible, however, estimates of cost will be prepared and a general scheme placed before the South African Government, which will doubtless be fully discussed in Parliament.

Coal Storage under Water.—The best method of preserving the working power of steam coal is a subject of considerable importance to the engineer without distinction of class. It has been stated that a steamship will have to consume more than twice the normal amount of coal per indicated horse-power if the coal has been kept in store for, say, six months. Whether this may be taken as a true exposition of the case or not, it will be admitted that the storage of coal for considerable periods results generally in a lowering of its calorific value. The subject is revived by a pamphlet we have received from Mr. John Macaulay, general manager of the Alexandra Docks and Railway, Newport, Mon., in which he gives his views of the case, based on experiment and practical experience. Mr. Macaulay's experiments have been directed particularly to the determination of the beneficial results obtaining from storing coal under water. He had an experimental quantity of coal placed under sea-water in a suitable vessel and special manner for two months. At the end of the time an estimation was made of its calorific power and compared with one made of the coal before immersion, both samples being of Monmouthshire steam coal. The loss was found to be less than 1 per cent., or, to be accurate, ·8075. This appears to be very small, but even if far larger, it would compare very favourably with the loss of power arising from the present method of storing. Some further experiments on a more extensive scale were afterwards made by Mr. Macaulay with four varieties of coal—*i.e.*, the best Monmouthshire, coal that had been three years under water, coal that had been 10 years submerged, and coal recovered outside the mouth of the River Usk or "river" coal. The order of value in steam raising and actual working results in which these coals came out in the tests was: first, the "river" coal; second, the coal that had been under water 10 years; third, fresh coal; and fourth, coal that had been three years under water. Comparing values with the fresh or test coal, the "river" coal was 4 per cent. better, and that which had been under water 10 years 1·8 per cent. That which had been under water three years had lost 1·6 per cent. of working power. From his experiments, Mr. Macaulay is able to arrive at several broad conclusions, first among which is that steam coal loses very little of its power by submersion under water for the length of time it would be reasonably kept in naval storage. Storage in a concrete reservoir holding, say, 250,000 tons would offer the following advantages: first, cheapness; and, second, the coal could be easily got at when used, as all that would be necessary would be to pump the sea-water out of the reservoir. Assuming the salt in sea-water to be accountable in a measure for the improvement in long submerged coals, it is suggested that the addition of more salt to ordinary salt water would improve coal submerged for less lengthy periods. But Mr. Macaulay is pursuing his experiments upon a larger scale, and we may expect to hear more of the subject before long.

Aluminium Conductors.—On this subject there were two contributions to the proceedings in Section G of the recent Southport meeting of the British Association. The first was submitted by Mr. J. B. C. Kershaw under the title "Aluminium as an Electrical Conductor"; the other by Prof. Ernest Wilson on "The Electrical Conductivity of certain Aluminium Alloys as affected by Exposure to London Atmosphere." In both these papers the authors describe experiments made with aluminium rods and wires under exposure to the atmosphere, but the conclusions obtained in each case are in directly opposite directions. Mr. Kershaw's paper may be taken as a continuation of that read before the Institution of Electrical Engineers in January, 1901, as it records the results of further tests made at Waterloo, in Lancs., since that date. Summarising these results, Mr. Kershaw says that all the samples of aluminium gained in weight during exposure, and that all were pitted and corroded, especially on the underside, where the water drops had collected and dried. He regards it as only a fair deduction from these exposure tests that aluminium manufacturers have yet to prove the metal a satisfactory and desirable substitute for copper in bare overhead transmission lines, or for electrical work which involves exposure to climates near the sea coast. Turning to the other point of view as expressed in the second paper, we find that Prof. Wilson carried out his tests in the neighbourhood of King's College, London. The results obtained up to July, 1902, have been communicated to the Institution of Electrical Engineers, and the present paper gives the results of another year's exposure of specimens of certain alloys of aluminium on the roof of King's College. It was shown in the previous paper that during the first year's exposure the series of copper-aluminium alloys (Nos. 16, 4, 13, 14, 15) diminished conductivity to a greater extent the greater the percentage of copper. It is seen from the table which accompanies the present paper that this process has progressed still further, but that the variation during 1902-3, expressed as a percentage of the value found in 1902, is smaller than the corresponding quantity in 1901-2. In the 1902 communication it was shown that alloys No. 21, 22 had not diminished conductivity by exposure. They have now done so. On the other hand, alloy No. 23 has not changed during 1902-3; whereas it diminished conductivity 2·34 per cent. during 1901-2. The Mn series (Nos. 9, 10, 23) have changed very little, and No. 23 has a comparatively high breaking load of 35,300lb. per square inch. The Ni series (Nos. 7, 8, 20) have also changed very little during 1902-3. For exposed light aluminium alloys the results confirm the conclusion previously arrived at—namely, that copper alone should not be used in comparatively large quantity. In the discussion which followed the reading of these papers, it appeared that the differences in the results obtained by the two authors were fairly accounted for by the differences in the composition of the materials actually used. The wires experimented with by Mr. Kershaw have a very considerable percentage of other metals—about 5 per cent.—whereas those exposed by Prof. Wilson in London were

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much more pure. It would appear, therefore, that the corrosion, as was to be expected, is largely influenced by the composition of the aluminium. It also seems from Prof. Wilson's figures than the rate of corrosion decreases with time.

Telephone Wayleaves.—Although ranking among the most progressive places in the country, Birmingham is one of those towns which have not yet taken up the telephone as a municipal question. Its citizens remain dependent for local telephonic communication on the National Company and its wiles and favours. The fanciful methods of the company are pretty well known, and probably our readers will not be unduly astonished at the following little episode which is told in one of the Birmingham dailies. A solicitor of that city applied to have his office connected to the company's system, and the company sent him a form of contract containing a condition that he was to allow the company to acquire "all such wayleaves for poles, wires, and other appliances on or over any property as the company in its sole discretion considered necessary." While ready to offer all reasonable assistance and facilities to the company on his own present property, he objected to the wayleaves applying to property "under his control" as agent or trustee, and also to leaving the wayleaves to "the sole discretion" of the company. On the first point the company offered to give way, but declined to recede on the question of discretion. Representations were made by the solicitor to the Postmaster-General, who replied that there was no ground on which he could intervene. The matter, however, was apparently further considered by Mr. Chamberlain, and a second letter from his private secretary to the Birmingham solicitor shows how completely powerless the Post Office is to see fair play as between the Telephone Company and its subscribers. Mr. Chamberlain agrees that the stipulation which the company has attempted to enforce in this case is contrary to the public interest, but declares that he has "no power, either as member of Parliament or as Postmaster-General, to compel them (the company) to waive their stipulation." Mr. Chamberlain naïvely adds that, unfortunately, the circumstances were not as well understood when the National Telephone Company received its original license as they are to-day, but wherever altered circumstances give him the power to enforce new conditions precautions are now taken to guard against such extensive wayleave demands being made a condition of service. It comes to this, then, that an important monopoly having been created for the public convenience, the company may, if it suits its purpose, refuse a service by imposing conditions as to wayleaves of so stringent a character, however much opposed to the public interest, that no sane man could accept them. This course the company would appear to have successfully adopted in the Birmingham case, where a citizen is to be deprived of the benefits of the telephone because he declines to give the company an unlimited license as to wayleaves on his private property. Another instance of the company's questionable tactics is to be found in an advertisement which has appeared in some of the provincial papers in the form of news, wherein it is sought to prove that the Glasgow municipal undertaking has led to an additional tax of £5 per annum being placed on the shoulders of several thousands of citizens by inducing them to subscribe to both telephone systems. The paragraph, however, clearly shows—perhaps inadvertently—that the subscribers to the company's system are now able to communicate with some 4,000 or 5,000 persons who before the inauguration of the municipal exchange were not subscribers to the telephone. Such palpable misuse of figures does not reflect much credit on the company, although we cannot but admire the ingenuity displayed by the author in turning a handsome profit on last year's working of the Glasgow undertaking of nearly £1,700 into an apparent responsibility of £5 per head on several thousands of its citizens.

St. Marylebone Electric Lighting.—The unique case which has arisen at St. Marylebone of a municipality entering into agreement to purchase a company's business, and afterwards being unable to raise the necessary money, continues to be a subject full of interest and speculation. Unfortunately for the Marylebone Borough Council, the arbitrator's award, fixing the purchase price of the Metropolitan Electric Supply Company's undertaking in the borough at close on a million sterling, is binding, and forms the subject matter of a contract between the parties which is enforceable at law. Still more unfortunate is the fact that interest on this high sum is rapidly accumulating, and it is estimated that completion of the purchase even at the present time would cost the Municipal Council nearly a million and a quarter sterling. However, the prospects of the Council being able to raise the money at an early date are still far distant, and the situation is not much changed since we last wrote on the subject. In fairness to the Borough Council, it should be stated that it is trying every means at its disposal in an attempt to get rid of the technical difficulty which now prevents its borrowing the money required, owing to the withholding of the London County Council's consent. It was thought that if the Board of Trade would grant the Corporation a special license constituting it an electric lighting authority the situation would be saved, and the purchase completed before the end of the year. We, however, understand, although the formal decision has not yet been communicated, that the solicitors to the Board of Trade have advised that such a license should not be granted. The Borough Council is thus left with two other possible courses of action. The first is to appeal to the Local Government Board against the refusal of the London County Council to sanction the loan, and this has already been done. The appeal has been pending for some time awaiting the result of the proceedings at the Board of Trade, but now that that department has intimated its views on the subject, the decision of the Local Government Board is daily expected. The Borough Council, however, can hardly conceal from itself the fact that it stands no greater chance of success with one Government department than another, and in that case the only alternative will be an appeal to Parliament. This means further delay, as a Bill authorising the municipality to raise the money required cannot be promoted till next year, and even if passed could scarcely become law till well on towards the end of the session. It is, however, a last resourse, and be it said to the credit of the Borough Council, that it is straining every effort to meet its responsibilities in this matter. Another point which cannot fail to put further difficulties in the way of the Council is the order of Mr. Justice Buckley in the recent proceedings in the High Court, which rules that "the company are to retain the profits of the St. Marylebone undertaking in lieu of and in satisfaction of any claim due from the Borough Council for interest on the purchase money." Dec. 31 this year is named by the judge for the completion of the purchase, but the Council is to be allowed to apply for an extension of time. In the circumstances this it will, no doubt, be forced to do; but, in any case, another year's delay in the conclusion of the matter would be disastrous to the borough. At present the Council is building up hopes on the result of its appeal to the Local Government Board, but for ourselves we are unable to find any consolation on this score, and fear the worst.

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THE DISTRIBUTION SYSTEM AND ITS INSTALLATION AT THE WORLD'S FAIR, ST. LOUIS, 1904.

The distribution of the 20,000 kw. electrical energy necessary for light and power purposes at the World's Fair grounds, St. Louis, requires a very extensive net of cables, starting from the main switchboard in the machinery hall and spreading all over the grounds. The main switchboard will be installed upon a gallery in the centre of the west side of the machinery hall, and has a total length of 90ft. The details of this switchboard are now entirely worked out. It will be composed of several independent switchboard panels, a practice that has come into very extensive use in the United States. Each of these switchboard panels is made up of a marble plate bearing all the apparatus for one machine set. The marble plates are kept very plain. The edges are bevelled and polished. These plates are mounted upon an iron frame, and neither the switchboard panels nor the whole main switchboard have wooden framings, and wood is entirely avoided in the construction of the switchboard. The main switchboard is composed of 29 of these switchboard panels. The 'bus bars are installed upon a separate iron frame under the switchboard, and extend the whole length of the switchboard. The 'bus bars, as well as the switches for making connections from the switchboards to the 'bus bars, are in duplicate, thus decreasing the liability of interruption to a minimum. Oil switches are employed throughout the whole switchboard, these switches having been highly perfected in the United States, which explains their extensive use.

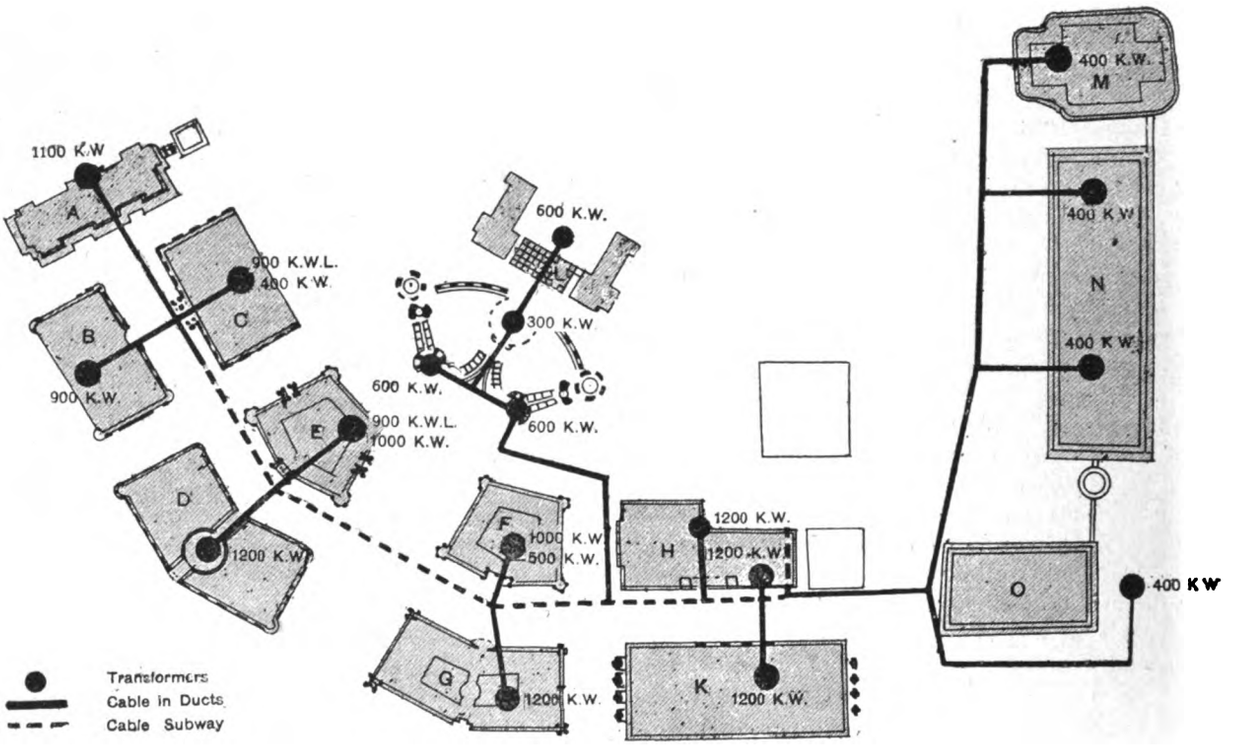

FIG. 1.—Distribution of Energy on the Grounds, World's Fair, St. Louis. A, Government; B, Liberal Arts; C, Mines and Metallurgy; D, Manufactures; E, Education and Social Economy; F, Electrical Machinery; G, Varied Industries; H, Machinery; K, Transportation; L, Fine Arts; M, Horticulture; N, Agriculture; O, French Government.

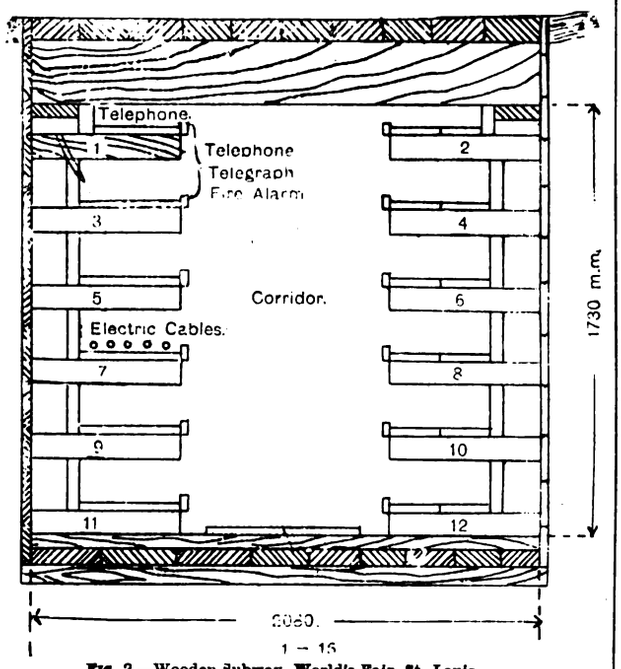

FIG. 2.—Wooden Subway, World's Fair, St. Louis.

The following voltages and current systems are available in the machinery hall and the other principal exhibit buildings: three-phase alternating current, 25 cycles per second, 6,600, 2,200, and 190 and 110 volts; two-phase alternating current, 60 cycles per second, 2,200 and 110 volts; single-phase, 60 cycles per second, alternating current, 4,000 volts; direct current, 550, 220 and 110 volts. In special cases all other voltages and current systems can be provided for the exhibitors.

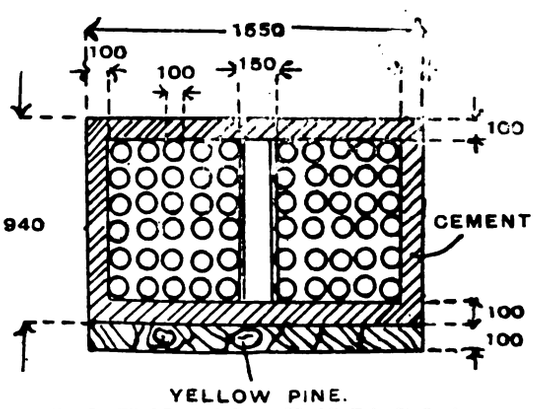

FIG. 3.—Tiled Ducts Subway, World's Fair, St. Louis.

Starting from the main switchboard, feeder cables conduct the current underground to the transformer stations. Our plan (Fig. 1) shows the way of installation and the situation and output of the transformer stations. The serrated line indicates the cables installed in the subway, the solid lines the cables installed in wood, conduits. In the transformer stations the energy provided for light is indicated by L, the energy provided for power is indicated by K. Where no indications are made the transformers serve

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exclusively for lighting purposes. The cable subway (Fig. 2) is constructed of wood, and measures 8ft. by 8ft. Each five cables are installed upon wooden brackets, and space of sufficient capacity to carry 60 cables is provided. An unoccupied space of 2ft. 8in. remains between the two rows of brackets, and this serves as a corridor for repair

FIG. 4.—Tiled Ducts Subway, World's Fair, St. Louis.

work and supervision. The two upper rows of brackets will be used for telephone, telegraph, and fire-alarm cables, whereas the other brackets carry the light and power cables. Unprotected bare lead cables are used throughout the whole installation, and in the three-phase lines the conductors are disposed in an equilateral triangle, and are twisted in order to prevent mutual induction.

FIG. 5.—Laying Cables in Wooden Ducts, World's Fair, St. Louis.

Where this subway crosses the lagoons it was not possible to build the subway, and the cables will, therefore, be installed in tile ducts. Figs. 3 and 4 represent this type of installation. The cross-section shows 60 of these tile ducts, each one having an interior diameter of 4in.; 10 of these ducts are put in one layer, making a total of six layers. All of these ducts are enclosed in a water-tight cement casing which rests upon a wooden support. In order to exclude any possibility of leakage, the prescription to the contractor was that the cement casing must be poured without interruption, thus necessitating day and night work. The wooden subway is 4,200ft. long, the total length of the cement casing with the 60 ducts is 540ft. The cost of the construction of these two subways amounted to £5,460. For all branches the cables are installed in wooden conduits (see Figs. 1 and 5), similar to those used for primitive water-mains.

Each of the principal buildings is provided with a transformer station, the whole output of the transformers amounting to 16,400 kw. The larger part of this electrical energy serves for light purposes, especially for the exterior illumination of the buildings. Power transformers are also provided in several buildings, and 1,900 kw. is available for this purpose. Rotary converters will be installed in all cases where direct current is needed, especially where arc lamps must be used, as these cannot be fed from an alternating line on account of the low frequency of 25 cycles per second. The primary wiring has no neutral, and the line is run at 6,600 volts. On the secondary side the neutral point of the transformer is used, and the lamp voltage is 110.

FIG. 6.—Installing the Decorative Illuminations, World's Fair, St Louis.

Special attention has been paid at the World's Fair to the exterior decorative illumination, and in the principal buildings alone the number of lamps provided for this purpose will be over 230,000. Besides this, 2,100 kw. is used for the illumination of the cascades; also a large amount for the illumination of the State buildings, buildings of the foreign Governments, and for the concessions. The 8-c p. incandescent decorative lamps are distributed upon the different buildings as follows: liberal arts' building, 20,000; educational building, 20,000; manufacturers' building, 30,000; palace of electricity, 20,000; varied industries building, 30,000; machinery hall, 30,000; transportation building, 30,000; horticulture building, 10,000; agricultural building, 20,000. The lamps are installed in such a manner as to follow the contours of the buildings, and are spaced from 10in. to 15in. apart. In the colonnades the lamps are installed on the back of the columns, so that the light is thrown upon the white walls of the building, by which a very diffused light is produced. So-called illuminating receptacles are used for these installations, that is to say, small porcelain receptacles without outdoor globes and with side connection screws; the distance between these screws corresponds to the distance

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the wires are strung, so that the wires run directly through; the wire is scraped bare at the attachment screw and clamped under the screw, thus permitting very rapid installation.

The circuits of the decorative illumination are entirely independent from the other lighting circuits and power circuits, so that the possibility of disturbances is minimised to the utmost. Four or five feeders run from each transformer house in the different buildings to the distributing points, which are installed directly under the roof, and are therefore almost inaccessible; from these distributing points the lamps are fed in groups of 20. Fuse plugs are used as safety devices at the distributing switchboards, whereas at the transformer stations automatic cut-outs are inserted in the feeders, and in the primary, also, an automatic cut-out oil switch of the Westinghouse type is installed. Besides this, dimmers are inserted in the decorative lighting circuits by which the brilliancy of the lamps may be gradually increased from "0" to full candle-power.

In the buildings the heavy cables are installed upon glass insulators, which are fastened to wooden cross-arms by wooden pins. The smaller feed wires are fastened to cleats, which are also used on the outside of the walls. The whole installation was executed according to the national electrical code, which has been worked out by the mutual agreement of the insurance companies, the electrical firms, and also the fire underwriters. These rule differ in many essential points from the rules of the German Electrical Society, and are far less strict and elaborate. For instance, wooden moulding is allowed according to the American national code, and wood is generally regarded as an insulating material. It is further interesting to note that the electrical installations at the World's Fair, St. Louis, are executed under the constant supervision of an official of the fire insurance company through which the buildings are insured; it is therefore seen that the American electricians have not succeeded in obtaining the same recognition by the fire insurance companies as their German colleagues. The accompanying illustration (Fig. 6) shows the method of installing the lighting decorations.

RADIUM AND OTHER RADIOACTIVE SUBSTANCES WITH A CONSIDERATION OF PHOSPHORESCENT AND FLUORESCENT SUBSTANCES. THE PROPERTIES AND APPLICATIONS OF SELENIUM AND THE TREATMENT OF DISEASE BY THE ULTRA-VIOLET LIGHT.*

BY WILLIAM J. HAMMER.

(Concluded from page 444.)

THE TREATMENT OF DISEASE BY ULTRA-VIOLET RAYS.

Some professional matters detained the writer in Copenhagen last summer for several weeks, and during his stay in that city he had the privilege of visiting the Finsen Light Institute at Rosenvaengat, a suburb of Copenhagen, and was enabled to investigate the system for the treatment of disease by light inaugurated by Dr. Niels R. Finsen. In Figs. 31 and 32 are shown views of the operating-room at the Finsen Institute, where a large number of patients from various parts of Europe were undergoing treatment at the time of the writer's visit. Dr. Finsen has conducted very extensive and most painstaking researches into the bacteriacidal effects of light, and he has found the violent end of the spectrum to possess remarkable curative powers, and he has also found that by utilising the blue, violet, and ultra-violet rays of the spectrum, those loathsome diseases of tuberculosis of the skin and lupus, diseases which have baffled surgical skill heretofore, have been successfully combated. It has recently been stated that in New York City alone there annually 20,000 cases of tuberculosis, with 8,000 deaths; and there is probably no disease with which mankind is afflicted which compares in deadly character to tuberculosis. In affecting certain of the internal organs it is known as consumption, and appearing externally, attacking the skin and underlying tissues, it is known as lupus vulgaris. As a rule it appears in single patches, most frequently attacking the face, especially the nose, cheek, and mouth. It may, however, attack the extremities, or, in fact, any portion of the body, and even mucus membranes. Fortunately, lupus is rather rare in this country, although very common in Europe. Koch and others have fully demonstrated that tuberculosis is due to the presence of specific organisms named "tubercle bacillus," which have been found to be present in both the internal and cutaneous forms of the disease. Doubtless many present remember the "blue glass craze" which swept over the country in 1876, or thereabouts. I have with me here a copy of General A. J. Pleasonton's book entitled "Blue and Sunlights: Their Influence upon Life and Disease," which I picked up in a second-hand book store some years ago; and I would commend the examination of this book to all who are interested in this subject. General Pleasonton and his system were condemned to both abuse and ridicule. Dr. Finsen, however, says "The general was absolutely on the right track."

For a considerable time Finsen's work received little credence and no encouragement; but he persisted in his investigations, and the results secured by him finally bore fruit, and to-day the world rings with his praises. In all parts of the civilised world his work is being taken up, and institutes are being founded for the treatment of disease by light rays—particularly the ultra-violet light. In England

PROF. NIELS R. FINSEN.

the initiative was taken by Queen Alexandra, and in Russia by her sister, the Czarina, they both investigating the system while visiting their father, the King of Denmark. Much has also already been done in the United States. It will be remembered that during Queen Elizabeth's reign a certain Court physician recommended strongly that patients suffering from small-pox should be kept in a room, the decorations of which, including the hangings, bed draperies, etc., should be red in colour, claiming that the red light had a soothing effect upon the irritated portions of the skin, lessening the severity of the disease. Little importance was attached to this method, and the originator of it was branded as a charlatan. Prof. Finsen has, however, found that this method of treatment of small-pox is of paramount importance. He has placed patients in a room into which the sun's rays could only penetrate through sheets of red glass, just as they would penetrate a photographic dark room, and he has found that patients placed in such a room prior to the most painful and most dangerous suppuration stage setting in, that suppuration has been entirely prevented, and that the scarring has been in nearly all cases absolutely prevented, and in the few cases where there was any scarring it was hardly perceptible. The disease has been in a much milder form, the fever usually accompanying the eruption disappearing, and the temperature remaining normal.* He has found that the use of

* A lecture delivered at a meeting of the American Institute of Electrical Engineers and the American Electrochemical Society, New York, April 17, 1903.

* Prof. Finsen has recently written the author that placing the patients in a dark room is fully as efficacious as placing them in a room lighted with red rays only, the important thing being to keep the patient from exposure to the actinic rays.

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ultra-violet light on these patients very much aggravated the disease, and even in cases where patients were almost cured, and they have been allowed to go out into the sunlight, the disease has at once been aggravated.

In connection with his investigations into the effects of light, Finsen made some interesting and ingenious experiments upon earth-worms placed in a box, one-half of which

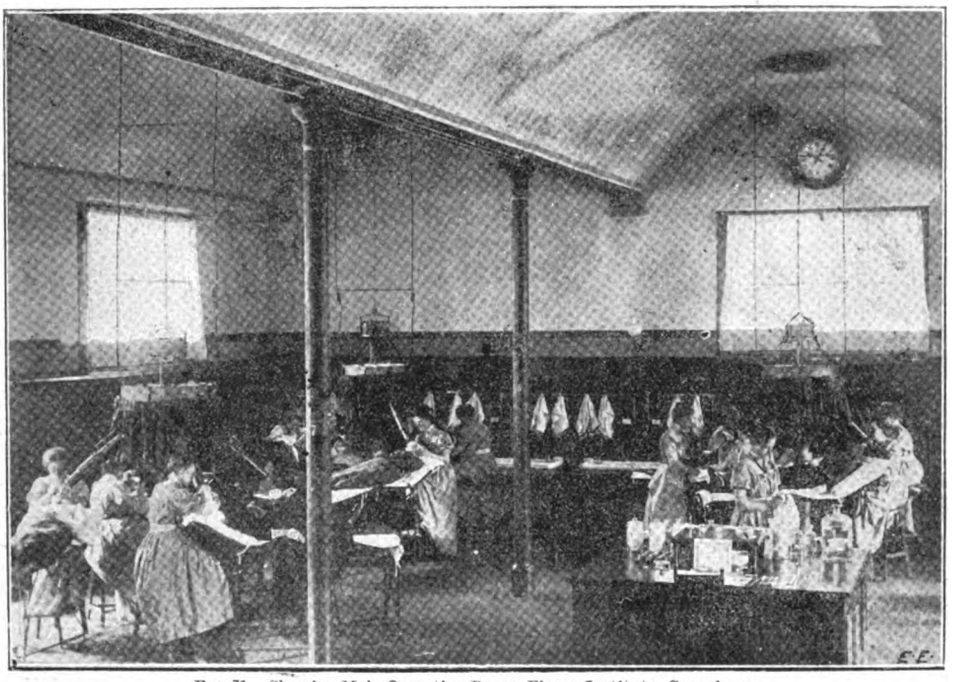

FIG. 31.—Showing Main Operating Room, Finsen Institute, Copenhagen.

was covered with red glass and the other half blue glass, and he found the blue light irritated the worms so they invariably crawled under the red glass; and a chameleon, placed with its body midway between the glasses, turned almost jet black under the influence of the blue rays, while that portion under the red glass remained nearly white, which Prof. Finsen says showed that the chameleon

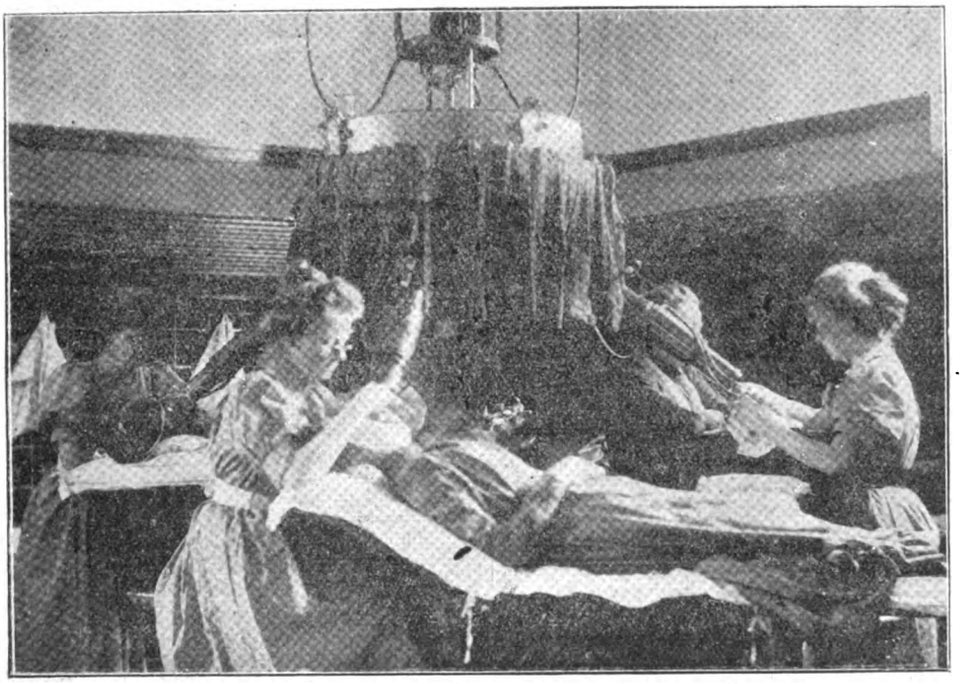

FIG. 32.—Showing Arc Lamp and Four Finsen Tubes in use at one time.

was altering its pigment cells to lessen the irritating effects of the blue light. The ultra-violet end of the spectrum contains the most refrangible rays, and it is these rays which are so harmful in cases of small-pox, and it is also these actinic rays which produce sun-burning, which one often experiences in the Alps or any high altitude where the temperature may be considerably below zero; and there are doubtless many present who have experienced considerable effect similar to sunburning by working in close proximity to arc lamps. While these ultra-violet rays are so harmful in the case of small-pox, they are of the precise nature which is most desirable in the treatment of such diseases as tuberculosis of the skin or lupus vulgaris. These rays not only destroy the bacilli, but they excite and stimulate nutrition and excite activity in granulation, thus assisting very greatly in the rapid recovery from the disease. Doubtless the rays emanating from the sun are very rich in blue, violet, and ultra-violet light, but the atmosphere readily absorbs these rays; and while Prof. Finsen for a time used the sun's rays in the treatment of tuberculosis of the skin and lupus, he found that by employing the arc light the same effect could be produced in a very much shorter space of time, and that he was in this way also independent of weather conditions.

The arc light is much richer in ultra-violet rays than the sunlight, and Broca and Chatin, of Paris, have found that by placing an iron core inside of the positive carbon electrode, this arc was still richer in ultra-violet light, and Görl, of Erlangen, has constructed a form of aluminium

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arc in which four arcs were formed between five aluminium electrodes. I have here a modification of Görl's lamps constructed by Messrs. Waite and Bartlett, of this city, in which there are four iron electrodes forming three iron arcs in series, which produce an intense source of ultra-violet light, which I shall presently show in operation. Bang and others have also made arc lamps employing

FIG. 32A.—Dressing Room, Finsen Institute, Copenhagen.

terminals of iron. It is claimed that by employing the iron arc the same results which take an hour and 10 minutes by means of the carbon arc can be accomplished in 20 minutes to half an hour, and also that so intense are these ultra-violet rays it is not necessary to use pressure to drive the blood away from the diseased part, and it is also unnecessary to use water to cool the rays.* Drs. Piffard and Jamieson have suggested the use of suprarenal extract in the form of adrenalin chloride, which the former prefers to introduce into the skin around the diseased spot by cataphorisis, thus producing a whitened area from which

FIG. 33.—Lupus Vulgaris, cured by X-Rays.

the blood has been withdrawn, which enables the treatment of this portion by the ultra-violet light without pressure being applied, and the blood does not return for half an hour or more. The cataphoric electrode is covered with a thickness of lentine saturated with adrenalin connected with a positive pole of the battery, using a current of from three to four milliamperes, the bleaching taking from four to five minutes' time.

The Röntgen rays have been found very effective in the treatment of certain diseases, especially where hard tubes are employed, and as we are considering particularly the treatment of lupus vulgaris, I would call attention to Fig. 33, which represents a patient treated by my friend, Dr. William H. King, of this city, in which the X-rays successfully cured a case of lupus vulgaris brought on by the patient's pricking a tiny boil on the side of his nose with a pin taken from the lapel of the coat of a friend who was suffering from tuberculosis (consumption). The rapid progress of the disease is shown in the illustration, and was taken three weeks after using the pin, and was largely augmented by the man's age (45), and his being in poor health (a chronic rheumatic). Two bacteriological exami-

FIG. 34.—Finsen's Original Blue Lens for use with Sunlight.

nations showed conclusive evidence of the presence of tubercle bacilli. In Fig. 34 is shown the original blue lens used by Finsen when employing sunlight. It consists of a flask full of light-blue ammoniacal sulphate of copper. The bottle with its contents makes a plano-convex lens. The sunlight passing through

* Prof. Finsen has recently written the author emphatically asserting that iron electrodes are not as efficacious as carbon electrodes, as the rays from the iron arc, he claims, do not penetrate as deeply as the rays from the carbon arc.

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this is found to work very well; but it was too slow, and the sun was frequently obscured. Finsen later used plain water, finding that the blue water cut off most of the ultra-violet rays, and he found the clear water very largely absorbed the ultra-red rays which caused the heat.

In Fig. 35 is shown a form of telescope which is now adapted in standard practice at the Finsen Institute. It contains four rock crystal lenses, which act to cut off considerable of the heat rays, but allows the ultra-violet light to pass through it. It will be remembered that ordinary glass cuts off almost all of the ultra-violet rays, whereas a

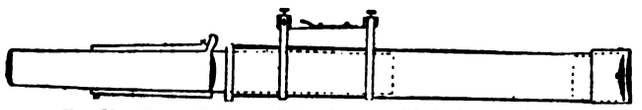

FIG. 35.—Finsen Telescope Tube, for use with Carbon Arc Light.

block of rock crystal 4·4mm. thick will allow 60 per cent. of the ultra-violet to pass through it. A part of the heat is also absorbed by the distilled water which is contained inside of the telescope. In order to keep this water cool, there is an outside jacket on the telescope, through which circulating water may be passed for this purpose. In Fig. 36 is shown the method of arrangement of the telescope and the arc lamp; and in Fig. 32 is shown a set of four of these telescopes arranged around the arc lamp and in actual operation. The arc lamp uses from 40 to 80 amperes and

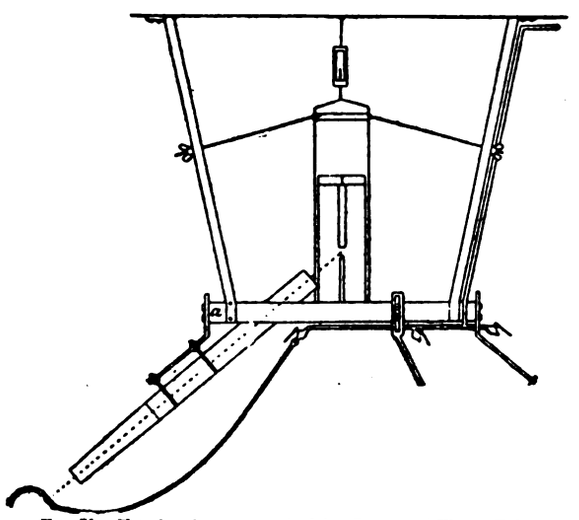

FIG. 36.—Showing Arrangement of Arc Lamp and Finsen Tubes.

operates at 45 to 50 volts. Blood is opaque to ultra-violet light, and it is therefore necessary to drive the blood away from the diseased portion which is to be treated. This is accomplished by what is known as a pressure glass (shown in Fig. 37). It consists of a plano-convex lens of rock crystal kept cool by circulating water—the glass acting to focus the light on the diseased portion, and also to exert considerable pressure there. The patient does not suffer from exposure to the rays; but after the treatment, which is usually an hour and 10 minutes per day, he appears

FIG. 37.—Pressure Lens.

to be considerably sunburned. He is then allowed to recuperate until the next day, and the treatment is then repeated. After a series of these treatments, the patient is sent away apparently cured. Sometimes he does not return, but more often he must come back for a second or a third, and even more series of treatments, due to the fact that certain of the microbes which have been deep seated have worked their way to the surface, the disease having started anew.

It is said that out of over 600 cases treated at Copenhagen, there have been only 1 to 2 per cent. of failures due to fault in the treatment, but there have been cases where the disease has been in such an advanced stage and for such a very long period that it has not yielded successfully. But I was informed that in the majority of cases after very few treatments, the patients are dismissed absolutely cured. In order that you may properly appreciate the remarkable results which have been secured by Prof. Finsen, and the stupendous importance which his successful combating of these loathsome forms of disease represents to many of the most sorely afflicted people of the world, I have inserted in my paper several photographs (see Fig. 38), which I secured at the Finsen Institute, of patients afflicted with lupus vulgaris—these pictures showing them before and after the treatment with the ultra-violet rays produced by the arc light. I feel that their presentation in this paper requires no apology; on the contrary, electrical engineers should feel a sense of pride that in the use of the arc light in this remarkable advance in medicine and surgery, their profession has contributed in no small degree. Those caring to look up these and similar cases will find full descriptions in English in "Phototherapy after Finsen's Methods," by Valdemar Bie, M.D., Prof. Finsen's assistant (published by Lippincott), or "Die Bekampfung des Lupus Vulgaris Niels R. Finsen" (Gustav Fischer, Jena), and "Die Finsen von Therapie und ihr gegenwartigen stand in des Dermatologie" (Von Dr. Forch-hammer, 1 Cohen's Buchdruckereien, Kopenhagen). It is sad to contemplate that Prof. Finsen, who has conferred such a priceless boon upon humanity, is

FIG. 38.—Showing a Patient of Lupus Vulgaris Before and After Treatment with Ultra-Violet Light at the Finsen Institute, Copenhagen.

himself an invalid, suffering from an incurable disease, and one which has made it at times well nigh impossible for him to prosecute his work. The Finsen Institute was established in 1896, through the munificence of Copenhagen's public-spirited citizens, and through a gift by the city of the property on which it was erected.

THE PARALLEL WORKING OF ALTERNATORS.*

BY B. HOPKINSON.

The question of the parallel working of alternating-current dynamos, under which term may be included the working of synchronous motors and of rotary converters, has been much discussed during the 20 years which have elapsed since it was first shown that it could be done. No very definite result, however, has been arrived at from the theoretical point of view, though engineers have evolved various empirical rules of design, and have produced the well-known "amortisseurs," in consequence of which the difficulties of parallel running have ceased to be serious, and the theoretical problem has lost much of its importance. Of late, however, a new interest has been given to the discussion of this question by the introduction of large gas-engines, with which it is more difficult than with steam to satisfy the requirements of the dynamo designers as to the uniformity of angular velocity necessary for satisfactory running. In this paper I do not propose to add much new matter to the discussion, but rather to attempt to co-ordinate the

* Paper read at the British Association, Southport, 1903.

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mathematical treatment of the subject with the practical rules which have been framed, and which are now regarded as good standard practice, and to point out the reason for certain phenomena which have been observed. It would appear that hitherto the mathematical treatment of the subject has been carried out without sufficient reference to practical conditions, and on the other hand it is possible that the empirical rules of practical engineers, though their success is a sufficient guarantee of their correctness under the conditions to which they have been applied, may not be fully applicable without modification to the new conditions which have followed the introduction of the new types of prime mover.

Dynamically, the question of the parallel working of alternators, or the running of a synchronous motor or converter, is a problem of oscillation about a state of steady motion. Consider an alternating dynamo connected to a source of supply of constant amplitude and periodicity, and driven by a constant power or working against a constant resistance. For simplicity of expression we may suppose that the dynamo, and the generators giving the supply, have all the same number of poles. Then the dynamo will run with the same angular velocity as the supply generators, but with a certain difference of phase, which we may call ϵ, dependent on its excitation and on its load or driving power. This is the state of steady motion. If that state be disturbed—say, by temporarily varying the load on the dynamo if working as a motor—the dynamo will make oscillations about it, sometimes running ahead of and sometimes lagging behind the position of steady motion. When ahead of that position it will take less, and when behind it will take more, than its proper supply of energy from the mains. The practical problem is to keep these oscillations, with their accompanying fluctuations in the flow of energy to or from the mains or 'bus bars, within moderate limits.

The oscillations may be either free or forced. To clear the ideas we may consider the case of a dynamo working as a synchronous motor, but the results are immediately applicable to the case of a generator. Suppose that the load on the motor is slightly increased. The motor will take up a position in which the phase difference between it and the generators is rather greater than before, becoming say, $\epsilon - \xi$, where ξ is reckoned positive in the direction of motion of the motor. The torque developed by the motor, which was T, is now $T - \xi \frac{d\,T}{d\,\epsilon}$, or, say, $T - c\,\xi$. The constant c is readily calculable from the electrical constants of the machine. If, now, the additional bit of load $-c\,\xi$ be removed, there will be a balance of torque of that amount available for accelerating the motor, which, accordingly, will proceed to catch up, so to speak, the state of steady motion. After a time it will arrive at the position of steady motion, corresponding to torque T (for which, of course $\xi = 0$), but will then be moving with more than the steady motion velocity. In consequence of the difference of velocity, the motor will not exert quite the steady motion torque, T, but there will be a balance of torque tending to accelerate it or retard it. This, if the difference in velocity is small, will be proportional to that difference and equal, say, to $b \frac{d\,\xi}{d\,t}$. Adding the effect of this and of the term $c\,\xi$, we find the equation of motion of the motor,

$$M \frac{d^2\,\xi}{d\,t^2} + b \frac{d\,\xi}{d\,t} + c\,\xi = 0,$$

where M represents on a suitable scale its moment of inertia. Under a rigorous mathematical treatment, differential coefficients of higher order will appear, but the terms here given are the most important. The solution of this differential equation is

$$\xi = \xi_0\, e^{-\frac{b}{2M}t} \sin(\delta\, t + \eta),$$

where $\frac{2\,\pi}{\delta}$ is the period of the oscillation and δ is equal to $\sqrt{\frac{c}{M}}$ nearly, if (as is usually the case) b^2 is small compared with $4\,c\,M$.

The oscillations represented by this expression are the free oscillations executed by the dynamo when disturbed by a temporary change of conditions—*e.g.*, if its load be suddenly thrown off, or if, being a generator, it be switched into parallel with its fellows. Dr. Hopkinson showed many years ago that the quantity c is positive—in other words, that if the state of steady motion be disturbed the forces so called into being tend to restore it, or the motion is stable. Since then Kapp and others have worked out the value of c. It is easy to show that, sufficiently nearly for all practical purposes,

$$c = \sqrt{\frac{A^2}{2\,L'}}$$

where $\frac{A\,p}{\sqrt{2}}$ is the open circuit E.M.F. of the dynamo ($\sqrt{\text{mean}^2}$) ($2\,\pi/p$ being the periodic time of the alternations) and L the self-induction of the armature, including therein the armature reaction and the self-induction of any conductors in series with the armature. Another expression for c, at once deducible from the above, is $c = \sqrt{\frac{E\,i_0}{p}}$, E being the open circuit E.M.F. and i_0 the current in the machine when short-circuited and driven at the proper speed.

It is obvious that the importance or otherwise of these free oscillations depends on whether they are damped out or not. It has usually been assumed that b is a positive quantity—*i.e.*, that the oscillations are resisted by a sort of viscous force—and if that is so the oscillations will, of course, rapidly disappear. I have, however, recently shown that under certain circumstances b may be negative, in which case the oscillations will continually increase in amplitude and the running of the dynamo will be unstable, even though b be very small.

Suppose that the dynamo is working as a generator and is driven by a force with a certain periodic variation—*e.g.*, by a reciprocating engine. It is supposed to be coupled in parallel with such a number of other machines that the 'bus bar potential is practically constant. The equation of motion then is

$$M \frac{d^2\,\xi}{d\,t^2} + b \frac{d\,\xi}{d\,t} + c\,\xi = P \sin \delta'\, t,$$

where $2\,\pi/\delta'$ is the period of the variation in the force. The solution of this equation is (leaving out the free oscillations)

$$\xi = \frac{P}{\sqrt{b^2\,\delta'^2 + (c - M\,\delta'^2)^2}} \sin(\delta'\, t - \eta),$$

where

$$\tan \eta = \frac{b\,\delta}{c - M\,\delta'^2}.$$

I shall presently show that in practical cases $b\,\delta'$ is small compared to c, so that the equation for ξ is, unless c is nearly equal to $M\,\delta'^2$,

$$\xi = \frac{P}{c - M\,\delta'^2} \sin \delta'\, t,$$

$$= \frac{P}{c\left(1 - \frac{\delta'^2}{\delta^2}\right)} \sin \delta'\, t,$$

where $2\,\pi/\delta$ represents, as before, the period of the free oscillations. These are the forced oscillations produced by uneven turning moment in the prime mover. Superposed on them there will be the free oscillations already considered.

The possibility of parallel working, or of the working of a synchronous motor, therefore depends on two conditions. First, the quantity b must be positive, so that any free oscillations are damped out within a short time of being set up. Second, the forced oscillations must be of such moderate amplitude as not to interfere with practical working. I will deal first with the last-named condition, as it admits of much simpler treatment than the other.

For an ideal machine, without any flywheel effect at all, δ is infinite, and we have $\xi = \frac{P}{c} \sin \delta'\, t$. In this case the

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phase displacement is always such as to correspond exactly with the torque exerted by the prime mover. Such a machine would run fairly well in parallel with others, simply delivering to the 'bus bars at all times exactly the energy given to it by its engine. But, now, if a flywheel be added, δ becomes finite, and so long as it remains greater than δ'—that is, so long as the natural period of the alternator is less than that of the variation in turning moment—the amplitude of the oscillations becomes greater with increase of flywheel until, when $\delta = \delta'$, there is perfect resonance, and the oscillations are only restrained by the viscous damping. Further increase in the flywheel effect results in a continuous diminution of the oscillations. If δ is so far diminished by increasing the flywheel that δ' is several times as large as δ, the formula for ξ becomes

$$\xi = -\frac{\frac{P}{c\,\delta'^2}}{\delta^2} \sin \delta' t$$

$$= -\frac{P}{M\,\delta'^2} \sin \delta' t.$$

Now, the practical rule always adopted by designers for working in parallel is that the angular displacement of the machine in a revolution when running unloaded as compared with a uniformly revolving wheel shall not exceed a certain fraction (varying from $\frac{1}{110}$ to $\frac{1}{70}$) of the angular pitch of the poles. If the machine is unloaded the equation of motion is

$$M \frac{d^2 \xi}{d t^2} = P \sin \delta' t,$$

or,

$$\xi = -\frac{P}{M\,\delta'^2} \sin \delta' t.$$

ξ is the phase-angle of displacement measured in such units that the angle between a pair of adjacent poles (or pitch-angle) is π. The practical rule, therefore, directly limits the angular amount of the forced oscillations, provided that δ' is large compared with δ, or that the natural period of oscillation of the alternator is large compared with the period of variation in turning moment.

Limitation of the angle by which the machine deviates from perfectly uniform rotation is not, however, precisely what is needed. What should be limited is rather the amount of the fluctuation in the rate at which energy is delivered by the machine to the 'bus bars. This, since the speed is practically constant, is proportional to the variation of torque—that is, to $c\,\xi$. Now, c is equal to $\sqrt{\frac{A^2}{2L}}$, and depends upon the electrical properties of the machine. Hence a machine with small self-induction will operate worse in parallel under a given amount of angular displacement than will another of large self-induction, always supposing the above-mentioned condition of long natural period to be fulfilled. Here, therefore, is a sufficient explanation of the wide variation in angular deviation permitted by different designers; what suits one machine will not suit another, and a machine with small self-induction and armature reaction, or what is called a machine with good inherent regulation, must be subject to more stringent rules as regards angular deviation than one with large self-induction.

Another cause which makes a fixed rule as to angular deviation inapplicable to all cases, is the fact that in some designs the natural period of oscillation may not be long, compared with the period of the engine impulses. Should these two periods become even approximately equal—if, for example, δ were anywhere within 20 per cent. of δ' then the rule quite ceases to be applicable, and the amount of angular deviation in actual working as a generator bears no fixed relation to, but is much greater than, the same deviation when unloaded. As a matter of fact, in machines as now designed, in which the self-induction and armature reaction are usually sufficient to allow the machine to be short-circuited when partially excited without damage, the natural period of oscillation even without a flywheel is usually greater than the period of engine impulse. The latter period, even in a slow-speed engine, will not, as a rule, exceed one-third of a second, while the natural period will be found to be of the order of half a second or more, and very much greater with a heavy flywheel. Probably, therefore, a designer will generally be justified in assuming that the two periods are sufficiently different to ensure that he will get about the same angular deviation when delivering energy to the 'bus bars as when the machine is running disconnected. He will, however, have to take account of the change in the rate of flow of energy to which that deviation corresponds on his particular machine, and it is in neglecting that factor that the practical rule seems to be illogical.

We have, so far, considered that particular component of variation in turning moment which is responsible for the major part of the phase displacement when the machine is running disconnected, and which is, accordingly, alone regarded in the practical rule for flywheel effect. That, however, is not in fact the only component of the variations; there will be other components of both longer and shorter period. Take, for example, the case of a single-cylinder double-acting Körting gas-engine running at 90 revolutions. The principal variation in turning moment, and the only one producing any appreciable effect on the phase displacement when running light, will be due to the explosions, and will have a period of one-third of a second. As stated above, the natural period of oscillation of the alternator will probably be much greater than this. But there will also be a variation in turning moment due to the weight of the crank, with a period the same as that of the revolution of the engine, or two-thirds of a second. Now it is not impossible, with a light flywheel, for the period of oscillation of the alternator to have that value, and if that were so violent hunting would be set up, even though the variation in turning moment due to this cause were too small to produce an appreciable effect on the phase displacement when running light. Only, in this case of a small disturbing force, the approximation of periods must be fairly close to produce serious effects. The ordinary rules as to flywheel effect generally result in the natural period of oscillation being substantially greater than the period of revolution of the engine, but in a somewhat roundabout and accidental way. It seems highly desirable on many grounds to pay more attention than has hitherto been usual to the natural period of oscillation of the alternator when specifying flywheels. The period of oscillation of the governor of the engine should not be lost sight of. This is generally fairly long, and may not impossibly give rise to resonant oscillations.

So far, we have considered the forced oscillations caused by the uneven turning moment of the prime mover in a generator working in parallel with a number of others. A very similar and equally important problem is that of a synchronous motor or rotary driven from mains in which the potential varies periodically owing to unevenness of rotation in the supply generators. Here, if the motor or rotary had no flywheel effect at all, it would follow the generators precisely in their oscillations, and it is easy to see that if ξ_0 be the maximum phase displacement in the generators and ξ_0' that in the rotary, then

$$\xi_0' = \xi_0 \Big/ \left(1 - \frac{\delta'^2}{\delta^2}\right),$$

where $2\pi/\delta'$ is the period of the variation in the generators, and $2\pi/\delta$ the natural period of oscillation of the rotary. In the case of a rotary, however, it is unusual to have any flywheel, and consequently δ, though usually less than δ', may be sufficiently near it to cause the oscillations of the rotary to exceed in amplitude those of the generator. Furthermore, the danger of actual resonance with the revolution of the engine, is in this case very much greater. I came across a case recently of a motor-generator which could not be worked owing to resonance. Its natural period happened to be very nearly equal to that of the revolution of the generator—about two-thirds of a second—and it dropped out of step in a very short time, though the variation of turning moment of the period in question must have been quite small. By altering the field current so as to increase the natural period about 25 per cent., the forced oscillations disappeared almost completely, showing that the difficulty was entirely due to resonance. This suggests the reflection that it might possibly be better in some cases to put flywheels on the comparatively high-

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speed rotaries, and allow a small flywheel and a bigger angular deviation in the slow-speed generators.

The question of free oscillations is a very much more complicated and difficult one than that of forced oscillations. The period is, of course, easily determined, but, as already indicated, the importance or otherwise of these oscillations depends almost entirely on the way in which they are damped or on the sign of the quantity b. If b be positive, the oscillations are damped out and are unimportant. On the other hand, if b be negative, even though very small, the oscillations will continually increase according to an exponential law, and the running of the machine will be impossible as a practical thing. The stability or otherwise therefore depends in this case on the sign of a small quantity and may be affected by a very small change in the conditions. I have recently investigated this question, and I have shown that under certain circumstances* b may be negative. I will not reproduce the mathematics here, but will merely give the conclusions.

Consider an ideal synchronous motor in which the exciting current is maintained absolutely constant, while the field magnets and the armature core and conductors are so perfectly laminated that no appreciable eddy currents flow therein. I find that the motion of such a motor is unstable or b is negative, provided that $\mathrm{L}\,p > \rho$ Here ρ is the resistance and $\mathrm{L}\,p$ is the reactance of the armature and any conductors in series with it. The actual value of b I find to be

$$-\frac{1}{2}\rho\,\mathrm{A}^2\,\frac{\mathrm{L}^2\,p^2-\rho^2}{(\mathrm{L}^2\,p^2+\rho^2)^2}.$$

The condition $\mathrm{L}\,p > \rho$ is generally fulfilled, so that an ideal motor such as that described is in general unstable, and all motors have this element of instability. In actual machines, however, there are a number of causes which give rise to real viscous forces, and generally overcome this tendency to instability. Such are the local currents induced in the substance of the armature conductors, and (generally but not always) the "amortisseur" effect of currents induced by the oscillations in the pole-pieces, the field coils, and in any special "amortisseur" coils put there for the purpose. It will be found, on working out the value of b, that in machines of modern design and any considerable size, it is insignificant under ordinary conditions of working. In small machines, however, and in large ones on long transmission lines, it may be important. I have myself experimented with a small motor, the running of which was actnally unstable from this cause.

Of the causes mentioned above as making for stability by producing a viscous damping effect, the most important is that described as giving rise to "amortisseur" action. Consider an ideal motor of the type described in the last paragraph coupled to mains giving constant alternating potential moving steadily and doing external work. For simplicity, we may suppose the open-circuit potential of the motor to be equal to that of the mains. The effect of the armature current on the field will be to decrease the induction in the field magnets somewhat and also to distort it, so that the point of maximum induction and zero back E.M.F. is displaced backward against the direction of rotation. Suppose, now, that the motor executes oscillations about the position of steady motion. Then the field will experience variations of like period, both as regards its magnitude and its distortion. To put the matter in symbols, suppose that $\mathrm{A}\cos\theta$ is the induction linked with armature and field coils in the steady motion (θ being an angle defining the position of the armature). Then in the oscillation which is given by $\xi = \xi_0 \sin \delta\, t$, the induction will be $(\mathrm{A} + a_0' \sin \delta\, t) \cos\theta + b_0' \sin \delta\, t \sin\theta$, the quantities a_0' and b_0' being positive, since when ξ is positive there is a greater total induction and a less displacement of point of maximum induction than when ξ is zero.

Now suppose that the pole-pieces are surrounded by short-circuited copper conductors, and that the pole-faces are covered with copper plates, or have copper conductors threaded through them to form a grid. Then the changes of magnetising force due to the armature current will cause induced currents to flow in these conductors, and the general effect of the currents will be to somewhat reduce the amplitude of the changes of induction in the pole-pieces, and to cause them to lag rather behind the changes in armature reaction which give rise to them. The consequence is that the induction linked with armature and field coils is now

$$\{\mathrm{A} + a_0 \sin('t - \eta)\} \cos\theta + b_0 \sin(\delta\, t - \zeta) \sin\theta,$$

where a_0 b_0 are (for the motor) positive quantities less than a_0' and b_0' respectively, and η ζ are positive angles which depend upon the resistance of the "amortisseur" conductors and on the armature reaction. Thus, at the time when the armature is passing the position of steady motion ($\xi = 0$), but moving with more than the steady motion velocity, the induction, instead of having its normal value, $\mathrm{A}\cos\theta$, has the value $(\mathrm{A} - a_0 \sin\eta)\cos\theta - b_0 \sin\zeta \sin\theta$. In other words, the currents then circulating in the "amortisseur" coils are such as to reduce the magnetisation somewhat, and to displace the point of maximum induction or zero open-circuit E.M.F., rather behind the position which it would occupy in ordinary steady motion. We have now to consider the effect of these changes in the induction on the torque at this moment, since it is the then deviation of the torque from its steady value that determines the value of b.

First, as regards the demagnetisation, due to diminution of current in the field coils, or to currents in short-circuited windings surrounding the pole-pieces. It is easy to show that the effect of reducing the field current in a synchronous motor may be either to increase or diminish the torque—it depends on the load on the motor. Let β_0 be that component of the current which is in phase with the back E.M.F., and $\mathrm{A}\,p$ the back E.M.F. of the motor, so that the rate of working of the motor is $\frac{1}{2}\,\mathrm{A}\,p\,\beta_0$. Then a reduction in the field current will result in a reduced torque provided that

$$\beta_0 > \frac{\mathrm{A}\,p\,\rho}{\mathrm{L}^2\,p^2+\rho^2},$$

where, as before, ρ is the resistance, and $\mathrm{L}\,p$ the reactance of the armature and any conductors in series with it. Similar considerations apply when the dynamo is working as a generator, only in this case the effect of the induced currents when $\xi = 0$ is to increase the magnetisation while the sign of β_0 is changed. The general result is that if β_0 be outside the limits $\pm\frac{\mathrm{A}\,p\,\rho}{\mathrm{L}^2\,p^2+\rho^2}$ the induced currents tend to damp out the oscillations. On the other hand, if β_0 be within these limits, the induced currents tend to increase the oscillations, and under such circumstances damping coils surrounding the pole-pieces are additional causes of instability. In the case of a machine connected direct to 'bus bars in parallel with others, these limits for β_0 are very narrow; but in motors or converters on long transmission lines they may be so far apart as to give rise to instability at light loads. There is little doubt that trouble has been experienced from this cause. It was one reason for the instability of the small motor to which I have referred, and the constants of that motor might easily be repeated on a much larger machine if there were considerable self-induction and resistance in circuit with it.

We may now consider shortly the damping effect of solid pole-pieces, copper plates over the pole-faces, or copper bars threaded through the pole-face to form a grid. As already pointed out, the effect of the currents in such conducting bodies at the moment when the motor is in the position of steady motion, but moving with more than the steady motion velocity, is to so distort the field as to move the position of maximum induction somewhat behind that which it occupies in steady motion. This is in effect the same as reducing the phase difference between motor and generators, and it therefore in all cases results in a reduction of the torque of the motor as compared with the normal steady motion torque, or on the balance in retardation of the motor. Hence damping coils of this kind invariably exert a true damping or viscous effect. Moreover, I have worked out the amount of the effect, and find that it is much greater than that due to the variation of current round the pole-pieces. It is these conductors across the face of the pole-pieces that are the really useful

* Paper read before the Royal Society, June 18, 1903.

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"amortisseurs," and by their use it would seem that b can always be made positive and the motion stable.

I do not propose here to go into the actual value of the damping effect produced by these "amortisseur" coils. It has been worked out, and the results will shortly be published. One thing, however, may be noted here, and that is that as the resistance of the coils is diminished, the effect increases to a maximum and then diminishes. It is obvious that if the pole-pieces were surrounded by perfectly conducting coils and faced with perfectly conducting plates, there could be no changes of induction produced by an oscillation about steady motion, and, therefore, no damping effect. The point is that the coils diminish the amplitude of the changes of induction produced by armature reaction approximately in proportion to their conductivity, and at the same time give rise to a difference of phase between those changes and their cause. The amount of damping effect is proportional to the amplitude of the changes and to the phase difference. It is, therefore, possible to increase the conductivity of the coils too far—that is, to such an extent that the diminished amplitude more than compensates the increased phase difference. Whether this happens in practice I am not prepared to say, as it depends on many elements, such as the period of oscillation, amount of armature reaction, etc., but I am clear that it is not impossible with constants such as one meets with in ordinary designs.

One other point is of interest in connection with "amortisseur" coils. They have been regarded here as a means of making b positive, or of removing that tendency to instability as regards free oscillations which is inherent in all machines. Of their great value for that purpose there can be no doubt whatever. It has often been suggested that they also play an important part in reducing the forced oscillations which were considered in the first section of this paper. My own belief, however, is that their action in that respect is insignificant. Looking back for a moment to the expression for forced oscillations, damping being taken into account, we found that it was

$$\xi = \frac{P}{\sqrt{b^2 \delta'^2 + (c - M \delta'^2)^2}} \sin (\delta' t - \eta),$$

while the free oscillations were

$$\xi = \xi_0 e^{-\frac{b t}{2M}} \sin (\delta t + \epsilon).$$

Now, by the courtesy of the Westinghouse Company I have been able to observe the free oscillations on a rotary converter fitted with heavy dampers round the poles and across their faces. The design of these coils was the outcome of much experience, and they may probably be taken as giving the most powerful attainable damping effect. I found that if the machine were paralleled when a little out of phase, one could hear it make six or eight complete oscillations There can be no doubt that the ratio of the two successive oscillations was much less than $1/e$. Assuming it to be equal to $1/e$, we readily find that

$$\frac{b}{2M} \cdot \frac{2\pi}{\delta} = 1.$$

Hence in the expression for the forced oscillation

$$b \delta' = \frac{\delta \cdot \delta' M}{\pi}.$$

Now I have already pointed out that the effect of the ordinary flywheel rules is to make δ considerably less than δ'. Hence $b^2 \delta'^2$ is but a very small fraction of $M^2 \delta'^4$, and unless c is nearly equal to $M \delta'^2$—that is, unless there be resonance—the forced oscillations are almost unaffected by the damping. If there be resonance we have $\delta' = \delta$, and

$$b \delta' = \frac{M \delta^2}{\pi} = \frac{c}{\pi}.$$

Hence the amplitude of the forced oscillations is

$$\xi = \frac{P}{b \delta} = \frac{P \pi}{c}.$$

In other words, in case of resonance the forced oscillations would be about three times as big with this amount of damping as they would if there were no flywheel effect at all and no damping. It would seem, therefore, that damping coils are not of much use for dealing with cases of resonance. A slight variation of the period is a much better solution. To sum the whole matter up, the proper way to deal with forced oscillations is to use the right flywheel, while damping coils must be used for giving stable free oscillations.

MECHANICAL COAL-CUTTING.

A committee appointed by the North of England Institute of Mining and Mechanical Engineers to investigate the question of mechanical coal-cutting has just issued the first part of its report, which deals exclusively with long-wall machines. The full report should be in the hands of every consulting and contracting engineer having to do with coal-mining. The committee collected information in the first instance from some 80 colliery companies owning some 200 machines, and an analysis of the information gathered shows that (1) disc machines in long-wall faces are those most generally in use at the present time; (2) few collieries have been using them for more than six years, or to any large extent; (3) compressed-air machines are still in a large majority, although electricity is being increasingly used as the motive power—according to the reports of H.M. inspectors of mines for 1900, out of a total of 316 machines which were at work, electricity was the motive power in 69 only, but according to more recent returns the proportion now is about two driven by air to one by electricity; (4) the thickness of seams in which long-wall machines are in operation varies from 1ft. 1in. to 6ft. 6in.; (5) the depth of cut runs from 2ft. 10in. to 7ft.; (6) the amount of coal cut per machine per year averages roughly 13,000 tons. According to the reports of H.M. inspectors of mines, mentioned above, the average was about 10,000 tons. These figures correspond with those from America, where during the years 1890 to 1896 the tons per machine averaged a little over 10,000 tons, and rose to a little over 12,000 during the years 1896 to 1900; but the American machines are nearly all of the percussive and chain-breast types, and are working, as a rule, much thicker seams and under different conditions.

The committee afterwards made a selection of collieries to be visited in different localities, and 30 chosen for their representative character were inspected by the members. The three points chiefly investigated were cost of working as compared with hand labour, increased production per man employed, and increased percentage of round coal obtained using machines. Under the first heading the committee found that the cost of working per ton as compared with hand labour is reduced in some cases as much as 1s. But on the average from 4d. to 6d. per ton is saved, and in certain cases this cost is not reduced at all. On the other hand, on the average some 65 per cent. more coal is produced per man employed, and this is a very great advantage when house accommodation and free coal are given to the miners. It also enables scarcity of labour to be partially overcome, and may result in the working of thin seams of coal which could not otherwise be profitably undertaken. The increase of round coal varies from 5 to 20 per cent.—that is, 20 per cent. of the total output. In other words, if there is 60 per cent. of round coal worked by hand and 70 per cent. worked by machine, the increase is a 10 per cent. one. The report then discusses the conditions of working and the advantages of various types of machines to meet these conditions most economically. It shows that there is a great advantage in having a machine which will cut in either direction whenever practicable, as this saves a great loss of time in moving the machine from the one end of the face to the other. Into the details of the various makes of machines seen at work we do not propose to enter. As mentioned above, the majority in use at present are of the disc type, and the committee attribute to defective construction the comparative slow progress made by the bar machines. The chain machines introduced comparatively recently are stated to be gaining ground. They have most of the

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advantages of the bar type, with the additional one that the chain brings out the cuttings better than the bar. The need for convenience for rapidly replacing the cutters is dwelt upon in view of the frequent changes required when working. The point in which our readers have the greatest interest is that of the motive power. At present electricity and compressed air are fighting for the supremacy. We, therefore, give the following extracts from the report on this point in full:

"The relative advantages and disadvantages of the use of compressed air and electricity for the purpose of transmitting power underground have been so often and so fully described and discussed, that it is not necessary for the purposes of this report to touch upon them any further than is requisite having regard to the coal-cutting machine itself. Until comparatively recently, compressed air has been more largely used in collieries for power purposes than electricity, and is still preferred by many engineers, despite its lower efficiency, more especially in mines which are of a fiery nature and subject to outbursts of gas, on account of its greater safety under such conditions. The great improvements in air-compressing plant, by means of which the output has been greatly increased and the supply of air regulated in accordance with the demand, as well as the advance which has been made in the manufacture of cheaper and better pipes for its conveyance, have materially increased the efficiency of compressed air. Its comparative simplicity, when placed in the hands of inexperienced workmen, its ready adaptability for all power purposes, and the comparative freedom from injury to the machines worked by it in damp or wet pits, are further points of consequence. On the other hand, the greater efficiency of electricity, and the simplicity and lower cost with which it can be conveyed from the surface to the face, has led to its increased introduction for power purposes. For coal-cutting its use is extending very rapidly at the present time.

"*Compressed-Air Cutters.*—Machines driven by air are generally subject to a greater amount of vibration than those which are electrically driven. This renders it most desirable to have the machines frequently examined and small repairs constantly attended to, as, otherwise, the machine is apt to get into a bad state of repair, necessitating its withdrawal from the pit for complete repair and renovation. It is a desirable plan to keep spare machines, and to have each machine withdrawn after it has been in use for a certain time for a thorough overhaul. This is generally done on the surface, though in one instance an underground workshop has been established in order to avoid the expense of removing the machines from the workings. It is a material point to have the air freed from moisture, so as to avoid the mist which is otherwise caused by the exhaust, and for this purpose underground air-receivers are very beneficial. The face connections or hoses in use with compressed-air machines are heavy and awkward to manipulate. Their first cost is high, as well as the upkeep, as they are very liable to be cut and injured when drawn along the face, and spare lengths should always be kept in readiness for this reason. There are several descriptions of hose is use; and, probably, under ordinary circumstances, the ordinary indiarubber hose, marlin-wrapped, gives the most economical result.

"*Electric Cutters.*—The conditions in which coal-cutting machines have frequently to work are a peculiarly severe test of the construction of continuous-current motors. The heavy vibration, the great and sudden variations of load, coal-dust getting into the coils, moisture damaging the insulation, and the confined space which limits their size are all inimical to their constitution. Yet, it must be allowed, in face of the good results which in many cases they are giving, that the difficulties have been overcome to a large extent by increasing the capacity of the motor and strengthening its construction. Perhaps the chief trouble is the liability to overheating. As is well known, a current passing along a conductor generates heat, which is proportional to the square of the current multiplied by the resistance. This resistance increases with the rise in temperature, and even a small rise in temperature has a damaging effect on the insulating material and reduces its insulating power. The vibration and the presence of coal dust or of moisture also tend to break down the insulation of the coils of the armature. When a heavy strain is put upon a series-wound continuous-current machine, as frequently happens from the presence of pyrites or ironstone nodules in the stratum cut, or from coal or other material falling on the disc, an increased rush of current flows through the motor. If this continues for more than a few minutes, the insulation of the armature coils will be destroyed owing to overheating, and the machine will break down. This is by no means a rare occurrence in the early trials of electric disc machines, owing to the ignorance and inexperience of the attendants. To avoid it needs the close attention and ready judgment of the man in charge to switch off the current at the right moment. Bar and chain machines are not likely to become jammed, they consume less power, and therefore are not so liable to break down in this way. In view of the trouble arising from overheating, it is wiser not to let an electric coal-cutter run continuously for a long time without a stop. It works better when kept cool, but in practice stoppages are generally quite frequent enough.

"*Three-Phase Current.*—Three-phase induction motors have been applied successfully to coal-cutters, both of the disc and bar types. An experience of more than a year at Acton Hall Colliery, where they were first applied for this purpose, goes to show that they are practically free from this liability to break down. They have given great satisfaction there, and are preferred to continuous-current machines. The difficulty of their low starting torque has been overcome by a simple mechanical contrivance, which allows the motor to make a few revolutions before engaging the disc or bar. No commutator or sliding contacts are needed. A reversing switch is attached to the machine, and it can be reversed from full speed in one direction to full speed in the other without shutting off the current. The motor slows down, and then starts off in the opposite direction. During their considerable experience at Acton Hall Collieries they have never yet blown a fuse, though disc machines frequently have been stopped suddenly by coal falling on the disc. Three-phase motors occupy more height, which is a disadvantage in low seams. Electric cutters, owing to the rotary motion in place of the reciprocating, are not subject to such heavy mechanical strains as compressed-air machines. They require, however, to be constantly examined, and, with the cables, carefully tested and kept in order, as otherwise the efficiency of the plant will rapidly diminish. More skill and attention is undoubtedly required than is the case with compressed air. It is of the greatest importance that electric plant should be of a high class, both as regards material and workmanship, and that there should be no cheeseparing about an installation. A properly-constructed plant will give satisfaction, but an inefficient one probably gives more trouble than anything that can be put into a colliery, and it is the worst form of false economy. With electric cutters the face connections or trading cables are handier than the compressed-air hoses, but require to be properly protected. A twin cable appears to be the best, and this may be taped and armoured outside, or may be covered with leather or placed in an indiarubber pipe.

"As regards capital expenditure, there does not appear to be much difference between the first cost of a coal-cutting plant to be worked by compressed air and that of one to be electrically driven. From careful estimates of a first-class plant of either sort, consisting of generating plant complete, and the necessary cutters and their accessories (including two spare machines, without pipes or cables) suitable for a pit at which it is desired to run 10 machines, the cost per machine works out at about £1,000 in the case of compressed-air and £1,100 in that of electrically-driven machines. Electric machines are more expensive than compressed-air machines, the large ones costing about £350 to £450 each as against about £250 for compressed-air machines. The cost of pipes or cables is, of course, dependent on the depth and distance inby. Pipes are more expensive than cables, and, consequently, the greater the distance, the greater the saving in first cost under this head by the use of the latter, though probably the depreciation is considerably heavier. The estimated cost of pipes or cables for a plant of the dimensions named

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above, including all face connections, works out at about £270 per machine for pipes and about £200 for cables, assuming that the depth of the shaft is 600ft. and that the distance from it to the workings is 4,200ft. With plant of increased capacity, the cost per machine would naturally be modified somewhat."

With the details of labour in connection with the machines we do not propose to deal, but in the paragraph relating to the cost of working per ton some figures are given to show that when electrical machines were first adopted high expense was incurred in consequence of armatures being burnt out. This cost in one of the collieries visited was as high as 1s. 2½d. per ton, but this was largely due to unsuitable plant. The committee's conclusion is that 7d. per ton on the average leaves some margin on the right side. As regards the increased production per man, a round average figure may be said to be three tons per shift with hand working and four tons when machines are employed. In other words, for an output of 1,000 tons 333 men are required with hand huing, as against 250 with machines. There is besides this a further gain in the concentration of the workings due to the increased output from a given face, requiring less length of road and less off-hand labour.

ELECTRIC TRANSMISSION DEVELOPMENTS IN NEW ZEALAND.

Through the courtesy of Mr. R. C. White, who is the engineer-in-charge of the Government electricity works at Rotorua, N.Z., we are able to give the following interesting information about electrical development in that district. Some of our readers may not know that the Government of New Zealand has a department devoted to tourists and health resorts, and has erected a sanatorium near the hot springs at Rotorua, which are noted for their medicinal properties in connection with the cure of rheumatism and kindred ailments. In order to supply the sanatorium and other houses in the district, electrical energy is being transmitted from the Okere Falls, 13 miles away. The curves we are able to give herewith clearly show the output and the type of load which this interesting little transmission has to cope with. It will be seen from Fig. 1 that on April 9 this year a maximum output of 85 kw. was required. The regulation is effected in such

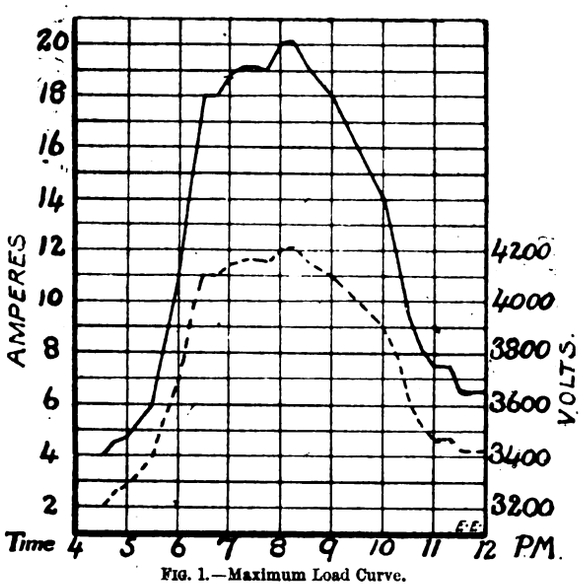

FIG. 1.—Maximum Load Curve.

a way as to keep a constant E.M.F. of 3,000 volts at the Rotorua end of the transmission line. In order to do this with a load of 85 kw., it will be seen that at the transmission end 4,200 volts are required. This means a loss in the line of no less than 1,200 volts. In view, however, of the cheap and practically unlimited power at the Okere Falls, this loss is quite permissible for the present. The minimum load in the current year occurred on Feb. 1 (Fig. 2), when the maximum only reached 40 kw. As is to be expected in an installation of this kind, there is clear evidence that the doctors insist on the patients going to bed early. Thus it will be seen that the maximum load occurs at 8 p.m., and after that time the load rapidly falls away. We understand that the plant is shortly to be extended very considerably, owing to the fact that a new sanatorium is being erected, which will involve much more generating machinery. The good work which has been done in this district with the transmission line of 13 miles is merely the forerunner of large transmission schemes in New Zealand, which will most likely be under the superintendence of the Government. An example of this, which has recently been referred to in our columns, is that of the Huka Falls, where

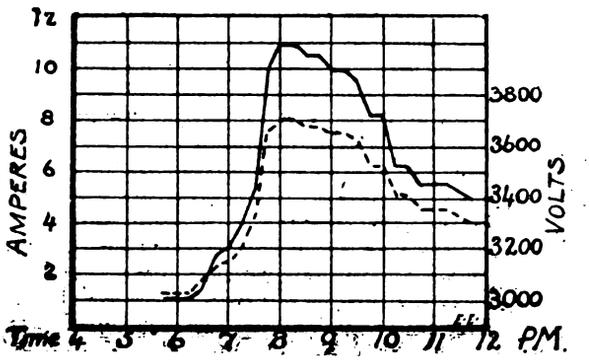

FIG. 2.—Minimum Load Curve.

very large water power is available. It is suggested that in this case sufficient electrical energy should be obtained to work all the trains on the North Island Trunk Railway from Auckland to Wellington. The Minister for Public Works, in answer to a question in the Legislative Assembly, stated that the Government had secured the services of an expert with great experience in America to advise them in the matter. The scheme would involve a transmission of over 200 miles. It is worthy of note that the New Zealand Government is so public spirited as to take the lead in the development of the country's unbounded natural resources.

APPOINTMENTS VACANT.

Junior Engineer, Dundee Town Council.

Working Electrical Engineer. See advertisement.

Armature Winders, Manchester. See advertisement.

Shift Engineer, £100 per annum. See advertisement.

Shift Engineer, Taunton Corporation, £100, 28th inst.

Station Superintendent, Motherwell Electricity Works, £117, Oct. 2.

Canvasser for a London electricity supply company. See advertisement.

Chief Tramways Officer, London County Council, £1,500, 28th inst.

Assistant Demonstrator, City and Guilds of London Institute. See advertisement.

Inspector of Apparatus, British Thomson-Houston Company. See advertisement.

Assistant, meter and testing department, National Electric Supply Company. See advertisement.

Motor and Meter Inspector, supply station in North of England 30s. per week. See advertisement.

Clerk of Works during the construction of tramways and road widenings, Aston Manor Urban District Council, £3 per week. Duties to commence early in October, and duration of engagement for about 12 months. Applications, stating age and experience, to Mr. Robert Green, 37, Waterloo-street, Birmingham, by 26th inst.

Superintendent of Electric Lighting, etc. The Crown Agents for the Colonies will receive applications for the appointments of (1) superintendent of electric lighting, and (2) assistant electrical engineer, under the Public Works Department of the colony of Lagos. Salaries £400 and £300 per annum respectively, appointments for two years' service in the colony. Four months' leave on full pay in this country at the end of each 12 months' continuous service if returning to the colony, and two months if not returning to the colony. Half salary on the first voyage out, but on subsequent voyages full salary will be paid. Applications by letter, stating age and experience, and accompanied by copies of not more than three recent testimonials, will be received by the Crown Agents for the Colonies, Downing-street, London, S.W., up to Oct. 7. The following reference should be quoted on the top left-hand corner of letter of application, M.1,751.

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THE WINTER SESSION.

Men and societies will now be settling down for the winter's work. The interval has been a busy, an interesting, if not an eventful one. The rapid progress in various directions, not only in electrical matters but in other engineering ways, has resulted in the multiplication of societies, each one of which pays particular attention to a special branch of the industry or science it is designed to represent. We are not alarmed at this state of things, though much has been said detrimentally about the number of institutions. There is one phase of the question, however, about which we should like to offer a suggestion. While it seems necessary for the better consideration of details that a number of societies should exist, there are certain fundamental questions relating to all. The British Association has of recent years introduced a system for the discussion of common questions which we think might with advantage be extended, and followed by many societies dealing with different phases of the same subject. It is somewhat invidious to refer to particular societies, but as no reflection is intended, there can be no harm done. It is quite conceivable that an interesting paper could be contributed which would be equally attractive to the Institution, to the Physical Society, to the Faraday Society, and to similar societies—not forgetting to mention the parent of all, the Royal. Men can only devote a certain time to society meetings, and a common meeting with a lapse of an ordinary meeting might enable a larger number to take part in the proceedings. There is far too much exclusiveness in some of our institutions. They are carried out simply as mutual admiration societies, with a curt stand off addressed to those who will not fall down and worship a man whom they are told they ought to worship. Some of them are intensely cliquish, and run more for the benefit of a few active spirits than for anything else. Just as travel broadens the mind of the traveller, so the bringing together of various societies to discuss a common question would tend to prove that no one society contains all the talent of the kingdom We badly want variety, even crass heterodoxy. It is too often only necessary to glance round the faces at a meeting to be able to foretell the names of the speakers, and most frequently it is easy to foretell what they will say. A man who has something to say, and says it in a few words, is a *rara avis* (if a man can be compared to a bird), while the man who has nothing to say, and hides his dearth of such information under a mass of verbiage, is but too apparent.

Another suggestion as to very important questions not coming within the purview of existing societies. Take three questions at the present time important, but not to be dealt with by existing societies in the manner they ought to be dealt with: municipal trading, depreciation in municipal work, and the fiscal question as it affects the electrical industry. These subjects are dealt with in societies and institutions having definite aims and objects, but opposing interests have seldom or never been brought together to try and find out the real points of difference and the points of agreement. Is it impossible to try to get at the truth rather than at some conclusion which seems to assist the party that comes to that conclusion? To give an example outside of electrical matters—some men have written of a certain branch of the glass trade as having been killed by free trade; others give chapter and verse that the trade has been killed by the stupidity of trades unionism. We have at various times given details of electrical apparatus obtained from foreign sources. The value of this appears in the imports, yet the importation has no more to do with free trade or pro-

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tection than we have with the government of Mars. Surely, then, it is necessary that men who know the inner details of business should discuss questions affecting a large industry, rather than allow questionable conclusions to be deduced by those unacquainted with the realities of the question. How and when now can such subjects be considered?

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

INTERMEDIATE SWITCHES AND WIRING.

SIR,—Having been greatly interested in the development of two-way and intermediate wiring from their earliest days, it is gratifying to notice how general the adoption of the latter is also becoming, as your "Questions and Answers" columns of Sept. 11, 1904, show (Answer 610, pp. 399-401).

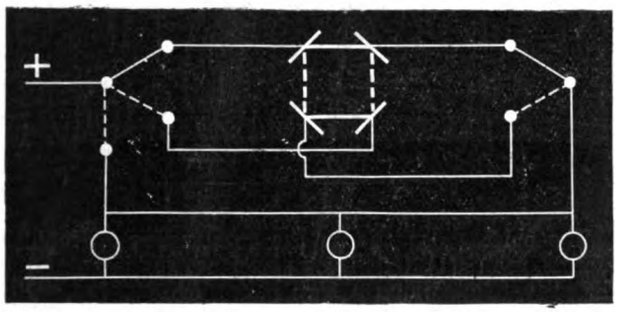

FIG. 1.

I do not think it is generally known, but to Mr. W. H Massey, M.I.C.E., we are indebted for this simple system, where intermediate switches are used to give alternate paths to the current and allow perfect control at every point (Patent No. 16,091, 1891), the first adaptation being

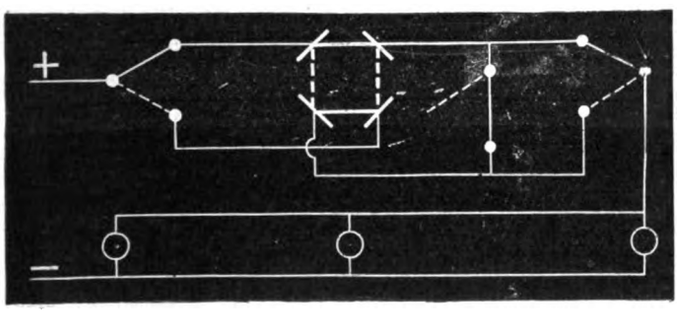

FIG. 2.

made in the autumn of 1891 at the house of H. M. Brunel, Esq. Mr. Massey has done much to advocate the use of this ingenious arrangement, and it now appears as if a general adoption will result.

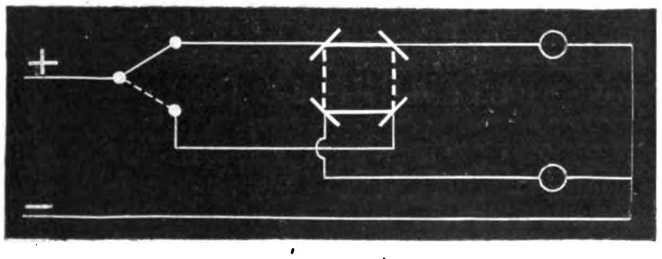

FIG. 3.

A few variations on the original idea may be of interest, and prove at times useful to adopt. Fig. 1 shows how a three-way switch is used at one end in place of the usual two-way switch; this arrangement enables a janitor in flats to cut out of circuit all other switches at times when it is undesirable that the lamps should be turned off. Fig. 2 shows that by the insertion of a simple "master" switch between the two + wires *at any point*, control of the lamps is prevented. Fig. 3 shows a two-way switch used for turning on either of two lamps, or of two groups of lamps; it will be seen that any number of intermediate switches may be fixed in series with such and allow control from other points.

Some mention has been made of the disadvantage of having to use two types of switches (the thumb-key and tumbler) on the same circuit, as the tumbler movement could not be obtained adapted for "intermediate" use, or at the best, the necessity of coupling two tumbler switches together, which means less simple connections and an ugly fitting. I have a tumbler switch movement constructed in accordance with my patent No. 131, 1901, to form an intermediate switch, the article being of standard size except for a slightly thickened base. Fig. 4 shows the circuit connections where only tumbler type switches are used.

While on the subject of intermediate wiring, it may be of interest to your readers to study the patent specification

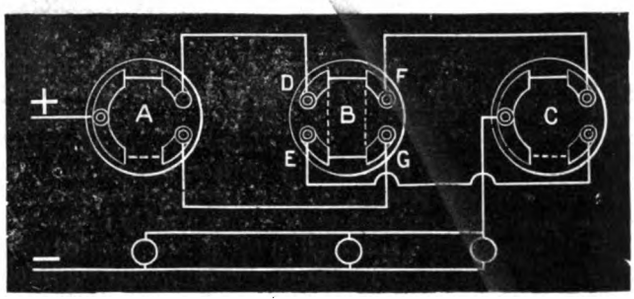

FIG. 4.

of C. A. Allison, No. 6,606, 1894, which describes a different plan for accomplishing a similar object to that shown in Fig. 4.—Yours, etc., A. P. LUNDBERG.

London, N., Sept. 17, 1903.

PRIORITY IN OIL-BREAK SWITCHES.

SIR,—In the paper read before the British Association recently by Mr. W. B. Woodhouse, it is said "that the first oil-break switch to be put to practical use was at the Paderno power station in 1897," and that "this was designed by Messrs. Brown, Boverie, and Co."

This statement should have been qualified to apply to the Continent only, because it is well known that oil-break switches were used in this country earlier than 1897. This company designed oil-break switches in 1894. The first large switchgear made which contained oil-break switches was installed by us at the City of London Electric Lighting Company's works at Bankside. The switches were erected and tested in 1895, and the complete equipment was put into constant use in the following year, and it has been giving—as far as we are aware—satisfactory results ever since. Originally the gear consisted of 60 panels, each suitable for a maximum capacity of about 750 kw. at 2,000 volts, but has since been extended to about 80 panels of the same design.

It may also interest your readers to be reminded that Mr. Ferranti's patent for "electric switches in which the contacts are immersed in oil or other insulating fluid upon breaking" was applied for in 1895.—Yours, etc.,

FERRANTI LIMITED.

Hollinwood, Lancs., Sept. 22, 1903.

ON SINGLE-PHASE REPULSION MOTORS.*

BY WILLIAM CRAMP, A.M.I.E.E.

It is a matter of common knowledge that if it were possible to construct a single-phase alternate-current motor having the characteristics of a direct-current series motor, and no serious drawback, it would find a very extensive

* Paper read before the British Association, Southport meeting.

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application, on account of its extreme suitability for the transmission of power, especially in connection with railway work on long lines. There are many forms of single-phase induction motor on the market, some of which are, for certain purposes, very useful. Yet in spite of these, the single-phase motor is avoided wherever possible, as is clear from the many costly alterations which are being carried out in this country. It is only necessary to mention a few examples of this. In Croydon a direct-current plant has been laid down for the centre of the town, solely to provide for motors, in addition to the already existing alternating supply. The City of London Electric Lighting Company are slowly replacing alternating by direct current, for similar reasons. The towns of Coventry and Sheffield are introducing two-phase in place of the existing single-phase system. No doubt, much of this will be changed if the Baltimore and Annapolis Railway is successful, since that will demonstrate the existence of single-phase motors comparable to the direct-current series motor, and the extreme simplicity and flexibility of the single-phase system will again recommend its adoption in cases where three-phase plant is now in contemplation.

At present there is a choice of three types of motors on single-phase systems.

1. *The Synchronous Motor.*—The disadvantages of this form, where starting and stopping is frequently necessary, are sufficiently obvious

2. *The Asynchronous Induction Motor.*—The disadvantages of this motor are that special devices, always cumbrous and often very expensive, must be employed to start it up, and even then a current usually considerably in excess of the full-load current is needed to run it up to speed under load—often a grave objection on lighting circuits. Moreover, even under favourable conditions, the power factor is poor, the efficiency not high, the possibilities of varying the speed almost nil.

3. *The Series Alternate-Current Motor.*—This moter bids fair to rival the previous forms for general application, and will, as we have said, be thoroughly tested on the Baltimore and Annapolis Railway. Its disadvantages are that the frequency at which it is most successful is very low, thus rendering it inadmissible on lighting circuits, while its power factor tends to decrease with load, and pressure difficulties at the commutators are almost unavoidable.

The only other type at present practicable is the repulsion motor. For several years past I have been working to ascertain the lines on which really efficient and satisfactory motors of this type might be designed, and I now believe that repulsion motors may be built, up to at least 20 h.p., which will compare favourably with any type of motor at present in use. In its simplest form the repulsion motor consists of a laminated electromagnet or stator excited from the single-phase mains, and an armature or rotor wound almost exactly like the armature of a direct-current machine, and fitted with a similar commutator. Brushes rubbing on this commutator are set at a particular angle and short-circuited. The alternating flux set up by the stator induces in the coils of the rotor currents in such directions that the coils carrying them tend to move out of the inducing field. The action is exactly the same as that shown by Prof. Elihu Thomson to exist when a plain copper ring is brought into the field of a solenoid excited by an alternating current.

Figs. 1 and 2 show clearly the two main forms of repulsion motor. In Fig. 1 the angle θ is usually 45deg. or less. This type has the following peculiarities: (*a*) the E.M.F. of a quarter of the rotor opposes that of the other three quarters, leaving half the rotor for useful E.M.F.; (*b*) the rotor current passes through all the coils, whether in a useful position or not, thereby increasing the $C^2 R$ loss; (*c*) a quarter of the rotor gives a torque opposing rotation; (*d*) individual coils short-circuited by the brushes are constantly giving a torque opposed to rotation, and causing difficulties with commutation. These disadvantages led me to construct repulsion motors on the lines of Fig. 2; and it is partly due to the adoption of this form that I have succeeded in obtaining satisfactory commutation. The difficulties of construction, chief among which is commutation, have led most writers to speak of repulsion motors with much distrust. Thus Elihu Thomson, whose patent of 1889 covers the whole principle of repulsion motors, refers to them as capable of giving out considerable power, "though with what economy is unknown." Prof. Jackson condemns them as "bulky, expensive, and inefficient," though he adduces no evidence in favour of this verdict. Mr. Steinmetz writes "they have the disadvantage of using only part of the rotor," but as recently as December, 1902, he said that he believed better results were to be obtained from them than from series alternate motors. To show how very misleading are these statements, I here add: (1) That Mr. Hobart proposes using only 50 per cent. of the armature for his recent direct-current machines. (2) If the coils of the rotor are only half of them used at any given instant, it is obviously possible to work at a higher current density. In one of my experimental motors I have had eight amperes through No. 21 wire without serious heating. (3) In such alternators as the Mordey-Victoria, only half the armature is ever really active at one time.

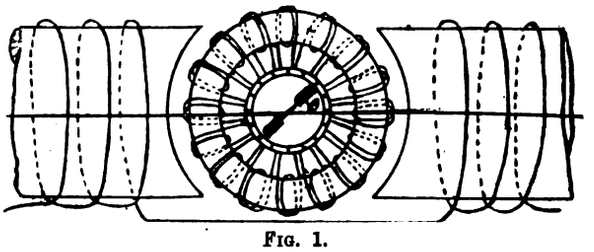

FIG. 1.

The chief difficulties in the construction of repulsion motors are: (1) liability to vicious sparking and (2) difficulty in obtaining a high power factor. In the first form of repulsion motor which I tried I found that the spark was almost as great on closing the coil as on opening it. In order to investigate this, I had some experiments carried out on the opening and closing of circuits, of which I now relate briefly the results. With an inductive circuit there was less tendency to spark on the make than with a non-inductive circuit, and there was much less tendency to spark on the make with copper than with carbon contacts. I find, on the whole, that to avoid sparking on the make, a good, firm, clean, low-resistance contact is adequate. For this reason I have so far used copper brushes in the motor, but, despite this, the choice between carbon or copper has to be decided by the consideration of the whole of the circumstances, which would be too long to discuss now. With copper brushes I have been able to get absolutely sparkless commutation, working from

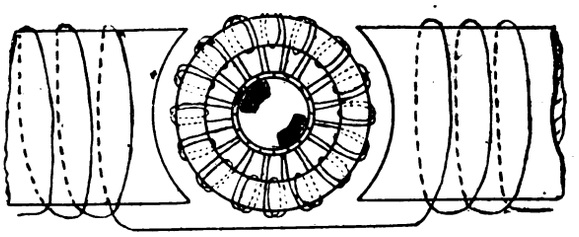

FIG. 2.

nothing to full load, on a motor whose design was in other respects distinctly faulty. These results refer more particularly to motors of the class represented by Fig. 2, whose only disadvantage is the long arc of brush contact, entailing corresponding friction. Having by copper brushes provided for closing the circuit sparklessly, I was enabled to obtain sparkless opening by means of the same principles that are employed in what is known as "resistance commutation"—that is, providing a sufficient interpolar space to enable each rotor coil to pass entirely outside the magnetic field, so that the current can die down before the opening of the circuit. It is obvious that a form of commutation might be employed corresponding to what in dynamo design I call "E.M.F. commutation" (a term which explains itself); or, better still, a combination of E.M.F. and resistance commutation, and as the output of the motor undoubtedly increases with pole width, it might pay to use one of these modifications, on which point, indeed, I am at present experimenting. In considering the actual

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design of a repulsion motor, the first object is to decide which form of commutation you are going to rely upon. Having settled this, the form of stator is practically fixed, for if resistance commutation is to be relied on entirely, the stator must have distinct poles—by this I mean that there must be considerable air-space left between one polar winding and the next, as in the direct-current machine. On the other hand, if E.M.F. commutation be used, the stator may be built exactly like that of an ordinary single-phase motor. I have tried both forms, and find that while both may be rendered sparkless between certain limits, the former gives good commutation over a wider range, while the latter gives better starting torque and better power factor. But I would insist on the fact that every form of repulsion motor may be rendered sparkless if the design of the rotor winding is properly considered. Thus, what has been hitherto the great disadvantage of the repulsion motor disappears.

We therefore proceed to consider the design of the rotor winding. We may choose an arrangement such as that in Fig. 1, or a modification of Fig. 2. The salient differences between these two forms are: (1) in Fig. 1 all the short-circuited coils are in series, while in Fig. 2 they are in parallel; (2) in Fig. 1 the rotor current always passes through the whole of the rotor coils, whether active or useless; in Fig. 2 this is obviously not the case. If the rotor winding has to carry a large current, Fig 2 is not very suitable on account of the fact of the large heating that takes place at the commutator, and the large proportion which brush resistance bears to the resistance of the coil lying between any given pair of segments. I have already

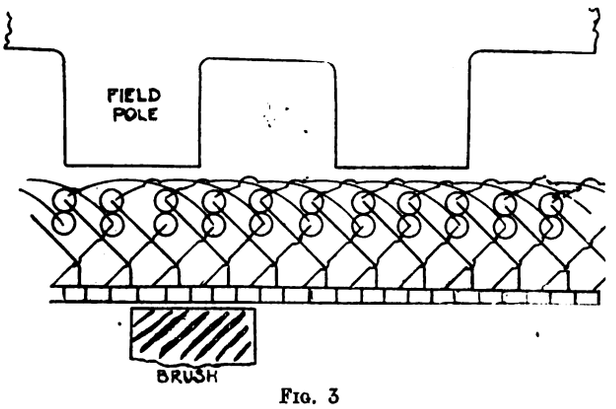

FIG. 3

stated, under the head of "Commutation," other reasons for selecting windings of the type of Fig. 2, but I ought to add that recent experiments with windings of the type of Fig. 1 impress me very favourably, and all motors at present under construction are of this type. In actual experiment with windings like Fig. 2, I have found that if the rotor is of the closed-coil type, as shown, besides those coils actually short-circuited, there are other closed circuits carrying useless, or even harmful currents. Hence, in the particular motor on which most of these experiments were made, the winding has been altered to that of Fig. 3, thus practically converting the rotor into an open-coil armature, with two coils in parallel.

These considerations determine the type of rotor winding, and we now pass to the discussion of the E.M.F., current, torque, etc., taking first the case of a bipolar motor with a single coil, as in Fig. 4A. This diagram is really a simple case of Fig. 2. If the pole arc is 50 per cent. of the pole-pitch, and equal to the width of the coil, and the distribution of magnetic flux radially around this pole arc is sinusoidal, then the E.M.F. set up in the coil is a pure sine wave. If, however, the flux is distributed *uniformly* radially over the pole arc (as is more probable in an actual machine), the lines enclosed by the coil when the field is constant are as represented in Fig. 4B. This is a sine wave with some odd harmonics, which are of small importance in the present case; the third harmonic, which is the largest, has an amplitude of only 1/9, the fundamental. I shall assume, then, for present purposes, that both the time variation of the main flux and the time variation of the area of the coil with respect to the total flux are both sine functions. We then have, if number of turns on the stator winding $= t_1$, number of active turns on the rotor $= t_2$, maximum magnetic flux per pole $= F$, speed of motor in revolutions per second $= n$, periodicity of stator current in periods per second $= f$, R.M.S. primary E.M.F. $= e_1$, R.M.S. secondary E.M.F. $= e_2$. Then it is found that

$$e_2 = \frac{e_1}{\sqrt{2}} \frac{t_2}{t_1} \sqrt{1. + \left(\frac{n}{f}\right)^2}$$

which means that the secondary E.M.F. may be represented by the resultant of two lines at right angles, as shown in the phase diagram (Fig. 5).

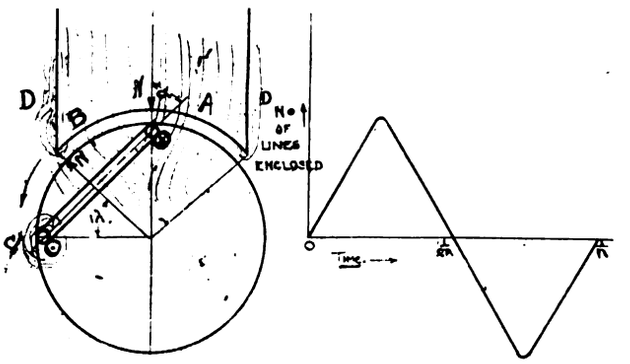

FIG 4.

Passing on to the equations for current, we have, upon closing the circuit when one side of the coil is just coming into the field, a current made up of two terms—(A) the exponential term, (B) the ordinary sine wave. The term (A), which may usually be neglected in other alternating-current apparatus, is often, in the case of the repulsion motor, of great importance. It is extremely difficult to show the value of this term in any phase diagram, but its general effect is to shift the rotor current slightly forward in phase, and to cause the torque of the rotor to sink to zero at a lower speed. The cases in which it is of greatest importance are those of the type of Fig. 2, in which the number of turns per coil is large. I found its effects to be very strongly marked in the first two motors I made; but I do not anticipate that in future designs its effect will be so marked, for two reasons: first, because I now aim at few turns per rotor coil; and, secondly, because I use a greater number of commutator segments. Coming now to term (B), I think it is easier to

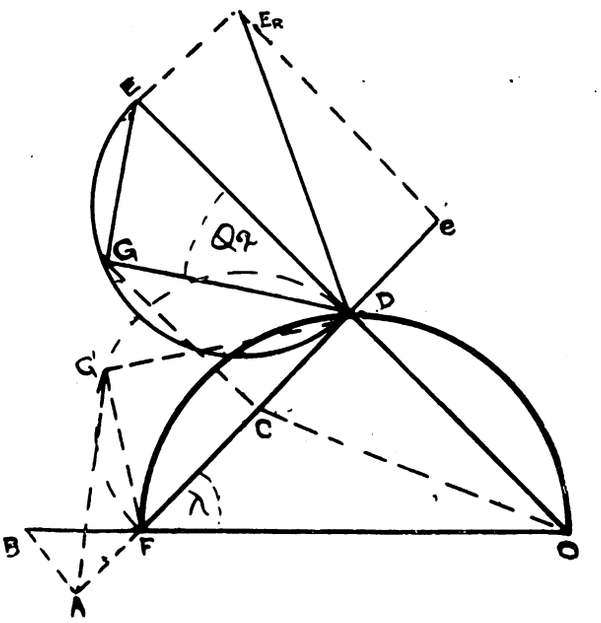

FIG. 5.

consider the action of the motor from the standpoint of the Heyland diagram. In Fig. 6 we have a representation of the transformer diagram. Figs. 4 and 6 are lettered alike. S is the stator, R the rotor. Let the flux at T T be represented by O F (Fig. 5).

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Now, we may resolve the field O F in two directions in space—viz., along the line of the brushes and at right angles thereto. F D and D O will represent these components, the point D lying upon a semi-circle, as shown. The angle D F O is that corresponding to λ in Fig. 4. D F now represents the field which vibrates through the rotor coil, and D E, at right angles and proportional to it, must represent *in time* the E M.F. generated in the rotor coils. (It is better to keep time and space separate by arranging all quantities in *phase in time* in one plane. Thus D E would be drawn in a plane at right angles to that containing D F O, as is done in the author's model.) The E.M.F., D E, may be resolved into two components at right angles in time D G, G E. Of these two, G D is proportional to the C R drop in the rotor coil, and hence to scale (with constant rotor resistance) represents the magnitude and phase of the rotor current. G E represents that component of the rotor current tending to demagnetise the stator. The angle ϕ_2 is the angle of lag of the secondary or rotor current. As ϕ_2 increases, the rotor C R drop D G decreases and the rotor demagnetising component increases till E G = E D, when the rotor current is zero and the field F D is balanced. Now, since D E is proportional to D F, it may be drawn of the same length. Then the semi-circle D G E may be applied to the line D F, so that E falls on F D G, and E G becomes F G^1, and shows the way in which D F becomes gradually balanced. The angle G^1 D F then = G D E = ϕ_2. Now, the component of D G in phase with D F or D O is the projection of D G on D F = D C = D G sin ϕ_2. This component multiplied by D O is proportional to the torque of the motor—*i e*, the torque varies as the area of the triangle D C O.

We have rotor current $\propto$ D G $\propto$ D E cos ϕ_2;

D E $\propto$ D F = O F cos O F D = O F cos λ;

D O = F O sin λ;

D C = D G sin ϕ_2.

Hence torque at starting = D C $\times$ D O;

= D E sin ϕ_2 cos $\phi_2 \times$ O F sin λ;

= O F . O F . sin ϕ_2 cos ϕ_2 sin λ cos λ;

which is a maximum when $\left\{\begin{matrix}\sin\lambda=\cos\lambda\\ \sin\phi_2=\cos\phi_2\end{matrix}\right\} = \frac{1}{\sqrt{2}}$—*i.e*,

when α and ϕ_2 = 45deg.

Now, O F $\propto$ primary voltage (nearly). Hence the starting torque is proportional to O F^2—*i.e.*, to the primary voltage^2.

These are the starting conditions.

Running Conditions.—Directly the starting torque is large enough the rotor begins to revolve, the coil F (Fig. 4) tending to set itself so that it encloses a minimum of the magnetic lines issuing from the stator. Thus motion takes place in the direction of the arrow in Fig. 4; and this must be due to the fact that the current sets up a field in the rotor coils which is on the whole of opposing—*i.e.*, identical—polarity to that existing in the stator. Thus, if at a particular instant (in Fig. 4) the polarity of the stator is north, as marked, the polarity of the rotor field, due to the lagging rotor current, must at the same instant be north. At this particular instant the lagging rotor current must be in the direction shown by the cross (+) and dot in Fig. 4. By Lenz's law the E M.F. set up by rotation must oppose this current. Therefore, directly the rotor begins to revolve, the rotor lagging current is reduced, or, in other words, the coefficient of self-induction of the rotor coil is virtually diminished. Suppose, now, the rotor is running, then the coil shown in Fig. 4, immediately it moves, would have its place taken by the one next it, and thus, although the rotor revolves, we may, as it were, speak of an "equivalent stationary coil," whose axis is settled by the diameter upon which the brushes are set. Considering now the coil shown in Fig. 4 as representing this equivalent stationary coil, we see that its coefficient of self-induction may be altered to a certain extent by moving it round in the direction of rotation. In this way, however much the phase of the rotor current may be altered by the E.M.F. due to rotation, the original conditions may be reproduced by moving the brushes in the direction of rotation. Theoretically, this may be carried on till the axis of the coil is at right angles to the axis of the field, when the speed of the rotor is infinite. Naturally, in practice there is a limit, depending upon the particular form of stator and the torque necessary to overcome the friction of the rotor bearings, etc.

In order to show this E.M.F. due to rotation in Fig. 5, we remember that it is really produced by the field D O, and, therefore, will be at right angles to D O in space. Thus it may be represented by D *e*, and its effect is obviously to reduce the secondary lagging current, thus reducing the primary lagging component and the total primary current. With increasing speed, then, the point *g* will tend to travel along its semi-circle. The value of the component

$$\text{D E} = \frac{e_1}{\sqrt{2}}\frac{t_2}{t_1}, \text{ whilst D } e = \frac{e_1}{\sqrt{2}}\frac{t_2}{t_1}\cdot\frac{n}{f}.$$

Thus at synchronism D *e* = D E, and if the motor started with maximum torque the point *g* will have arrived at E, when the motor arrives at synchronous speed.

The above results are only approximately correct, for the following reasons. We have assumed conditions of constant field which do not exist exactly in ordinary conditions. Again, we have assumed that the current-conductor distribution around the rotor is sinusoidal, which is not true, and that the number of conductors acted upon by the field D O is the same as that under the influence of the field D F. Later I hope to have an opportunity of showing how each of these peculiarities affects the phase diagrams already given. For the present it is important to note that the machine will generate if revolved in the direction opposite to the arrow in Fig. 4.

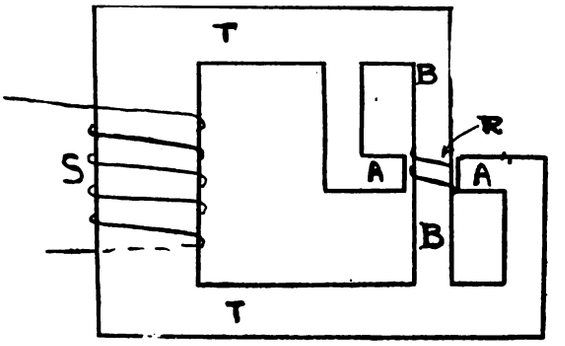

FIG. 6.

Since the law of the diagram is so simple, a model may easily be constructed, ruled by the fact that O F is of constant length, and the point D moves along a semi-circle. From this model the values of primary and secondary current, torque, and power factor may readily be deduced, and the following peculiarities may be noted:

1. The *torque* depends on the relative phases of stator and rotor currents, and at starting it is a maximum when the power factor is about 60 per cent. At any speed the torque will always be a maximum with about this power factor, but in order to keep this maximum torque the brushes would have to be gradually moved in the direction of rotation as the speed rose. In the case of small motors, I should say that there is no reason at all why the brushes should not be moved forward, either automatically or by hand in this way, since, as already shown, sparking difficulties may be completely overcome.

2. *Power Factor.*—If maximum torque is required of the motor at starting, and the brushes are to be kept fixed, it follows that the power factor can never exceed 70 per cent. This at first sight appears a serious drawback, but in actual practice there are many cases where it will be no disadvantage at all. Take, for instance, a small printing establishment, or a tramway system of no great length. The disadvantages of the lagging current are two-fold: (1) C^2 R loss in the line—of small importance, as we have supposed the line short; (2) reduction of the voltage at the generating station by reaction upon the alternator fields, which is clearly counter-balanced by the fact that the power factor of such motors is a maximum at starting and gradually decreases as the stator current decreases while

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running. Thus the actual value of the lagging current will not vary very seriously, and, so far as the engineer at the central station is concerned, should cause no trouble. In fact, the motor is in this respect in as good a position as a polyphase motor started with resistance in its rotor circuit, and in a far better position than any ordinary single-phase induction motor. In the case of large motors or long transmission lines, the power factor of the motor with maximum torque at high speeds may be very materially increased. Perhaps the best way of doing this is by means of slip-rings attached to the rotor windings, just as if it were a rotary converter. Resistances inserted between these slip-rings are gradually cut out as the speed rises, so that the motor finally acts as an induction motor, a device of mine incorporated in a repulsion motor arranged at the Central Technical College three years ago, and which I see from an article by Herr Schüler in the *Electrical Engineer* of Sept. 4 has recently been the subject of an English patent.

3. *Efficiency.*—In any class of electromotor this is bound to depend largely on the amount of material put into it. Comparison is, therefore, admissible between motors of different types and of the same weight. In this connection my present experience does not enable me to give any definite figures, but I should say that the repulsion motor for a given power will be heavier than the corresponding polyphase motor, and lighter than the single-phase motor with its starting apparatus. Considering the enormous waste of energy in starting the latter, the repulsion motor will be far more economical for non-continuous running. Unfortunately, detailed results of actual output per kilowatt during continuous running are not yet forthcoming from any source.

4. *Starting Advantages.*—Under the best circumstances the repulsion motor may be started under full load with a current only slightly exceeding the full running current. This great advantage is obtained without any expensive and cumbersome starting arrangement, and it is this which must be put forward as the great advantage of this type of motor. Of course at starting the motor is really a special case of the split-phase type of motor, and the only reason why it is so much better than other motors depending on this principle, is that the phase splitting is performed by the motor itself, and depends on no additional apparatus. Further, by careful design the phase difference produced at starting must be so very much greater here than in any starting apparatus for single-phase motors, except such as depend on the introduction of a very large condenser.

This paper must, of course, be considered as preliminary, in that no curves of results are given, but these I hope to have ready to publish shortly.

(To be continued.)

PERSONAL.

Mr. Alfred S. Blackman, M.I.C.E., who has for four years been electrical engineer to the borough of Poplar, has been appointed by the Electricity Committee of the Bradford Corporation to the position of electrical engineer, formerly held by Mr. Chattock, at a salary of £600 per annum. Mr. Blackman is a member of the Institution of Electrical Engineers, is 33 years of age, and has been electrical engineer at Poplar for four years, previous to which he had experience in a similar position at Aberdeen, and was assistant engineer at the works of the Hove Electric Lighting Company, West Brighton. He goes to Bradford with excellent testimonials. The appointment will come up for formal approval of the City Council this week.

Mr. W. H. Merteus, Brighton, has been appointed assistant electrical engineer and clerk of works for the new electrical supply installation at Londonderry.

Mr. Richard Pape, borough electrical engineer at Morecambe, has resigned, he having received the appointment of municipal electrical engineer at Port Elizabeth, South Africa. The selection of a successor is to be made to-day. We understand that the candidates selected are Messrs. W. H. Hall, Yeaman, and J. Hargreaves.

Tariff Controversy.—The present time is particularly opportune for the publication of any volume dealing with the question of fiscal policy. Our readers will be glad to know that Messrs. P. S. King and Son, Westminster, have just published "The Tariff Problem," by W. J. Ashley, the well-known writer and lecturer on economics.

QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any questions should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

621. Resonance occurs when the natural period of discharge of a circuit is equal to the generator frequency, and is complete when the self-induction and capacity of the line exactly neutralise each other. Explain this clearly.—T. G.

622. Explain how to find the efficiency of an alternating-current motor of 6 h.p., the speed being 1,500 revolutions per minute.—W. F. F.

ANSWERS.

Question No. 613.—I have two motors, 2½ h.p., 85 volts, and my voltage on the mains is 110. Please tell me the best economical method of using above motors.

Best Answer to No. 613 (*awarded* 10*s.*).—The question does not state whether the motors are shunt or series

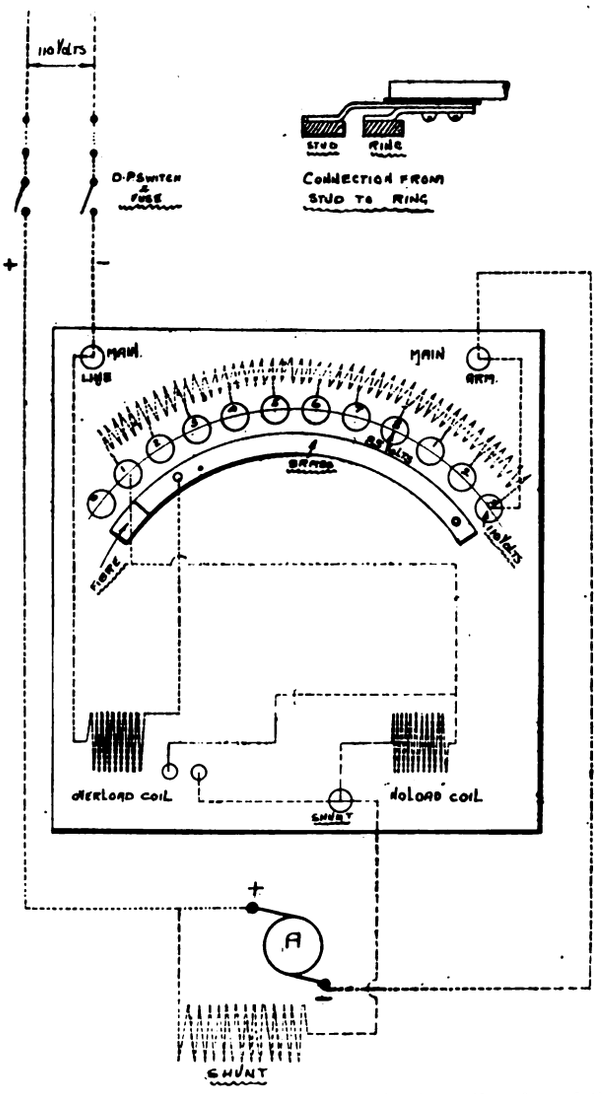

Diagram of Connections for Motor-Starting Switch. Connections shown dotted

wound, so I presume they are shunt. I do not think there is really an economical method of using the motors in question without any alteration to the winding of same,

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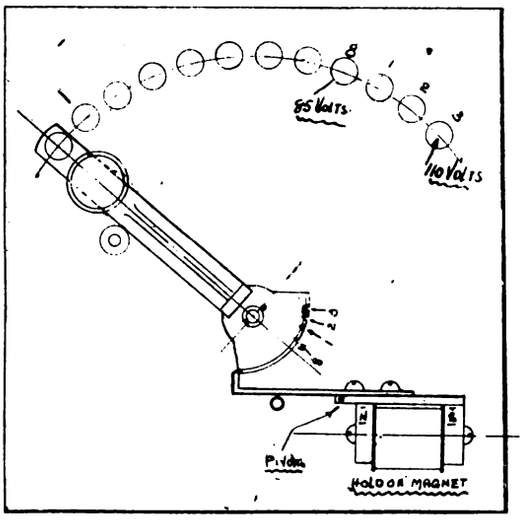
which, I presume, must not be done, because the extra volts or watts (110-85) is practically all waste if the motor is to run on 85-volt mains and no higher, but if an increase of speed is required (which is often the case) then the extra power may be used to advantage—*i.e.*, the resistance being cut out and the E.M.F. at the brushes increased. If the machines are liberally designed the extra volts ought to make very little difference in the working (especially if of the open type) for two or three hours at the least, when the temperature will rise if on full load, but if on three-quarter or half load the rise will be most noted in the field coils, which are designed to carry a certain current at 85 volts, then when 110 volts are applied the C^2R loss will be increased, according to Ohm's law, but I do not think sufficiently to be harmful to the machine. If this was found to be unsafe, a permanent resistance would have to be inserted in series with the shunt winding, either contained in the starter, or, preferably, in the form of extra shunt winding, the cost of which would be very small. It will be noted from the diagram that the armature starting resistance is in series with the shunt winding, which might help matters, and if the no-load release magnet (which is in series with the shunt winding) were wound with resistance wire this might also help.



Starter Front, showing Arrangement of "Hold-on" Magnet.

Summing up, I think the most satisfactory method would be to make an experiment with the machines and obtain exact data accordingly, which would be useful to the makers of the starting switch, and then to have a starter specially made and connected as shown in diagram. It would contain, say, 11 contacts in all, eight for the 85 volts and three from 85 to 110 volts, a lower current density being allowed in the coils connected to the last three contacts than in the starting coils, because they would perhaps be used continuously. When the starting resistance is all cut out, the lever will stop on that contact (No. 8) and on each of the succeeding ones (1, 2, and 3) but on no one between 0 and 8, as per arrangement shown in sketch herewith. The starter will be of the automatic type, having no-load and overload release, the latter being wound for maximum 110-volt current and adjustable as usual.—P. P. D.

Answer to No. 613 (*awarded* 7*s.* 6*d.*).—The question as raised might refer to either continuous or alternating current motors. Taking the case of a continuous-current motor first, if the motors in question are series wound, by running them straight off the 110-volt mains a greater speed will be attained, and so a greater output available with any given current than when running on 85 volts. The increase in speed will be directly as the increase of voltage. If, however, the motors are shunt wound it will be quite safe to put 110 volts on the armature, but the resistance of the shunt field circuit will have to be increased in the proportion of 110 : 85—*i.e.*, by approximately 30 per cent.—in order avoid overheating. If the poles are not already saturated, the necessary additional resistance might well be obtained by winding additional turns on over the present spools, and connecting these turns into the shunt circuit. If, however, the poles are nearly saturated, it would be simpler to make up a resistance to put in series with the shunt field winding of the motors, one for each. In this latter case a definite amount of energy which is not being utilised will be dissipated in the resistance, but this would be so in any case if, as is supposed, the poles were already saturated. This dissipated energy would be about 23 per cent. of the total amount expended in the field circuit. In the former case the speed increase will depend on the change of flux; in the latter case, where the flux is unaltered, the speed will increase directly as the voltage. In each case the available horse-power will be nearly three. If the motors are compound wound, the shunt field winding only will need alteration and will be treated like the field of a shunt motor. If they are induction motors, it would not be advisable to run them at 110 volts on a circuit of the frequency for which they were designed at 85 volts. They would run satisfactorily on a circuit of 110 volts and a frequency 30 per cent. higher than that for which they were designed. In the former case the starting current would be much higher, and the magnetising current would also be much higher depending on the type of machine. If the saturation of the core is not high, the motors might run satisfactorily at 110 volts and rated frequency, but it is doubtful.—J. M. R.

Answer to No. 613 (*awarded* 7*s.* 6*d.*).—If the machines are not running at an excessive speed already, they can probably be put directly on to the higher voltage without harm, provided that a small amount of resistance is inserted permanently in series with the shunt winding to prevent the latter overheating. If this resistance is arranged to keep the shunt current the same on 110 volts as it is at present on 85 volts, the speed of the motors will increase exactly in proportion to the voltage—*i.e.*, some 30 per cent. The current taken to develop 2¼ b.h.p. will fall some 30 per cent, so that at the old full-load current the motor will really be capable of developing 2¾ b h.p. to 3 b.h.p. on 110 volts, with practically the same temperature rise and at least as good an efficiency as before at 2¼ b.h p. If the increase of speed is inadmissible, it will be necessary to completely rewind the armatures of the motors, putting on about 30 per cent. more turns of a wire 30 per cent. less in sectional area than the present wire, and at the same time inserting the resistance in the shunt winding as above. The speed and output would then remain unchanged, and the current taken from the mains to develop 2¼ b.h.p. would be reduced in the ratio of 85 : 110.—Q.

Answer to No. 613 (*awarded* 5*s.*).—From the wording of the question "J. W." has probably not tried the effect of running his 85-volt motors direct on the 110-volt mains, as it is quite likely that a satisfactory result would be obtained by so doing. The only objections are that the speed would be increased about 15 to 20 per cent., and that the field coils would get rather hot. The first of these two difficulties can probably be overcome by fitting pulleys of rather smaller diameters to the motors, and the second by placing small resistance coils in series with the field windings to reduce the field currents. There would be a small loss of power in these resistances, amounting to ·4 kilowatt-hour per day, assuming the two motors to be both running for eight hours a day, and this would amount to a total yearly loss of about 23s. if the motors are running every day. It is quite possible that the field coils are very cool on 85 volts, in which case the heating might not be excessive on 110 volts, and consequently no resistances would be required.

If the method cannot be carried out owing to the speed being definitely fixed, it is possible to use a main circuit resistance in series with the motor armatures to absorb 25 volts out of the 110 volts on the supply circuit, and so to allow 85 volts across the motor armatures. In this case the loss of power would be very great, being 10 kilowatt-hours per day of eight hours, which amounts to a yearly loss of about £28 on the two motors. Instead of allowing this power to be wasted in the resistance, it could be used for driving a small fan motor, wound for the special low voltage, which would cost about £4 complete, and would

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probably be a useful article for ventilating any office or building close by. The armature and field coils of the motors could be rewound for 110 volts at a total cost of about 45s., and then no resistances of any kind would be required; but it does not appear to be advisable to do this unless the speed is definitely fixed, as in the writer's estimation the method first mentioned is the cheapest and most economical.—P.

Question No. 614.—In motor starters, graded in G.P. and having wires with a rating proportional to dia.$^{\frac{3}{2}}$, how should the constant K (or the diameter of the wire) vary from the first to the last contact for the same temperature of wire, and for the greatest economy in resistance material, allowing the same space of time on each contact (say three seconds). Consider a 5-h.p. starter with 16 contacts, and a similar one with 24 contacts.

Best Answer to No. 614 (*awarded* 10*s.*).—Suppose the 5-h.p. motor to be on a 110-volt circuit and taking 40 amperes at full load, also that it is shunt wound, having an armature resistance of ·2 ohm. Generally, for our purpose, the shunt winding may be neglected. The formula giving amount of resistance is

$$A \times r^n = R,$$

where A = resistance of armature;
r = ratio (in this case $\frac{3}{2}$);
n = number of parts into which resistance is divided;
R = whole amount of starting resistance.

We then have for a starter with 16 contacts—that is, the whole resistance divided into 16 − 1 = 15 parts $R = ·2 \times (\frac{3}{2})^{15}$.

$$\therefore R = 8·75 \text{ ohms}$$

Commencing with the armature, we then have the series—

$$·2;\ ·2 \times (1·5);\ ·2 \times (1.5)^2;$$
$$·2 \times (1·5)^3 \ . \ . \ . \ ·2 \times (1.5)^{15}.$$

With such conditions and turning lever of starter to first contact (allowing for brush resistance), the current will have an approximate value of

$$\frac{110}{9} = 12·2 \text{ amperes.}$$

This current may not start the motor, as it is less than one-third of the full load current, and, consequently, the torque will be less in proportion to the current flowing in the armature. On turning lever to the second contact current will be

$$\frac{110}{·2 \times (1·5)^{14}} = 18·3 \text{ amperes (approximate),}$$

and so on until sufficient torque is obtained.

For a starter with 24 contacts—that is, with the resistance in 23 divisions—we have

$$·2 \times (\tfrac{3}{2})^{23} = 63·39 \text{ ohms.}$$

With such an arrangement, under the conditions supposed, it is almost certain that the armature would not move until the lever had passed over several contacts. A general rule is to allow the resistance wires to carry from one-sixteenth to one-eighth their fusing currents. It is impossible to give definite figures. Even with the best starting switches damage may be done by starting up too quickly, or by leaving current on the resistance for too long a time.—M. M.

TRADE NOTICES AND NOVELTIES.

Steam Accessories.

We are indebted to Messrs. Holden and Brooke, Limited, Sirius Works, West Gorton, Manchester, for a quantity of their recently-issued trade literature, which comprises a large number of illustrated lists of uniform size and excellence, each forming a part of the firm's Catalogue C, first edition. Among the specialities dealt with in these lists may be mentioned injectors for boiler feeding by means of live steam; exhaust steam injectors for boiler feeding, heating, raising and circulating water, heating buildings, etc.; lifters, ejectors, or jet pumps for lifting or forcing to a height, conveying long distances on the level, mixing or extracting liquids, semi-liquids, or gases; feed-water heaters for use with exhaust or with high-pressure steam; ejector heaters for heating, boiling, and circulating liquids by the direct application of live or exhaust steam; valves and fittings, feed regulators, water gauges, relief valves, exhaust heads, and steam traps, etc.

V.I.R. Flexible, etc.

From Messrs. Johnson and Phillips's Electric Cable Works, Old Charlton, Kent, we have received a copy of their price-list of new standard V.I.R. flexible, etc. The specification of this flexible is as follows: "Each conductor composed of high-conductivity tinned copper wires, ·0076in. diameter (No. 36 S.W.G.), insulated with one coat of pure Para rubber and two coats of vulcanised indiarubber. Insulation resistance 600 megohms per mile at 60deg. F. after 24 hours' immersion in water, and one minute's electrification. Test voltage, 1,000 volts alternating for 15 minutes." The list also deals with electrolier and fittings wire, 2,500 megohms grade, and extra high-grade pure rubber flexibles.

Mono- and Poly- Phase Motors.

Pamphlet No. 1,101 issued by the Union Electric Company, Limited, 151, Queen Victoria-street, London, E.C., deals with "Union" mono- and poly- phase motors ranging in output from 1-12 b.h.p. to 30 b.h.p., and suitable for every-day industrial purposes. The machines are carried out both with and without slip-rings, and the rotors are constructed to carry a considerable overload without falling out of step.

Motor-Driven Hack Saw.

An illustrated price-list recently issued by Messrs. Edward G. Herbert, Limited, Cornbrook Park Works, Manchester, deals with a motor-driven hack saw of their well-known quick-cutting eccentric type. It is claimed that these machines cut much quicker than the ordinary hack saw, due to the eccentric motion. The cutting speed is further increased by running the machine at double the ordinary speed and using a rotary pump to supply the blade with water. The machine illustrated in the list before us is capable of cutting bars and girders up to 12in. by 8in., and the motor, which is fixed in an inverted position under the bed, is of the fully-enclosed constant-speed type, wound for 600 revolutions per minute, and gives ½ h.p. at that speed. It is driven direct from the motor by chain gearing having a ratio of 6 to 1. As all the necessary switches are attached to it, the machine is entirely self-contained and portable. This machine is not only suitable for engineering works where electric driving is in force, but also for iron merchants and others who have no shafting, and structural engineers should find it a useful tool to have working on the job.

Howard Conduit.

Some useful information relating to the asphalt solid system of the Howard Conduit Company, Limited, Trafford Park, Manchester, is contained in a booklet recently issued by this firm. Numerous illustrations and engineers' opinions of the system are included.

Miscellaneous Apparatus.

A few of the many specialities manufactured by Messrs. Offord, Wilson, and Barfield, 98, Woodcock-street, Birmingham, are illustrated and described in this firm's new price-list. Mention may be made of the following: automatic time switches, automatic switches, photographic arc lamps, resistances, meters (ampere and volt), motor starters, field regulators, theatre and optical arc lamps, stage accessories, cast-iron plugs and sockets, switch service fuses, and main switches.

Brush Holders, etc.

Price-list G, issued by Messrs. D. Santoni and Co., Limited, 28, Ely-place, Holborn-circus, London, E.C., deals with brush holders, brushes, carbons, and a safety suspension lock for arc lamps.

Electrical Sheet Iron, etc.

Armature discs of various types, laminated pole-tips and pole-shoes, stator and rotor stampings, transformer stampings, and Swedish iron bars—rounds, squares, and flats—are illustrated on a collection of sheets issued in pamphlet form by Messrs. Turner Bros., 134, Upper Thames-street, London, E.C. For the most part the illustrations take the form of line drawings, the dimensions when given being clearly marked in.

Insulating Material.

One great trouble in the design of electrical apparatus lies in the fact that practically all our insulating materials are subject to faults either in their electrical or mechanical properties. In consequence of this, a large number of firms have experimented on various compositions in order to get as near perfection as possible, and to obtain an insulating material which shall possess good mechanical properties without sacrificing its insulating character. Amongst these manufacturers we would call attention to Psychiloid, Limited, which company has its works in Bridge-street and Love-street, Sheffield. The material produced by this company is termed Psychiloid, and it has been subjected to severe mechanical and electrical tests by independent authorities. As an example of this, we are informed that a

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square inch of Psychiloid sheet ¼in. thick will stand a pressure of 25 tons without crushing. The material is insoluble in all the ordinary solvents, and is quite unaffected by boiling water. In the same way it resists animal, vegetable, and mineral oils. Messrs. Ferranti subjected some samples of this material to electrical stress, and found that a grey sample 3-16in. thick successfully withstood 20,000 volts alternating between opposite fuses. The surface leakage was also exceedingly small. The firm are specialising in the manufacture of formers and bobbins for dynamo field coils and in the various other accessories, such as commutator rings, switch handles, etc., for which the combination of mechanical strength and high electrical resistance in the insulating material are so much required.

LEGAL INTELLIGENCE.

GEORGE F. MILNES AND CO.

Mr. Justice Bucknill, at the Vacation Court on Wednesday, had before him a petition presented by John Lysaght, Limited, for the winding up of George F. Milnes and Co., Limited.

Mr. Hamilton, K.C., for the petitioners, said it was a creditor's petition, asking for a compulsory order for winding-up, or, in the alternative, for a supervision order and the appointment of Mr. Mackenzie Sharp, a chartered accountant, in place of the present voluntary liquidator. The company was established for the purpose of manufacturing electric tramcars, and the plaintiff company was the holder for value of bills of exchange amounting to £246, which had been dishonoured. In addition, there were claims for goods supplied for £85.

Mr. Bramwell Davis, K.C., for the company, said the assets were in the hands of the voluntary liquidator, and there was, therefore, no urgency.

Mr. Hamilton said there was going to be a sale, and that proposal constituted urgency.

Mr. Davis said they were not going to sell without the sanction of the Court, and he would undertake, if such sanction were asked for, to give due notice to the petitioner.

On this undertaking his **Lordship** directed the petition to stand over to the first petition day in next sittings.

BRITISH ELECTRIC STREET TRAMWAYS.

Mr. Justice Bucknill on Wednesday had before him the matter of Bond *v.* the British Electric Street Tramways, Limited, and another before him on a motion for an injunction to restrain the company dealing with its assets.

Mr. Bramwell Davis, K.C., for the plaintiff, said his lordship would not be troubled with the motion on that day, owing to the continuance of the undertaking. However, the urgency of the matter was that one of the companies concerned in the action would be actually dissolved next month.

His Lordship directed the motion to stand over for a week, further affidavits to be filed by Wednesday.

ANGLO-AMERICAN ALUMINIUM COMPANY.

Before Mr. Justice Bucknill in the Vacation Court on Wednesday the case of Hamilton *v* the Anglo-American Aluminium Company, Limited, was again heard on a motion for the discharge of Mr. C. P. Nelson, who was appointed receiver in this debenture holders' action by Mr. Justice Walton a fortnight ago.

His Lordship said the suggestion was that Mr. Nelson's appointment was a snatched appointment. He regretted that this was so. After reading all the papers in evidence, his Lordship came to the conclusion that there was no good reason adduced for the removal of Mr. Nelson. He was not satisfied that the present position of the company was brought about by Mr. Nelson's management.

Accordingly the motion was dismissed.

PUBLIC UNDERTAKINGS SYNDICATE.

A petition for a compulsory winding-up order against the Public Undertakings Syndicate, Limited, was heard by his Honour Judge Parry at the Manchester County Court last week.

Mr. Mansfield, representing the petitioning creditors, Messrs. Aubrey Ward, Thomas, and John Wilding Donaldson, consulting engineers, Victoria-street, Manchester, said the syndicate was registered in March, 1901, with a nominal capital of £10,000, for the carrying out of public works and conveniences in the United Kingdom, such as electric tramways, piers, harbours, and docks. The petitioners were engaged by the syndicate as electrical engineers in connection with the promotion of a Bill in Parliament for the incorporation of the West Cumberland Electric Tramways Company. The Royal assent was given in August, 1901. The petitioners were unable to obtain payment of their charges, amounting to £2,360. 17s. 2d., and commenced an action to recover them, but the syndicate agreed to the matter going before the official referee for the amount due to be fixed. Nearly a month was occupied by those proceedings, which resulted in a direction that judgment for £2,049 should be signed, only about £30 being struck out of the claim. A few days prior to the signing of the judgment, the syndicate gave notice of an extraordinary meeting to consider a proposal to go into voluntary liquidation. This was eventually agreed to by the shareholders. It was represented that there no trade creditors, and that the assets of the syndicate were 3s. 1d. in one bank, 4s. 8d. in another, and £20 unpaid capital.

In opposing the motion, **Mr. McConkey** said the syndicate's only hope of getting more money lay in the floating of the statutory company, for which parliamentary powers had been secured, and their point was that the petitioner's claim was really against that company.

His Honour said he did not think a case had been established by Mr. Mansfield. The petition would be dismissed with costs as from Aug. 4.

THEFT OF ELECTRICITY.

At South Shields Petty Sessions a labourer named John Pratt was charged with having stolen electricity, the property of the Northern Countities Electricity Supply Company, Hebburn.

Mr. A. Robson, who appeared for the company, explained that the charge was rather a novel one. The defendant's house was wired by the company, the installation including a penny-in-the-slot or prepayment meter. The electricity had been stolen by the current being diverted, making a separate circuit so that it did not pass through the meter. By this means the consumer was enabled to have the use of the light without having the quantity registered on the meter.

Walter Bates, mains foreman for the electricity company, said that on Aug. 5 he visited the defendant's house and examined the meter. He found that it registered 16 hours and there was 3d. in the till. On Aug. 26 he again examined the meter. It registered five hours and there was 1d. in the till. Witness became suspicious and on putting off the switch he found that the light in the house still burned. He thereupon made an examination and discovered that a piece of wire had been inserted diverting the current so that it did not pass through the meter, the object being to defraud the company.

Defendant pleaded guilty and was fined 40s. and costs.

THE SPEED OF ELECTRIC TRAMCARS.

Mr. Moffat Ford, managing director of the Motorcar Company, Limited, has applied to Mr. Lane at the West London Police Court for directions in the matter of the summonses he had issued against several drivers of the London United Tramway Company for exceeding their legal speed limit. Mr. Ford reminded the magistrate that the case had been before the Court on two previous occasions and had been adjourned, the first time upon a point of law, which had subsequently been waived, and the second time upon the magistrate's own suggestion that an independent referee should be appointed to conduct an official test of speed before all parties concerned, the defence being that it was impossible for the defendants' tramcars to exceed a speed of 13 miles an hour. Mr. Ford stated that although a month had elapsed since the last adjournment, and although a referee had been agreed upon between the parties, yet he could not obtain an appointment for the test from the defendants, who did not seem at all anxious to hurry the matter forward. The magistrate remarked that Mr. Rose, before whom the previous hearings had been, would return very shortly to the Court, and he had no doubt that before that time the defendants would come to some arrangement with Mr. Ford for the official test to take place in ample time for the case to be continued immediately Mr. Rose recommenced his sittings at the Court.

COMPANIES' MEETINGS AND REPORTS.

CENTRAL LONDON RAILWAY.

An extraordinary meeting of proprietors of this railway was held on Friday at the Company's offices in High Holborn, under the presidency of Sir Henry Oakley.

The meeting was called to consider resolutions providing for the conversion and consolidation into ordinary stock of the Company of the 15,000 shares of £10 each created and issued under their Act of 1901, and for authorising the directors to raise the additional £150,000 of capital authorised by the Company's Act of 1902 by the creation and issue of ordinary stock instead of shares, as mentioned in the resolution passed at the extraordinary meeting held on Feb. 4 last.

The **Chairman** said their ordinary capital was £2,850,000, in shares, and they had powers under two separate Acts of 1901 and 1902 to raise £150,000 share capital by each of those Acts. In the ordinary course these Bills were submitted to the shareholders, and the Board were authorised to create the capital and to dispose of it from time to time, according to the requirements of the Company, on the best terms they could obtain. This authority was given at two meetings—in February, 1902, and in February of this year. At their meeting in February he explained that the capital was in debt to the amount of £103,000, and that in the course of this half-year it would be necessary for the Company to raise some of it in order to carry on their business and to pay their dividend. The capital was now all created in shares. The directors had sold £150,000, but as the whole of the ordinary share capital was now stock, and no longer shares, it was necessary that this £150,000 should be placed in the same category. The resolutions to be submitted were as follows: "That pursuant to the powers conferred upon the Company by the Companies' Clauses Consolidation Act, 1845, the 15,000 shares of £10 each created and issued under the Company's Act of 1901, all fully paid up, be converted or consolidated into ordinary stock, to be divided amongst the shareholders according to their respective interests therein. That the directors be and they are hereby authorised to raise £150,000 additional capital authorised by the Company's Act of 1902 by the creation and issue of ordinary stock instead of by the creation and issue of new shares, as provided

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in the resolution passed at the extraordinary meeting held on Feb. 4, 1903."

The resolutions were unanimously adopted.

CHLORIDE ELECTRICAL STORAGE.

The annual general meeting of the shareholders in this Company was held at the offices, Clifton Junction, near Manchester, on 16th inst., Mr. Bannister presiding.

The **Chairman**, in moving the adoption of the report (*vide* last issue), considered that the balance-sheet was clear evidence of the prosperity of the Company, and stated that the Company had not alone increased their business during the year, but had also increased their profits and their favour among the public. The balance-sheet presented a very healthy appearance.

The **Vice-Chairman** (Dr. Hopkinson), in seconding the motion, took occasion to refer to the interest which the Electric Storage Battery Company of Philadelphia had, during the year under consideration, acquired in the Company. He had little doubt it would be greatly to their advantage in the future. It was an example of American co-operation with England which could not but produce the greatest advantage.

Mr. Herbert Lloyd, a director and president of the Electric Storage Battery Company of Philadelphia, pointed out that the American Company was managed by Englishmen. The Electric Storage Battery Company in America did business last year to the extent of about £800,000, and made a profit of nearly £250,000, and he expected the turnover of the present year would come to approximately £1,000,000. He hoped to see this Company, by the adoption of their methods, largely increase their turnover, especially in the line of central-station work.

The motion was carried unanimously.

Sir Bache Cunard having been appointed a director, a dividend at the rate of 6 per cent., less income tax, on the preference shares, and of 8 per cent., free of income tax, on the ordinary shares was declared, and the meeting separated.

YORKSHIRE ELECTRIC POWER.

The first ordinary general meeting of this Company was held at the Hotel Metropole, Leeds, Mr. Arthur G. Lupton presiding.

It was announced that the contractors are in possession of the land for the first power station at Thornhill, and work on the buildings was being rapidly pushed on. Tenders had been accepted for a 6,000-h.p. generating plant, together with the necessary equipment for transmission and distribution. The generators are to be of the latest type of Curtis steam-turbines, and are to be built at the British Thomson-Houston works at Rugby. The Company are now in a position to negotiate for the supply of power within a radius of 10 miles of the first station, and power will be available in about 10 months' time.

Mr. W. B. Woodhouse, engineer in charge of the generating stations at Newcastle-on-Tyne Electric Supply Company, has been appointed resident engineer, and Mr. J. J. H. Stansfield secretary, both of whom will take up their duties early in October. The offices of the Company are at Central Bank-chambers, Infirmary-street, Leeds.

The following gentlemen were elected directors: Messrs. Arthur G. Lupton, Robert Armitage, Arthur Currer Briggs, J. O. Callender, E. A. Carolan, H. A. Earle, A. C. Embleton, W. P. J. Fawcus, and Robert Hudson, and Sir Richard Mottram.

ELECTRICITY SUPPLY COMPANY FOR SPAIN.

The report of the directors for 1902 states that the rent of 1,100,000 pesetas receivable under the lease of the Company's undertaking in Madrid to the Compania General Madrilena de Electricidad has been regularly paid. The revenue has produced £31,936, to which has to be added interest on deposits and transfer fees, making a total of £32,493. After deducting debenture interest, interest on loans, and all charges, amounting to £17,093, and after putting aside £1,852 for redemption of debentures there remains a surplus of £13,548, which, with the amount brought forward from last year, leaves a balance of £22,311. After providing for the 5 per cent. dividend on the preference shares for the year 1901, amounting to £8,665, paid on Feb. 27 last, the directors propose to write off £13,145, thus entirely extinguishing the suspense account, and to carry forward £500. In view of the arrangement referrred to below, the directors do not recommend any dividend on the preference shares for this year, it being thought advisable to accumulate a reserve against any unforeseen contingency, such as a further drop in the exchange. The shareholders may be congratulated on the greatly improved position of the Company, which has enabled the directors to wipe out in two years, instead of in five, as originally contemplated, the whole of the deficiency of £19,045 on capital account, as ascertained at the time of leasing the Company's undertaking. In addition to this, the sum of £1,852 has been set aside for the redemption of debentures. The first mortgage debentures for £75,000, and the £41,300 "B" debentures, fell due for repayment on July 1, 1903. The state of the money market during the early part of the year rendered it inadvisable to negotiate with the holders of these two series of bonds for their conversion into 5 per cent. consolidated debentures. The directors, therefore, decided that it would be better to arrange for the extension of the first and "B" mortgage debentures for a further period of eight years, during which time the whole amount would be paid off by annual drawings. A bonus of 3 per cent. was offered to the holders agreeing to renew their bonds, and an arrangement was made with a responsible guarantor to take up and extend the holdings of those who refused. The scheme has been successfully carried through, and signed agreements have been executed in respect of the whole of the first and "B" mortgage debentures. As the Company will be able practically to meet out of its income the whole of the charge for the interest and redemption of its debenture debt, the Company is in a very much stronger position than it has ever enjoyed to date. It is evident that as soon as the two series of debentures have been paid off the position of the shareholders will be immensely improved, as the sum available for dividend each year will be largely increased.

DICK-KERR.

The report of the directors for the year ended June 30 last states that profits amount to £110,449. Out of this had to be paid debenture and loan interest and trustees' fees, and there has been reserved the sum required to provide for the premium payable on the redemption of the present debenture stock. These items absorb £8,472, leaving a balance of £101,977, to which must be added the profits brought forward from last year—namely, £30,868—making a total of £132,845. It is proposed to carry £16,735 to reserve fund as required by clause 24 of the trust deed securing the debentures, and to place further sum to this reserve, £23,265; to pay a dividend of 10 per cent. and bonus of 5 per cent. on the ordinary shares, and to carry forward £35,545. The Company has completed during the year under review many important contracts at home and abroad, and are still busily engaged in the execution of further large contracts. Since the last report was issued the acquisition of the English Electric Manufacturing Company, Limited's, works in Preston has been completed, and these are fully employed in the production of machinery. Out of the dividends declared by the English Electric Manufacturing Company, Limited, on March 31, 1903, the sum of £30,000 has been carried direct to the credit of the reserve fund set aside under the provisions of the trust deed securing the debentures.

MERSEY RAILWAY.

The report of the directors for the half-year ended June 30 last states that receipts from all sources have been £32,278, as compared with £31,781 for the corresponding period of 1902. Working expenses, exclusive of the exceptional charges for pumping, ventilation, and lifts, have been £27,375, equal to 84·41 per cent., as against £23,066, equal to 72·58 per cent, for the corresponding six months. These exceptional charges for pumping, ventilation, and hydraulic lifts for the past six months amounted to £4,686, equal to 14·52 per cent., as compared with £6,389, or at the rate of 20·10 per cent., in 1902. The number of passengers conveyed has been 3,201,644, as against 3,104,294 for the corresponding period of 1902, exclusive of season-ticket holders. The net revenue account shows a debit balance of £3,728. This, added to the previous debit of £4,924, makes a total of £8,652. The working of the railway by steam locomotives ceased on May 4, 1903, and since that date it has been worked by electric traction. There has not yet been sufficient experience to enable a reliable estimate to be formed with regard to the probable receipts and expenditure of the new method of working, but the difficulties of ventilation have been overcome, and the suitability and capacity of electric traction for dealing with the traffic have been fully demonstrated.

NEW COMPANIES REGISTERED.

M. I. P. Electrical Syndicate, Limited.—Capital, £10,000. Object: to adopt an agreement with Sir Anthony Crompton-Thornhill, Bart., for the acquisition of the benefit of certain existing inventions relating to the production of electricity, etc.

Penarth Tramway Syndicate, Limited.—Capital, £3,000. Object: to obtain a provisional order or Act of Parliament for the construction of tramways or light railways between Cardiff and Penarth, etc. Registered office: 124, Bute-street, Bardiff.

Manufacturing Electric Company, Limited.—Capital, £6,000. Object: to carry on the business of manufacturers of and dealers in wires, cables, and lines of all kinds, electricians, electrical, mechanical engineers, etc. Registered office: 34 and 35, High Holborn, W.C.

Kolar Mines Power Station, Limited.—Capital, £30,000. Objects: to erect, establish, instal, and equip, near the Kolar goldfield, India, or elsewhere, a central electric power station or stations, and to carry on the business of an electric power supply company. The number of directors is to be five, one being appointed by each of the following companies—viz.: the Mysore Gold Mining Company, Limited, the Champion Reef Gold Mining Company of India, Limited, the Ooregum Gold Mining Company of India, Limited, the Nundydroog Company, Limited, and the Balaghât Gold Mining Company, Limited.

CONTRACTS FOR ELECTRICAL SUPPLIES.

Manchester.—The Corporation require tenders for a 32-ton electric lift. Tenders by Oct. 5.

Macao.—The Colonial Office at Lisbon invite tenders for the electric lighting of Macao. Tenders by Oct. 21.

Lisbon.—The Public Works Department require tenders for the public electric lighting of Macao. Tenders by Oct. 21.

Paris.—The Posts and Telegraph Department, 103 Rue de Grenelle, require tenders for two lots of electric wire. Tenders by Oct. 1.

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Bucharest.—The Government Railways require tenders for the installation of electric lighting and plant for their workshops. Tenders by Oct. 10.

Pietermaritzburg.—Tenders are invited by the Natal Government Railways Electrical Department for additional plant for the power station at Pietermaritzburg.

Dover.—Tenders are invited for an electrically swung bridge at the harbour. Tenders close in about 10 days. Particulars may be obtained from the Harbour Board.

Paris.—The Post and Telegraph Department, 103, rue de Grenelle, require tenders for 600,000 ko. copper wire and 80,000 copper junction boxes, lot of telegraph material, by Sept. 28.

Swansea.—The Corporation invite tenders for the supply, delivery, fixing, and connecting of ducts, troughs, cables, wires, street boxes, etc. Tenders by Oct. 31. See advertisement.

Transvaal Colony.—The Chairman of the Tender Board, Pretoria, requires tenders for installing and working the electric lighting of Potchefstrom for about five years. Tenders by Oct. 30.

Dublin.—The Port and Docks Board invite tenders for the supply of a 100-ton electric crane. Specification can be obtained at the office of the engineer to the Board, Mr. John P. Griffith, M.I.C.E., Eastwall, Dublin. Tenders by Oct. 5.

Blackpool.—The Corporation invite tenders for the supply of arc lamp carbons for the ensuing year. Specification, etc., may be obtained on application to Mr. Charles Furness, borough electrical and tramway engineer, Electricity Works, Blackpool.

Manchester.—The Paving, Sewering, and Highways Committee invite tenders for laying underground telephone pipes, with other appurtenant works. Specification, etc., may be obtained at the City Surveyor's Office, Town Hall. Tenders to the Chairman by Oct. 8.

Shanghai.—The French Colony propose to instal motor-propelled tramways. Tenders may be sent by Oct. 31, 1903, to Secrétariat de la Municipalité Française de Shanghai. Particulars may be obtained from l'Office National du Commerce Extérieur, Rue Feydeau, 3, Paris.

East Barnet.—The Urban District Council will receive proposals for carrying out the provisions of their electric lighting order within the Council's district. Further particulars upon application to Mr. Henry York, the Council's surveyor, Council Offices, Station-road, New Barnet. See advertisement.

Rochdale.—The Guardians invite tenders for certain new underground cables and switchboard alterations and additions required at the workhouse, Dearnley. Specifications, etc., may be obtained from Messrs. Shepherd and Watney, Greek-street-chambers, Leeds. Tenders by 26th inst.

Russia.—The Russian Minister of the Interior has sanctioned a plan for the reconstruction of three lines of municipal tramways—namely, those in Newsky, Sadovaïa, and Wassiliostrow districts. Each car is to provide for two classes of travellers, and will accommodate 52 persons.

New Barnet.—The East Barnet Valley Urban District Council invite proposals for carrying out the provisions of their electric lighting order within the Council's district. Further particulars can be obtained from Mr. Henry York, surveyor, Council Offices, Station-road, New Barnet.

Utrecht.—The Town Council will receive tenders for supply and erection of a central electric establishment for lighting, power supply, and working tramways. Contract, conditions, etc., to be obtained at the "Gemeente Secretaire" of Utrecht, on payment of 5fl. (8s. 4d.). Tenders by Oct. 1.

Brighton.—The Town Council invite tenders for the (1) supply of steel girder tramrails, fishplates, etc.; (2) tramcars; (3) points and crossings and other fittings. Specifications, etc., may be obtained from Mr. Francis J. Tillstone, town clerk, Town Hall, Brighton Tenders by 10.30 a.m. on Oct. 5.

London, W.—The Commissioners of H.M. Works and Public Buildings invite tenders for alterations and additions to Ealing telephone exchange. Drawings, etc., may be seen on application to Mr. J. Wager. Tenders to the Secretary, H.M. Office of Works, etc., Storey's-gate, London, S.W., before 12 noon on 29th inst.

Great Western Railway.—The Directors invite tenders for about 90 tons of steel bridge girders and other steel and iron work of British manufacture. Specifications, etc., may be obtained at the office of the Engineer between the hours of 10 a.m. and 4 p.m. Tenders by Oct. 6 to Mr. G. K. Mills, Paddington Station, London.

Manchester.—The Electricity Committee invite tenders for the supply and delivery as and when required of 1,200 electricity meters. Specifications, etc, may be obtained from Mr. F. E. Hughes, secretary, Electricity Department, Town Hall. Tenders to the Chairman of the Electricity Committee, Town Hall, by Oct. 1.

Johannesburg.—The Municipality require tenders for gas generating plant or for steam generating plant and for gas motors or steam motors, with electric generators and accessories. Particulars may be obtained from the Town Clerk, Johannesburg, or from Messrs. Mordey and Dawbarn, 82, Victoria-street. Tenders by Oct. 19.

Launceston (Tasmania).—The Mayor and Aldermen invite tenders for the supply of 500 or more electric meters. Particulars may be obtained on application to Mr. William Corin, city electrical engineer, Launceston, Tasmania, or to Messrs. John Terry and Co., 7, Great Winchester-street, London, E.C. Tenders by Sept. 28.

Bootle.—The Corporation invite tenders for the extension of the boiler-house at the electric light station, Pine-grove. Plans, etc., may be seen at the office of Mr. B. J. Wolfenden, A.M.I.C.E., borough engineer, on and after the 18th inst. Tenders to the Chairman of the Electric Power and Lighting Committee by the 30th inst.

Cienfuegos (Cuba).—The Municipal Authorities require tenders for the installation and working of electric lighting. They will pay an annual subsidy of 24,000 piastres for 150 arc lamps of 1,500 c.p. each and 350 incandescent lamps of 50 to 100 c.p. each for street lighting, and 16 to 25 lamps in public buildings. Tenders by 1 p.m. on Sept. 28.

Ashton-under-Lyne.—The Market and Lighting Committee invite tenders for the supply of arc lamp carbons and globes during ensuing year. Specification, etc., may be obtained at the office of Mr. Neville Appelbee, Electricity Works. Tenders to the Chairman of the Market and Lighting Committee at the Town Hall, Ashton-under-Lyne, by 29th inst.

London, N.—The Shoreditch Borough Council invite tenders for pulling down and rebuilding 3, Hoxton-square, N., to be used as stores for the electricity department. Specification, etc., may be inspected and bills of quantities obtained at the office of Mr. J. Rush Dixon, A.M.I.C.E. Tenders to the Town Clerk's Office, Town Hall, Old-street, E.C., by Oct. 6.

Swansea.—The Corporation invite tenders for (1) laying of permanent way, including rail bonding; (2) rails and fishplates; (3) steel tiebars, bolts, and nuts; (4) points, crossings, cast-steel curved rails, and special work; (A) overhead electrical equipment; (B) ducts, troughs, cables, wires, section and other boxes, etc. Tenders by Oct. 31. See advertisement.

Halifax.—The Tramways and Electricity Committee invite tenders for the supply and fixing of heating apparatus required at the several offices and workshops at the Skircoat depôt. Specifications, etc., may be seen and forms of tender obtained on application to Mr. James Lord, C.E., borough engineer, Town Hall, Halifax. Tenders to Mr. Keighley Walton, town clerk, by 30th inst.

Dundee.—The Town Council invite tenders for the relaying of distribution mains in the central area of the town. Specification, etc., may be had on application to Mr. H. Richardson, A.M.I.E.E., city electrical and tramways engineer, Dudhope-crescent-road, Dundee. Tenders to Mr. W. H. Blyth Martin, clerk to the Council, City Chambers, Dundee, not later than Sept. 30.

London, S.E.—The London County Council invite tenders for the supply, delivery, and erection in the electricity generating station to be established by the Council at Greenwich of four 5,000-h.p. vertical-horizontal steam-engines, each suitable for driving a three-phase generator. Particulars, etc., may be obtained at the County Hall, Spring-gardens, S.W. Tenders by 10 a.m. on Oct. 6.

London, W.C.—The Directors of the Savoy Hotel, London, invite tenders for the purchase of two Lancashire and two Cornish boilers, working pressure 150lb.; at present in use in connection with the electric lighting and heating of the Savoy Hotel. Further particulars can be obtained at the offices of the engineers, Kincaid, Waller, Manville, and Dawson, 29, Great George-street, Westminster.

Bradford.—The Corporation invite tenders for the construction of about 13 miles of light railways and tramways in connection with the Angram storage reservoir works. Plans may be seen and specifications, etc., obtained at the office of Mr. James Watson, M.I.C.E., waterworks engineer, Town Hall, Bradford. Tenders to Mr. Frederick Stevens, town clerk, Town Hall, Bradford, by 10 a.m. on Oct. 1.

Salford.—The Tramways Committee invite tenders for the supply and delivery of planing, turning, boring, drilling, grinding, milling, screwing, punching, and shearing, and wood-working machinery, power hammer, shafting motors, etc., at their central car depôt, Frederick-road, Pendleton. Specifications, etc., can be obtained from the General Manager, 32, Blackfriars-street, Salford. Tenders by Oct. 19.

Whitehaven.—Tenders are required for the joiners' work, slating, plastering, plumbing glazing, painting, electric lighting and bells for six houses at Wellington-row, Whitehaven. Plans and specifications can be seen on application to Messrs. A. and T. H. Anderson, builders, New-road, Whitehaven, or at the office of Mr. J. S. Moffat, M.S.A., 53, Church-street, Whitehaven, where tenders are to be delivered by 29th inst.

Oldham.—The Electricity Committee invite tenders for arc and incandescent lighting and power circuits in Greenhill station, comprised in specification No. 9. Copies of the specification, etc., can be obtained from the Resident Engineer. Specifications can be seen at the offices of Messrs. Kennedy and Jenkin, 17, Victoria-street, Westminster, S.W. Tenders to be sent to the resident engineer, Mr. S. Wilmott Newington, by Oct. 6.

Birkenhead.—The Education Committee invite tenders for the wiring of the Laird School of Art in Park-road for electric light, and for extensions to the electric light wiring of the Holt School of Science and Art. Plans can be seen and specifications, etc., obtained on application to the borough electrical engineer, Mr. William Bates, A.M.I.C.E., Electrical Engineer's Office, Craven-street. Tenders to reach Mr. Robert T. Jones, secretary, Education Department, Town Hall, by 9 a.m. on Oct. 9.

London, E.C.—Tenders will be received until noon on Sept. 28 (a for the supply of Swedish, Norwegian, or Finland red fir telegraph poles, to be delivered in London, at Northumberland Dock (River Tyne), West Hartlepool, Hull, or Grimsby, at Leven, Fifeshire, and at Swansea, Cardiff, or Newport; and (b) for creosoting the poles with 10lb. or 12lb. of creosote to the cubic foot, as may be directed. The poles to be felled during the winter of 1903-4, and to be delivered during the following summer at the port at which the creosoting is to be performed. Butt sections, 2in. thick, stamped with the shipper's mark, from not less than three poles, to show the quality of timber offered, must precede or accompany the tender of any person who has not already supplied the Postmaster-General with poles. Forms of tender may be obtained from Mr. S. C. Hoolley, controller of stores, Stores Department, 17-19, Bedford-street, London, W.C.

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RESULTS OF TENDERS.

Hammersmith.—The following tenders have been accepted: 38 arc lamps and accessories, Oliver and Co., £360. 3s.; W. Brown and Sons, £70 for painting at electricity station.

Portugal.—A contract has been entered into by the Municipality of Faro with Ferdinand Thudichum, of Aljustrel, for the public and private lighting of the town of Faro by electricity.

Preston.—The Corporation have accepted the tender of T. B. Garnett, Preston, at £11,272. 19s. 4d., for erection of a power station and car-sheds, Holmrook-road and Sussex-street East.

Nottingham.—The contract for the storage battery for the city asylum has been placed by the Corporation with the Electrical Power Storage Company, Limited, of 4, Great Winchester-street, London, E.C.

Edinburgh.—The Town Council have accepted the following tenders for the extension of M'Donald-road electric station: Builder's work, Colin M'Andrew, £16,829; engineer's work, Redpath, Brown, and Co., £6,591.

Liverpool.—The City Council have accepted the tender of the Wheeler Condenser and Engineering Company, Queen Victoria-street, E.C., at £11,975, for supply of condensing plant for the first section of the electric station in Lister-drive.

Bury.—The Electricity Committee have accepted the tender of Callender's Cable and Construction Company, Limited, for the supply and completion of the works embraced in electricity contract 11—tramway and lighting cables, feeders, etc.

London, W.—The St. James's and Pall Mall Electric Lighting Company, Limited, have placed the contract for the renewal of their storage battery with the Electrical Power Storage Company, Limited, of 4, Great Winchester-street, London, E.C.

Durban.—The Borough Council have accepted the tender of the Western Electric Company for exchange equipment for £7,640, and of the British Insulated and Helsby Cables, Limited, for underground cables for £5,241 for the proposed municipal telephones.

Fulham.—The following tenders are recommended for acceptance: Mr. Thomas Pearce for constructing a transformer chamber in Townmead-road, £455; British Electric Transformer Company, Limited, for the supply of four transformers (contract No. 26), for the sum of £292; Messrs. Windsor and Co. for the construction of sub-stations (contract A), for the sum of £520.

London.—The Bermondsey Borough Council have accepted A. E. White and Co.'s tenders for erection of buildings in connection with extensions to the dust destructor house, electric light station, boiler-house, etc., at the Council's works, as follows: Main estimate, £5,646; separate estimate for work to be completed in five weeks, £1,156; special estimate in connection with engineering section, and forming part of engineering contract, £1,561.

King's Heath.—The Urban District Council have received the following tenders for the construction of about three miles of electric tramway permanent way:

E. Taylor, Blackpool	£18,290	18	5
G. Law and Co., Kidderminster (disqualified)	15,946	4	8
R. W. Fitzmaurice and Co., Birmingham	29,262	2	3
Curnall, Lewis, and Martin, Birmingham	19,195	3	6
G. Freeman and Sons, Oldham	18,200	9	3
A. Faulkes, Loughborough	17,622	14	6
R. C. Brebner and Co., Edinburgh	20,229	5	5
R. W. Blackwell and Co., London (accepted)	16,892	11	7
J. White, jun., Birmingham	24,746	16	0
Macartney, McElroy, and Co., London	24,145	2	0
J. G. White and Co., London	17,594	11	5
Acme Wood Flooring Company, Limited, London	18,953	16	9
G. Trentham, Birmingham	22,108	11	9
W. Griffiths and Co., Limited, London	18,245	17	3
J. Branton, Hull	20,474	18	4

Hackney.—The following tenders were submitted at last night's meeting:

Electricity supply mains.

Western Electric Company*	£2,105	7	6
Henley's Telegraph Works	2,614	19	10
Callender Cable Company	2,890	8	1
St. Helens Cable Company	2,893	6	8
British Insulated and Helsby Cables, Limited	2,803	14	3
Siemens Bros. and Co.	2,124	2	4
Glover and Co.	2,940	12	1

Arc lamps and pillars.

Oliver and Co.	1,119	19	11
Oliver and Co.	1,111	10	11
Crompton and Co., Limited*	1,160	13	0
Crompton and Co., Limited	1,167	0	0
Johnson and Phillips	1,182	13	0
Johnson and Phillips	1,244	12	0
W. T. Allen and Co.	1,232	7	0
Gilbert Arc Lamp Company, Limited	1,243	1	6
Brockie-Pell Arc Lamp Company, Limited	1,285	14	6
General Electric Company, Limited	1,374	12	3
New Century Arc Light Company, Limited	1,510	0	6

For 500 electrolytic meters—Reason Manufacturing Company, 36s. 6d. and 60s. per meter, according to size.* For 500 motor meters—Ferranti Limited, 36s. and 117s. per meter, according to size.* Engine foundations—In consequence of the decease of Mr. B. E. Nightingale, whose tender had already been accepted by the Council for carrying out the construction of the engine foundations, it has been necessary to prepare the contract in the names of his successors, Messrs. A. C., W. H., A. E., F. A., and P. G. Nightingale.

* Recommended for acceptance.

Walsall.—The Corporation have placed the contract for the storage battery, Butts-road sub-station, with the Electrical Power Storage Company, Limited, of 4, Great Winchester-street, London, E.C.

Walsall.—The tender of Messrs. Crompton and Co., Limited, for supplying and erecting a duplicate booster, similar to that supplied to the Hospital-street sub-station, for £362, and the tender of the Electric Power Storage Company, Limited, for supplying and erecting a battery for the Butts-road sub-station, similar to the one supplied to the Hospital-street sub-station, for £1,062, have been accepted.

BUSINESS NOTES.

TRACTION.

Chatham.—The light railway company propose to double the line of tramways on Chatham Hill.

Brighouse.—The construction of the tramlines from Hove Edge to Brighouse has been commenced.

Perth.—A special meeting of the Town Council is to be called to consider the question of tramway extensions.

Cardiff.—The Tramways Committee are considering a suggestion for an extension of the Cathays tramway route.

Newcastle.—A further extension of tramways was opened for passenger traffic on Thursday—namely, the route to Benwell.

Eastbourne.—The Council have agreed to the erection of a shed for motor omnibuses and the charging of batteries of electric vehicles.

Penarth.—A syndicate has been formed with the object of promoting a scheme for a line of tramways between this place and Cardiff.

Bloemfontein (S.A.).—The Town Council have resolved to instruct their London consulting engineer to prepare a scheme of electric tramways for the town.

Anglo-Argentine Tramways.—A dividend on the preference shares of 2s. 6d. per share, being at the rate of 5 per cent. per annum, is announced, payable Oct 5.

Leamington.—The tramway reconstruction in the town is about to be entered upon by the British Electric Traction Company, who have submitted plans to the Town Council.

Exeter.—The City Council have decided to apply to the Board of Trade to nominate a referee to determine the value of the tramways in connection with their purchase by the Corporation.

Wishaw.—At the monthly meeting of the Town Council it was unanimously agreed to request the tramway company to cease running their cars on Sundays during the hours of church service.

Dovercourt.—The English Industrials Company propose to carry out a scheme for supplying the borough with electric light. The scheme also embraces a service of motor omnibuses and trams between Harwich and Dovercourt.

Leicester.—The first through line of the new electric tramways—from the London-road borough boundary to Belgrave—is nearing completion, and will shortly be opened for traffic. Progress is also being made with the other routes.

Paisley.—The negotiations for the purchase of the tramways by Mr. William Murphy have now been completed. It is understood that the price to be paid is about £15,000. The new electric system to be inaugurated will extend to Renfrew and Johnstone.

Swansea.—Plans and specifications for the construction of the light railways and the tramways authorised by the order and Act of 1902 have been approved by the Town Council, and will be laid before the Board of Trade. Tenders for the execution of the work are to be invited.

Scarborough.—The Corporation have generally approved the plans submitted by the tramways company, on the understanding that the details with regard to the position of the poles and the carrying out of alterations to the streets and similar matters are not included in such approval.

Ossett.—The General Purposes Committee of the Town Council have taken the necessary steps in connection with the proposed application for a provisional order authorising the Corporation to construct tramways within the borough. Mr. J. H. Rhodes, of Leeds, has been appointed engineer to the scheme.

Aberdeen.—At this week's meeting of the Town Council a letter was read from the secretary of the Aberdeen Suburban Tramways Company asking the approval of the Council of the scheme for the construction of the Donside section of the suburban tramways. The letter was remitted to the Tramways Committee.

Lisbon.—The *Diario do Governo* of Sept. 11 contains a notice to the effect that a project which has been presented by the Lisbon Railway Company (Companhia Carris de Ferro de Lisboa) for the construction of a new electric railway line in the city of Lisbon, is open for inspection in the office of the Inspector-General of Telegraphs and Electrical Works, Lisbon.

Soothill.—The Soothill Upper District Council and the Dewsbury Corporation have now arrived at an agreement in regard to the tramways question, and, subject to the veto of the Board of Trade, there is a probability of the network of tramways which intersect Dewsbury and district being completed as the result of the combined action of the local authorities of Dewsbury and Ossett and the two Soothills.

Hanley.—The delay in constructing the new tramways or light railways, for which the Potteries Electric Traction Company have obtained sanction, was commented upon at the last meeting of the Town Council, and a member expressed the opinion that when the company's time limit had expired the Council should themselves take

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the matter in hand and do the work. The power could be supplied from their own generating station.

Llandudno.—Owing to lapse of time the concession held by a syndicate for a light railway between Llandudno and Colwyn Bay has become, or will soon become, void, and the Urban District Council have decided to appoint a committee to consider the question of light railways in the district. There is a proposal for a light railway between Llandudno and Liverpool, but no definite scheme has yet been placed before the Council, who, however, are favourable to such a scheme.

East Ham.—The Urban District Council have received a letter from the West Ham Town Council agreeing to a conference with a view to running powers being mutually granted in the working of the authorities' electric tramway systems. It is hoped that the proposed arrangement will be extended to Ilford, so as to provide for a through service of electric trams from Romford parish boundary to the boundary of the London County Council's area at Bow Bridge, and in the intersecting thoroughfares.

Blackpool.—Total receipts from the electric tramways—reckoning the New-road section from June 18 last year to Sept. 17 this year, and the other routes from April 1—are announced as follows: £30,649. 9s. 4d., at 1s. 6¼d. per mile, showing a decrease of £139. 17s. 4d. On the three routes there was an increase in the number of passengers of 279,969—the figures being 3,963,393 as against 4,243,362—while the mileage showed a decrease of 26,824—the figures being 430,905 in 1902 and 404,081 miles this year.

The Dry-Seat Problem.—A rainproof cover for tramcars, invented by Mr. J. A. de Macedo, the Portuguese consul in Leeds, is to be tested on the circular route in that city. The appliance covers the whole of the top of an ordinary electric car, and the inventor claims that it can be put up or taken down in a couple of minutes. The trolley pole is fixed on the roof, and by the removal of the trolley standard two more seats are secured. Altogether the cover provides for six more seats than the ordinary car.

Leeds.—A deputation representing the governing bodies of Rawdon, Yeadon, and Guiseley has waited upon the Corporation Tramways Committee with the suggestion that the Horsforth line, which has already secured parliamentary sanction and only needs the finishing touch of the tracklayer, should be extended through their respective areas by the broad turnpike road which runs from Leeds to Guiseley and on to Ilkley and Skipton. No immediate decision was arrived at, the matter being referred to a special sub-committee.

Woking.—It is stated that in all probability the Woking tramways scheme projected by the West Surrey Light Railway Company will have to be abandoned. The Woking Urban District Council required all the roads along which the proposed tramways would pass to be widened to the extent provided for under the Tramways Act of 1870. The company having carefully considered this, felt that, owing to the enormous expense which would be involved, they could not meet the requirement, and it is understood the scheme will be abandoned.

Bromley (Kent).—At the last meeting of the Urban District Council a letter was read from Edmundson's Electricity Corporation, Limited, asking the Council whether they would be prepared to consider a scheme for tramways in Bromley. They thought there was a demand for trams, which could not be postponed much longer. They were very largely interested in the Bromley Electricity Supply Company, and would like to promote a system in connection with that company. It was decided to acknowledge the receipt of the letter.

Burton.—Dissatisfaction has been expressed by both motormen and conductors employed on the Corporation tramways at the dismissal of a driver, for no other reason, as they allege, than that he was acting as secretary to a trade union, and was organising the men. A largely-attended meeting of tramway employés has been held, when resolutions were passed to the effect that the Burton branch of the Tramway Men's Union become affiliated to the Burton Trades' Council, and also that the question of the employé's reinstatement be made through that body.

Wolverhampton.—The decision of the Tramways Committee to purchase the 11 miles of tramway track laid on the Lorain surface-contact system for £22,000 under certain conditions, was confirmed by the Town Council at a special meeting on Monday. It was also decided that the remaining routes under the Council's control should be equipped with the same system in order, as it is said, "to keep the B.E.T. Company out of the town." The result, however, is not in accordance with the views of all the members of the committee, and five resignations have been made from the committee as a protest.

South Shields.—At a meeting of the Tramways Committee held to consider what steps should first be taken in relation to the proposed new system of tramways in the borough, it was decided to take into consideration the whole question of routes to be laid down "irrespective of the present routes in accordance with the plans and specifications in the Act." The committee have instructed the borough engineer to get out the necessary plans, etc., and to present his report to a future meeting of the committee, when it will be decided what system to adopt. After that it is the intention of the committee to seek for tenders for the laying down of the new system.

Additional Traffic Returns.—Anglo-Argentine, £1,928 increase; Barcelona Ensanche y Gracia, £185 increase; Barcelona, £98 decrease; Brisbane, £59 decrease (month of August, £11,736, increase £294); British Columbia Electric (month of March), gross earnings £10,352, net income £2,658; Buenos Ayres and Belgrano Electric, £252 increase (month of August, £13,431, increase £533); Calcutta, £383 increase; Cape Town (month of August), receipts £15,349, expenditure £8,696; Isle of Thanet Electric, £215 decrease; Mexico Electric (month of August), receipts £48,600; expenses, £27,900; Perth Electric, £134 increase; Port Elizabeth (month of August), receipts £3,875, expenditure £2,305.

Southend.—Owners and occupiers in Leigh-road have petitioned the Tramways Committee, suggesting that in any renewals or reconstruction of the tracks along Leigh-road wood blocks or other suitable material might be used. The engineer has been instructed to submit designs of new cars, and the chairman and engineer will visit Gravesend and Margate to view the cars in those towns. The borough surveyor has submitted plans showing a proposed extension of the car-shed, the provision of a workshop at the western end, the provision over part of the roof of a water-tank as a site for the proposed additional cooling tower, etc., at an estimated cost of £2,250, which plans the committee have adopted.

Lancaster.—While one of the Corporation electric tramcars was being driven down Bowerham-lane, the steepest hill in the town, about 11 o'clock at night, the trolley jumped, and the driver losing control the car went down the steep incline at a high rate. At a place called the Pointer there is a curve where the metals intersect, and the car, jumping the points, rushed on to the footpath, cutting up a number of thick flagstones for a distance of about 20 yards before it came to a standstill. Fortunately there were no passengers in the car, and the last tram going towards the park had just passed before the mishap occurred. Neither the driver nor the conductor was much injured. The former states that the hand brake refused to act.

Leith.—At the last meeting of the committee of the whole Town Council it was resolved to recommend the Council that, in the event of Leith tramways being acquired by the Corporation, their policy should be to have the entire system electrified, and not to allow the Edinburgh cable system to be extended to Leith. With a view to formulating a proposal with regard to through traffic to the lessees of the Edinburgh system, the provost was requested, along with the consulting engineer, to enquire into the system in operation in London and elsewhere by which the electric cars are fitted with an adjustable gripper, which can be used to carry them over the cable system. The town clerk was instructed to proceed in due course with the necessary provisional order for extensions of the Leith system.

Bradford Fatality.—In the case of a man aged 60 who was knocked down by an electric car in Bradford and killed, a coroner's jury have returned a verdict of accidental death, adding the rider that if the lifeguard had been in proper working order the deceased's life might have been saved. The Coroner said doubtless Mr. Bird (the representative of the Corporation) would report the opinion of the jury to the proper quarter, who would see if something could not be done to make lifeguards more effective. Mr. Bird said the guard was recommended by the Board of Trade, and it would require very strong evidence that the guard was ineffective before corporations or companies who used it could be held to be negligent. He would place the opinion of the jury and the remarks of the coroner before the Tramways Committee.

Streatham.—The London County Council have a scheme for extending the tramways from the present terminus at Streatham on to the county boundary at Norbury so as to link up with the Croydon Corporation electric tramways, which run out to Purley. The scheme, as it deserves, has the support of the Streatham inhabitants, as the joining up of the two systems, requiring the construction of under two miles of line, would provide a through journey by electric car from Purley to London—or *vice versa*—a distance of some 13 or 14 miles. Unfortunately, the Wandsworth Borough Council up to now have declined to bear any portion of the cost of the necessary street widenings, but at their last meeting the recommendations of the committee to continue this policy did not meet with approval, and were referred back. In their reconsideration of the question we hope the committee will show more public spirit, and not try to kill a scheme with which the local inhabitants have every sympathy.

Loughborough Generating Station.—A party of members of the Civil and Mechanical Engineers' Society paid a visit on Saturday to the generating station of the London County Council at Camberwell. The station occupies a site near Loughborough Junction and supplies current for working the electric tramways in South London. There are two engines, each of 2,500 h.p., one supplying the cars and the other used as a stand-by, and each capable of generating 1,500 kw. The visitors were met on their arrival by Mr. Rider, electrical engineer to the Council, and by assistants representing Mr. Alfred Baker, the Council's tramway manager, and Dr. Kennedy, the consulting engineer. The generating station is only a temporary one, built to meet the immediate requirements of the Council in operating the first portions of their tramway system by electricity. It supplies the three sub-stations at Brixton-road, Clapham Park-road, and the Elephant and Castle, which feed the Tooting lines. As soon as the permanent generating station at Greenwich is ready, the supply will be by means of high-tension three-phase alternating currents transformed at sub-stations for the working line.

Portsmouth.—Mr. W. R. Spaven, the general manager of the Corporation tramways, has furnished the committee with his first annual report on the working of the system up to March 31 last. In it he states that during the year the permanent way has been maintained in an efficient condition. The overhead line, which has been kept in a thorough manner, is examined once a month, and any weakness detected in the insulation is immediately remedied. Mr. Spaven states that during the last 12 months there has been no failure in the supply of current. The slight interruptions in traffic have been solely due to the line taps having given out. He had been informed by the resident engineer that any appreciable addition to the maximum number of cars on the line will necessitate an increase of plant at the power station. The Board of Trade units generated during the past year were 3·6 times the number generated during the previous year. The rolling-stock has been thoroughly attended to. In addition to carrying out all ordinary running repairs, a considerable amount of work was done towards converting four of the old horse cars into motorcars. The equipment of the cars is in very

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good condition. The receipts, in spite of suffering so greatly from the effects of the inclement weather that was experienced last summer, might, on the whole, be taken as satisfactory, although the traffic was seriously impeded by the reconstruction of Fratton Bridge. The total number of passengers carried during the year was 16,355,692, or almost double that of the corresponding 12 months before. The receipts showed an increase of over £33,000. The profits for the year were £13,046. 18s. 7d. There are 14½ miles of tramlines, and on these 80 cars run daily.

North-Eastern Railway.—The new departure of the North-Eastern Railway Company in adopting electric traction for passenger traffic on the north side of the Tyne, says a local contemporary, is being watched with keen interest by all the railway companies of the kingdom. It is the first effort on a large scale to grapple with the problem of tramway competition. In addition to the Tyneside lines, the North-Eastern Railway is equipping the Quayside branch line for the electrical operation of the goods traffic. The railway company has, for the present at any rate, decided to purchase its current from the Newcastle-on-Tyne Electric Supply Company, Limited, who have a power station at Wallsend, rather than construct a generating station of own use. An additional power station is being constructed at Carville, farther down the river, and it is at this station that most of the current will be generated. Five sub-stations are being erected at Pandon Dene, Cullercoats, Wallsend Benton, and Kenton. As regards the rolling-stock, the construction of which is being undertaken by the North-Eastern Railway at the works in York, it will comprise simply motor and trailer coaches of the open corridor type, heated and lighted by electricity. The cars will be on two four-wheeled trucks. A train will consist of two motor coaches, with a trailer coach between. The motorcars will each be equipped with two General Electric motors, each rated at 150 h.p. There will accommodation in such trains for 48 first-class and 138 third-class passengers, but this may, if necessary, be increased by the addition of another unit train. An average speed of 22 miles per hour will be maintained, including stops, which will make the run from Newcastle to Tynemouth about 23 minutes, but express trains running through without a stop will do the journey in 15 minutes.

Electric Tramways in America.—A recent United States census bulletin contains figures showing the status of street electric tramways and railways in America, some of which are here presented by way of comparison, as well as for their own great intrinsic value. The bulletin was prepared by Messrs. T. Commerford Martin and E. Dana Durand, special experts, and is issued by Mr. W. M. Steuart, the chief statistician for manufactures. The statistics contained therein cover all street and electric tramways in the United States that were in operation during any part of the year ending June 30, 1902. During this period there were in existence 817 operating electric railway companies and 170 leased companies, making a total of 987 companies. These companies owned or controlled 22,576·99 miles of single track. The par value of the capital stock and funded debt outstanding, as reported, amounted to 2,308 282,099dol. The average net capital liabilities per mile of single track owned for the companies for the companies reporting both factors were 96,287dol. The total income and expenses of the operating companies amounted to 250,504,627dol. and 219,907,650dol. respectively. The companies gave employment on the average during the year to 133,641 wage earners, and paid 80,770,449dol. in wages. There were 7,128 salaried officials and clerks employed, to whom 7,439,716dol. was paid in salaries. The roads carried 5,871,957,830 passengers of all kinds. From the items as reported, it appears that the single-track mileage increased from 8,123 miles in 1890 to 22,577 miles in 1902, or 178 per cent, and the number of fare passengers carried from 2,023,000,000 to 4,810,000,000, or 138 per cent. The term "street and electric railways," as used in the bulletin, includes all electric railways irrespective of their length or location, and all street railways irrespective of their motive power. The total for 1902 includes 12 miles of track duplicated in reports of different companies, and in the figures for electric roads for that year are included six miles operated by compressed air. Of the electric roads, 21,280 miles were single overhead trolley, 23 miles double overhead trolley, 266 miles conduit trolley, 343 miles third rail, and 2½ miles storage battery. The length of single track—22 589 miles—reported for 1902 consists of 16,652 miles of first main track, 5,030 miles of second main track, and 907 miles of sidings and turnouts. Of the total single-track mileage, 21,914 miles, or 97 per cent, were operated by electric power, and 416 miles, or 1 9 per cent., by other mechanical traction, while only 259 miles, or 1·1 per cent., were operated by animal power, as compared with 69 7 operated in the last way in 1890. There were 66,784 cars of all classes reported. The largest number (3,612) reported for a single company is given for the Boston Elevated Railway Company, of Boston, Mass., which includes cars operated on both surface and elevated tracks. There were 60,290 passenger cars and 6,494 cars used for express work or other purposes. Of the passenger cars, 32,656 were closed and 24,250 were open. There were 159 water-wheels, with horse-power of 49,153, used as the primary power in the generation of electric current. The average horse-power per water-wheel was 309. The direct-current electric generators numbered 2,861, with a total horse-power of 972,314, the number having a capacity of 1,000 h.p. and over being 209, with an output of 330,456 h.p. There were 441 alternators, with 231,924 h.p., those over 1,000 h.p. numbering 58, with a capacity of 133,571 h.p. In the main stations storage batteries having an aggregate horse-power of 19,744 were reported, while the storage batteries in sub-stations had a total of 33,249 h.p. Of the 5,871,957,830 passengers carried, 4,809,554,438, or 81·91 per cent., were fare passengers and 1,062,403,392, or 18 09 per cent., were transfer passengers. The transfer passengers included those using free transfers, also in a few cases those using transfers for which an additional payment was required. There were 4,455 transfer points reported. The average number of fare passengers per mile of single track operated in the United States was 208,600. In preparing this average, only the companies from which complete statistics were received are considered. Of the total car mileage—1,099,256,774—the passenger cars travelled 98·7 per cent., and the freight, mail, express, and other cars 1·3 per cent. The fare passengers per car mile for all companies averaged 4·43.

LIGHTING AND GENERAL.

Horsham.—The Council have obtained sanction to borrow £9,500 for electric light extensions.

Eastleigh and Bishopstoke.—The Urban District Council have decided to take steps to obtain an electric lighting provisional order.

Babcock and Wilcox.—The directors have declared an interim dividend on the ordinary shares at the rate of 14 per cent. per annum.

Chester.—A distributing main is to be extended for supplying energy for public and private lighting at Handbridge at an estimated cost of £57.

Cape Colony.—It is proposed to raise a loan of £814,000 for the construction of certain public works and for telegraph and telephone requirements.

Montrose.—At the next Town Council meeting it will be proposed that an early opportunity be taken to introduce electric light into the town buildings.

Felixstowe.—An enquiry has been held into the application of the Urban District Council for a loan of £17,160 in connection with a scheme for electric lighting.

Boston.—An electrical engineer is to be appointed to prepare, construct, and work out a scheme for the electric lighting of the town on the lines of the present order.

Direct Spanish Telegraph Co.—An interim dividend at the rate of 4 per cent., tax free, on the ordinary shares for the half-year ended June 30 is payable on Oct. 1.

Eastern Extension, Australasia, and China Telegraph Company.—The directors have declared an interim dividend for the quarter ended June 30 last of 2s. 6d. per share.

Calcutta Electric Supply Co.—The directors have declared an interim dividend for the half-year ended June 31 last at the rate of 6 per cent. per annum, payable on Nov. 15 next.

Eastern Telegraph Co.—The directors announce the payment on Oct. 15 of an interim dividend of 1¼ per cent. on the ordinary stock, tax free, in respect of profits for the quarter ended June 30.

Manwell.—The cost of the Council obtaining a provisional order to supply their own electric light would be about £150. The matter has been referred to the Works Committee of the District Council.

Ossett.—At the last Town Council meeting it transpired, in connection with an offer of a syndicate to purchase the Corporation's electric lighting order, that the Council intend to put the order into force.

Hornsey.—The preliminary scheme for the supply of electricity which has been carried out has cost £90,000. The works have only been open about six months, and already the supply is paying working expenses.

Dalkeith.—A plan from Messrs. Crompton and Co. showing the streets in which it is proposed to lay down the electric mains, along with a schedule of streets in which mains are proposed to be laid, has been adopted.

Edinburgh.—Application is to be made to the Secretary for Scotland for consent to the borrowing of a further sum of £70,000 for the execution of capital works under the electric lighting provisional order of 1891.

Rawmarsh.—The Urban District Council are inviting objections to the proposed transfer of the undertaking granted by the Rawmarsh Electric Lighting Order, 1898, to the Mexborough and Swinton Tramways Company.

Southwark.—The Borough Council are fixing ¼-ampere Nernst lamps on to the electric light standards in Newington, and the Electric Light Committee will maintain the lamps at £5. 10s. per standard per annum.

Belfast.—The proposed extension of the electric main along the Old Lodge-road is in the hands of Mr. V. A. H. M'Cowen, electrical engineer. A report is also to be furnished regarding the various types of penny-in-the slot meters.

Dollar.—The agreement between the Town Council and Messrs. Crompton and Co. as to the supply of electric lighting of the streets of the burgh has been signed by the Council. It is expected that current will be ready about Christmas.

Saffron Walden.—The Town Council will consider at the next meeting whether they will apply for a provisional order to enable them to supply electrical energy for both public and private purposes in the borough.

Londonderry.—The Private Lighting and Power Committee will be able to supply current about February or March next. Messrs. Coates intend to open a branch in connection with house wiring and motor hiring, etc., almost immediately.

Removal.—Messrs. E. Goossens, Pope, and Co., electric lamp manufacturers, have removed to 18, Newington, Liverpool, owing, we are informed, to increasing business due to recent further improvements which have been made in their types of manufacture.

Lima (Peru).—A project for the acquisition of refuse destructors is before the municipality. They are anxious to secure these furnaces, but for want of funds the purchase is being postponed. Callao, Arequipa, Cuzco, Piura, Trujillo, in fact, almost all Peruvian towns, are worse off than Lima as regards sanitary arrangements of every kind.

Glasgow.—The electricity department of the Corporation have resolved to reduce the annual charge per light from £14 to £13 per

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annum, with a further reduction to £12 if the minimum number of additional lights is provided. A considerable increase can now be made in the number of arc lamps without any increase in the annual lighting bill for street electric lighting.

St. Albans.—The principal terms under which the Corporation propose to hand over their electric lighting order to the North Metropolitan Electric Supply Corporation were agreed to at last week's meeting of the Urban Committee. Mr. E. Macgregor Duncan, consulting engineer, and a representative of the Electric Corporation were present. The order was obtained in 1900.

New Book.—Vol. I. of Mr. W. Perren Maycock's "Electric Lighting and Power Distribution" has passed through a couple of new editions since the date of its publication in 1896. The second and concluding volume is now about to be issued by the publishers, Messrs. Whittaker and Co., of Paternoster-square. The new volume, we understand, comprises 684 pages and 400 illustrations.

Blackburn.—A deputation of the Guardians last week inspected the heating arrangements and electric lighting installation at Fulwood Workhouse, Preston, as they contemplate the introduction of electric lighting in the place of gas lighting at Blackburn Workhouse. We understand that, owing to the adoption of electricity at the Preston house, there is efficient lighting and heating and a saving of £300 a year as compared with the cost under the old system.

Aberdeen.—The Corporation have fixed the price to be charged for electricity for the year 1903-4 as follows—viz: (1) For lighting—for the first hour daily of the maximum demand, 6d. per Board of Trade unit; thereafter 2½d. per Board of Trade unit. (2) For motive power—for the first hour daily of the maximum demand, 3d. per Board of Trade unit; thereafter 1d. per Board of Trade unit. Minimum charge per half-year—for lighting, £1; for motive power, 10s.

Clydebank.—At the last meeting of the Town Council, an objection was made to the minutes of the meetings of the Magistrates' Committee on the question of the *plébiscite* to the ratepayers on the subject of whether or not the burgh should carry out its own electric light provisional order. A motion that the *plébiscite* was not satisfactory, the Council should proceed with the electric lighting order, combined with a refuse destructor, however only received two votes.

Belgium.—The Post Office notifies that on Oct. 1 the existing telephone services between London and Brussels will be extended to other Belgian towns, and communication will at the same time be opened between Birmingham, Brighton, Bristol, Cambridge, Cardiff, Derby, Ipswich, Leicester, Lowestoft, Newport (Mon.), Norwich, Nottingham, Sheffield, Southampton, Yarmouth, and Brussels and certain of the other Belgian towns. The charge will be 8s. for a conversation of three minutes.

Lecture—In connection with the Stafford Municipal Technical School a popular lecture was given in the borough hall last week by Mr. G. W. Hefford, B.Sc., the science master, assisted by Mr. J. Butters, B.Sc., the title of the lecture being "Electric Sparks." There was a good attendance. Mr. Hefford prefaced his lecture by remarking that its primary object was to provide a rallying point for old students and a starting point for new students at the municipal technical school.

Partnership.—Mr. Hal Williams, 60, Queen Victoria-street, London, E.C., has taken Mr. Walter Bridges into partnership, and the firm will be known as Hal Williams and Bridges. Mr. Bridges, who was for some years with Messrs. James Simpson and Co., engineers and contractors, London and Newark, has until recently been chief engineer to Messrs. Belshaw and Co., engineers and contractors, Westminster, S.W., and has had a unique experience in all classes of electrical and mechanical engineering.

Chippenham.—The engineer consulted by the Urban District Council as to an electric lighting scheme for the borough estimates that one can be installed for a capital cost of £10,000 or (alternately, to meet possible requirements) for £11,000 or £11,500. Revenue is so estimated that the three expenditures would result, after providing for working expenses and repayment of capital and interest, in annual profits of respectively £285, £555, and £1,140. It has been decided that steps be taken to obtain a provisional order to establish electrical works.

Stirling.—The electric light undertaking is making steady progress, the number of units generated this year being 194,076, as compared with 127,062 last year, while the quantity sold shows an equally gratifying increase. The revenue from the sale of current was £2,961 this year, as against £2,030 last year. Last year £1,552 went for interest and sinking fund, while this year, with the additional capital spent, this item had increased to £1,981. The debit balance on the year's working was £367, as compared with £784 last year and £905 in 1901.

Devizes.—Mr. Wingfield Bowles, Westminster, has reported on the proposed application for a provisional order for the purposes of electric lighting and supply, and as the result of his recommendations, it has been decided: (*a*) that the site of the generating station be at the wharf; (*b*) that the greater portion of the town be scheduled as the compulsory area, provision being made for extensions as may be required; (*c*) that the generating power shall be steam. Mr. Bowles is preparing the requisite plans and estimates. The Council will work the order themselves.

Peru.—A consular report on Peru states that in the near future there will be openings for the trade in electrical appliances of all kinds. There are already a number of installations for supplying electric light to towns and private houses. So far all orders for the plants have been placed with American, German, and Italian firms. No tenders were invited. It would therefore, the consul considers, be advisable for British manufacturers of electrical appliances to have active and reliable agents on the spot, so that no time may be lost as soon as an opening is heard of.

George F. Milnes and Co., Limited.—We have received a statement of the approximate liabilities and assets of the above company as at July 31, 1903, on which date a receiver and manager was appointed by the Court at the instance of the debenture holders. The liquidator, Mr. Max Meyer, is at present engaged upon negotiations for the sale of the business as a going concern. It will greatly depend upon the result of these negotiations what dividend there will be for the creditors. The liabilities are set down as £155,963. 13s. 10d., and the total assets, excluding goodwill and patents, as £185,315. 6s. 9d.

Whitehaven.—Last week at Carlisle Consistory Court, the Rev. C. B. S. Gillings, vicar of St. Nicholas, Whitehaven, and the churchwardens thereof, obtained a faculty to authorise them to instal electric light in the church instead of gas, and to use the present gas pendants for the purpose of carrying the electric lamps, and to sell the gas-meter and such parts of the gas fittings as are not required, on the distinct understanding that there would be no interference with the fabric, and also that the proceeds of the sale of the gas pendants, etc., should be applied to the fund for making the alteration and not to any extraneous purpose.

Brighton.—The municipal telephone system is to be inaugurated next week. The system will begin with 1,200 subscribers. A charge of £5. 10s. per year will be made for unlimited service. There will also be a limited service, costing £3. 10s. per year, and 1d. for each call made. Subscribers will not be able to communicate with the National Telephone Company's subscribers in the Brighton area, but will be able to communicate with the company's subscribers in any other town. The extension of the Brighton telephones into Hove is already under way. The conduits are being laid by Messrs. W. T. Henley's Telegraph Works Company, Limited.

Keighley.—The Electricity Sub-Committee recommend that the town clerk be instructed to endeavour to have included in the proposed provisional order to amend certain sanitary provisions of the Keighley Corporation Act, 1898, clauses empowering the Corporation to acquire, sell, or let on hire motors, arc lamps, and other appliances for extending the supply of electric energy. The electricity sold during August totalled to 9,799 units, as compared with 7,773 units for August last year, an increase of 2,026 units. For the two months ending Aug. 31 the increase over the corresponding period of 1902 in the sale of electricity was equal to 26·1 per cent.

Wandsworth.—The General Purposes Committee have been informed by the City of London and Brush Provincial Electric Lighting Company that the average price of the current sold by them during 1902 was practically 4½d. a unit, and they were prepared to quote guaranteed rates for 4½d. per unit for lighting purposes according to the character of the consumer's demands. The charge for current for power and heating purposes would be reduced to a flat rate of 2½d. a unit from Sept. 30, with a scale of discount ranging from 5 to 30 per cent. The matter has been referred back for further consideration on the chance of getting more favourable terms from the company.

Kingswinford.—Mr. J. H. McLean, who represented the Midland Electric Corporation, attended last week before the Rural District Council with regard to the electric lighting of the district. He said the company were pressing on with the work as quickly as possible, and had greater strength on. In two months the company had done close on 12 miles of streets, which was a record. The Council had refused to have any part of the district lighted without the whole of it was done. They could have the light at Wall Heath the next day if the Council would agree. He hoped that the work would be finished by Oct. 1, but he would promise that it should be all complete by Oct. 7.

Blackpool.—The last report of Mr. Furness, the borough electrical engineer, states that the returns for the month of August this year, as compared with the corresponding month last year, showed an increase in the works output of 25,766 units, made up as follows: Lighting—1903 116,854, increase over last year 7.045; traction—Corporation 106,314 (9.078), St. Annes trams 9,643 (9,643)—total, 232,811 (25,766). The wages for this month, as compared with August of last year, showed a decrease of £17, the figures being £419 as against £436. The cooling tower is now completed and ready for service, while the new steam winch and coal elevator are working and giving every satisfaction.

Stock Exchange Settlements.—The Stock Exchange Committee have appointed Sept. 29 a special settling day in Metropolitan Electric Tramways, Limited, further issue of 185,984 5 per cent. cumulative preference shares of £1 each, fully paid, Nos. 814,017 to 1,000,000, and ordered the undermentioned securities to be quoted in the official list: Eastern Extension, Australasia, and China Telegraph Company's further issue of £282,400 4 per cent. mortgage debenture stock; Eastern Telegraph Company's further issue of £302,169 4 per cent. mortgage debenture stock; Metropolitan Electric Tramways, Limited, further issue of 185,984 5 per cent. cumulative preference shares of £1 each fully paid, Nos. 814,017 to 1,000,000. Application has been made to the committee to appoint a special settling day in and to grant a quotation to the Oriental Telephone and Electric Company's 50,000 6 per cent. cumulative preference shares of £1 each, fully paid, Nos. 1 to 50,000. The committee has also been asked to appoint a special settling day in the Bournemouth and Poole Electricity Supply Company's provisional certificates (fully and partly paid) for a further issue of 4,500 ordinary shares of £10 each, Nos. 22,501 to 27,000.

Walsall.—The last report states that the total number of consumers supplied on Aug. 31 last was 281. During the past month the total units generated at the station was 52,297. The total output from the main generators was 55,937 units. The total units from the transformers was 44,368 (estimated). The total units registered on the meters was 42,494. The machinery was run for 612 hours. The wages paid amounted to £120. The electrical engineer has reduced his estimate for the loan of £24,550 by £650, in consequence of the

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Council having been able to lease buildings for transformer stations, and the sanction of the Local Government Board has now been received to the borrowing of the balance of the loan, amounting to £7,868.

Fulham.—The borough electrical engineer has reported on the lighting of the small hall, suggesting that to obtain satisfactory lighting with minimum expense, the best plan would be to alter four of the existing brackets, so as to have, instead of three electric lamps, four incandescent lamps and two Nernst lamps, the brackets to be reversed and relacquered before fixing. He also suggests that, for the purpose of lighting the stage, two five-light electroliers should be dropped from the ceiling at the opposite corners of the platform. If these two pendants be fixed, the two brackets at present over the platform could be dispensed with, and one single bracket could be altered for gaslighting only, in order to meet the requirements of the London County Council. The cost of carrying out this work would be £56. 4s. 4d.

Northfleet.—The Electric Lighting Committee of the Rural District Council recently discussed draft proposals submitted by the Sir Hiram Maxim Electrical and Engineering Company, Limited, for carrying out the terms of the Council's electric lighting provisional order, which, amongst others, included a provision that the Council should obtain a loan for the capital expenditure required for the construction of electricity works, and the provision of plant, machinery, and mains, such works and plant, etc., being constructed and provided by the company in accordance with plans and specification to be prepared by, and to be under the supervision of, the company's consulting electrical engineer (Mr. F. J. Warden-Stevens, of Westminster). The committee came to the conclusion that the only form of agreement which they might be willing to enter into would be a contract for the execution and maintenance of the works authorised by the provisional order, the company, of course, providing all capital and supplying electricity within the Council's area.

Battersea.—The Lighting Committee on Wednesday recommended the adoption of a scheme for the provision of plant for raising coal from barges at Grove Wharf and conveying it across to the central electric generating station at an estimated cost of £3,500, and the acceptance of an offer from the Rhodes Electrical Company, Limited, to supply to consumers within the borough motors on the "hire," "hire purchase," and "direct purchase" systems. The following particulars relative to applications for the supply of electrical energy to premises within the borough, including the Council buildings, were reported: Lighting—Consumers, number of applications quarter ended Sept. 15, 431 (38); actual, 404 (32); electrical energy, equivalent in 8-c.p. lamps, applied for, 34,977 (3,477); actually supplied, 29,797 (1,553). Motive power*—Equivalent in horse power, applied for, 381¼ (43¾); actually supplied, 323⅜ (9½). The figures in parentheses mark the increase over quarter ended June 16. * 20 amperes for charging accumulators applied for, 15 amperes connected; also 69 amperes for heating and cooking applied for and 48 amperes connected.

Carnarvon.—An enquiry has been held into the Council's application for sanction to borrow £17,000 for electric lighting. An agreement has been arrived at with the National Wiring Company for free wiring, the company undertaking, when required, to put at their own expense installation complete with plain fittings and lamps ready for connection to the mains on the following terms: (1) The consumer to sign an agreement in which he agrees to pay a rental of 4½d. per lamp per quarter for incandescent lamps of any standard candle-power up to 25 candles per incandescent lamp; above that candle-power 4¾d. per lamp per quarter, the agreement to be signed by the landlord of the premises when required. (2) The consumers to have the option at any time of purchasing their installation for 16s. 6d. per lamp, less 2½ per cent. per annum for depreciation. (3) The Corporation to have the option of purchasing the installation when the agreement is determined at 16s. 6d. per lamp, less 2½ per cent. per annum for depreciation; failing purchase, the Corporation to pay the company 4¼d. per lamp per quarter until purchase, but as each installation has been completed for 25 years the guarantee in respect of such installation to cease, the installation becoming the property of the Corporation without any further payment.

Stamford.—The great demand for electricity for lighting, heating, and power purposes has made it necessary to instal additional plant at the electricity works to meet the coming winter's load. These extensions, which are now being installed, consist of a duplicate Babcock and Wilcox boiler with a heating surface of 2,437 square feet. This will practically double the present capacity of the boiler-house. The new boiler is fitted with superheater having a capacity of 362 square feet, and electrically-driven Meldrum's mechanical stokers are to be fitted. The new steam set consists of a triple-expansion high-speed engine, coupled direct to a multipolar dynamo. The engine is an enclosed Belliss and Morcom one of 350 h.p. There is a shunt-wound dynamo of an output of 420 amperes at a pressure of 530 volts by Parker, of Wolverhampton. A larger storage battery is also being installed; the capacity of this battery is 600 ampere-hours at a discharge rate of 90 amperes. Cables have been laid connecting various streets with the object of thickening up the network and equalising the pressure of supply. The expectations of the company were that 6,000 lamps would be connected by Christmas next. The private lighting connections now are equivalent to 13,000 lamps. The above extensions, as was all the previous construction work, are being carried out under the supervision of the resident engineer, Mr. W. E. Milns, and in most cases by his own staff.

St. Marylebone.—At the last meeting the Town Clerk said, in reply to a question regarding the Council's position with regard to the electric light question, that the Board of Trade had not had the formal application for a license before them, which would have to follow advertisements and proper notices. They had met representatives from the company, the County Council and the Borough Council, that they might arrive at some mode of settlement, and they were very much surprised that the London County Council could not see its way to the settlement proposed. Having failed at the present in getting all four authorities to agree to a course they were still considering the question of granting the license, but had written to the parliamentary agents to state that the solicitors to the Board of Trade advised that the license should not be granted. The Local Government Board were awaiting the decision of the Board of Trade before themselves deciding on the appeal which had been made to them against the decision of the London County Council not to sanction the necessary loan. The Borough Council had already decided the procedure. Failing one department, they would go to the other, and failing that, they would go on with the Bill in November, after giving the necessary notice which the Council had authorised to be given. The Board of Trade's solicitors had reported that it was inexpedient, with regard to the facts, that the license should be given, and they convened a meeting of the officials of the four authorities, who could not come to a decision, and the matter was referred to the various authorities on that occasion.

Bermondsey.—Messrs. Kincaid, Waller, Manville, and Dawson, in a scheme for the extension of electric lighting which was submitted to the Council before the recess, anticipated that a sub-station could be provided at Bull Head Dock It has now been found impossible to carry out that design, and to provide a sub-station on other land would prove expensive. They have, therefore, submitted a further report stating that, if the expenditure was not too great, it would be better to continue the low-tension continuous-current system. In the case of Bermondsey, however, the expenditure on the low-tension mains, if this system in its complete simplicity was used to supply consumers at the farthest possible distance from the generating station, would be more considerable than if some system of automatically increasing the pressure along the feeders supplying the outside districts was utilised, maintaining the same method of supply to consumers within a reasonable distance of the generating station as that at present in use. The Electric Lighting Committee recommended at the last meeting that the latter course be adopted. The plant proposed to be installed includes an extension of the destructor-house by adding two new cells and a marine-type water-tube boiler. It would hardly be possible to get the whole of the new plant proposed installed in time for the coming winter owing to the period necessary for the erection of the new buildings; consequently the committee divided the estimate into two portions—one showing the cost of the work to be carried out before the winter, and the other the work which must be finished during next year. The first estimate involved an expenditure of £25,254, and the second £23,908 The committee recommended that the extensions be carried out. The recommendation was adopted, and Messrs. Kincaid, Waller, Manville, and Dawson were retained as consulting engineers.

London Gazette.—The petition for the winding-up of the Cheshire Electric Tramways Trust, Limited, by the High Court of Justice, heard on Sept. 9, 1903, will be reheard on Sept. 30, 1903, before the Court sitting at the Royal Courts of Justice, Strand, London, when the Court will be asked by the petitioner to make an order for the compulsory winding-up of the company, or in the alternative for an order continuing the voluntary winding-up of the company under the supervision of the Court. The Electric and Ordnance Accessories Company, Limited, of Stellite Works, Cheston-road, Aston, near Birmingham, fuse manufacturers, will apply to the justices of the county of Warwick, acting for the division of Aston, at the police court, Aston-juxta-Birmingham, on Oct. 28, 1903, at 11 a.m., for their assent to the establishment of a new factory for explosives upon premises situate in Cheston-road, Aston, near Birmingham. A dividend is intended to be declared in the estate of James George Cole, electrical engineer, 34, Summerhill-road, South Tottenham. Creditors who have not already sent in their claims are requested, on or before Oct. 10, 1903, to send in their names and addresses and the particulars of their debts and claims to Harry Egerton Knight, of Weavers' Hall, 22, Basinghall-street, London, chartered accountant. A general meeting of the members of the Anderson Electrical Traction Syndicate, Limited, will be held at the registered office of the company, 1, Cheapside, Bradford, on Monday, Oct. 26, 1903, at 3 p.m., for the purpose of having laid before such meeting an account of the liquidator, showing the manner in which the winding-up has been conducted and the property of the company disposed of, and of hearing any explanations that may be given by the liquidator. A general meeting of the members of the North-Eastern Telephone Company, Limited, will be held at the office of the liquidator, 12, West-street, Gateshead, on Thursday, Oct. 22, 1903, at 3 p.m., for the purpose of having an account laid before them, showing the manner in which the winding up has been conducted and the property of the company disposed of, and of hearing any explanation that may be given by the liquidator, and also of determining by extraordinary resolution the manner in which the books, etc., of the company and of the liquidator shall be disposed of.

Ladysmith.—The formal opening of the electric light plant took place on Aug. 29, when Mrs. Joseph Farquhar turned on the current to the street lights. It was through the work and enthusiasm of Mr. Joseph Farquhar, when mayor of the borough, that the idea of electric light was first taken up. Private lighting was commenced on the following Saturday. The power station is situated on the Market-square, and contains four generators, which are worked by two engines. There are three boilers of the locomotive type, each of 30 h.p., to which special fire-boxes have been fitted to suit the consumption of Natal coal. The boilers are Robey's, and the engines from Messrs. Willans and Robinson, of Rugby. The contract for the electrical work was given to Messrs. Hubert Davies and Spain, the price being £8,326, and the operations were carried out under the direction of Messrs. Reeves and Manning. Mr. L. Roberts, A.I.E.E., of Durban, was the consulting engineer, and it was from his specifications and

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plans that the scheme was first started upon, though it has since been increased, and extensions to the value of £2,000, made from specifications by the borough electrical engineer, Mr. J. Stanley White, of Manchester, who will also take charge of the whole of the workings when they are completed. Mr. A. Ritchie, of Durban, was the architect for the power station, and Mr. A. Fraser, of Ladysmith, was the builder. The four generators are each of 25 kw. capacity, and they are of the multipolar type, and are supplied by the Electrical Construction Company, of Wolverhampton. The current will be distributed on the three-wire overhead system. Each pole will contain five wires, but two will be switch wires for the street-lighting. The two outside wires will be power wires, and will each carry a direct current of 220 volts. Already the anticipated demand has so considerably increased that in Murchison-street it has been thought advisable to fix a cable of $^{19}/_{16}$ wire in place of the No. 6 cable as at first intended. The work of establishing house connections goes on rapidly, and no less than 50 are already connected. A hundred 32-c.p. incandescent lamps will be distributed over the town, one on each alternate pole, except in dangerous parts, where the lights will be on every pole. Four arc lamps are expected to arrive in three weeks' time. These are intended for the more central parts of the town. A further 75 incandescent lamps have been ordered for placing on the poles in the extensions of the original scheme. The power, under present arrangements, will be supplied throughout the night from dusk until daylight. The charge to private consumers will be 1s. per unit. The charge for connection is £1. 10s. This covers all cost of material, provided the premises stand sufficiently near the boundary line to enable one span of wire to be used from the mains. Where more than one span is necessary the customer will be charged to the extent of the cost of such extra work. Meters will be supplied at rentals varying from 1s. to 1s. 6d. per month, according to size.

Hammersmith.—The agenda for this week's meeting of the Borough Council contains a recommendation that the Council do join the Association of Metropolitan Borough Councils, and appoint representatives thereon. The alterations recommended by the Home Office factory inspector for the protection of the generating station and sub-stations will be carried out. The committee in their report say "that all the requirements for the protection of the high-tension 'bus bars on the high-tension distribution boards will be fully satisfied if the original scheme is completed and the space between the two boards filled in so as to make one continuous board. This will provide eight more feeder panels, and as all the present panels are in use, there are no spares for extensions, and it will be necessary to carry out this arrangement before any more high-tension feeders can be put to work. Messrs. Ferranti Limited (the makers of the original boards) have offered to carry out the work, including instruments, for £360. 4s., which is less per panel than the price charged for the original boards. With reference to the better protection of the main switchboard, the committee consider that the time has now come for the unsatisfactory temporary hand railing to be removed and a protection rail of good design substituted. Messrs. J. and A. Law have offered to supply the necessary material ready for erection for £49. 15s., or to be erected complete for £65. The extension of the rectifier platform has been completed. The Council have entered into an agreement for supplying steam from the generating station to the Imperial Tobacco Company's factory. As the demand for electricity has very greatly increased, the committee consider it advisable to have all the boilers in thorough readiness for meeting the load this winter, and as No. 1 boiler is of very little use in its present condition, the engineer has submitted the following report upon the subject of installing Howden's forced-draught apparatus to enable us to use this boiler with advantage: 'For some time now we have not been able to use the Lancashire boiler to any advantage on account of the very low draught obtainable at that end of the flue, as the chimney is loaded up to its full capacity. This is due to the large amount of air required by the boilers nearer the chimney, leaving very little for the boiler at the far end. This state of affairs will grow worse as the load increases, and I am afraid that we shall some day shut down for want of steam. I have given very careful consideration as to the best means of making this boiler permanently useful, and at the same time more economical. We have tried several forms of steam-jet apparatus, all of which have given trouble without any real advantage in return. The only thing which remains is to adopt some form of mechanical draught in which the required air is supplied by means of a fan driven by a steam-engine. The use of mechanical draught has been employed very largely in the mercantile marine, and the details having been thoroughly worked out so as to make it a reliable and economical system, there is no need for us to do any experimenting in this direction ourselves. There are, however, very few land installations where this system can be seen in operation, but there is no doubt that a proper system will show greatly increased economy, and will pay for the cost of installing by the amount of coal saved. I have carefully looked into the working of the Howden hot-air forced-draught system, which has been installed in over 13,000 furnaces, supplying steam-engines of nearly 5,000,000 h.p. The plant I inspected was at work driving the one boiler fixed to supply steam to the whole of Messrs. Howden's works. It consists of a fan driven by a small steam-engine, forcing the air into the furnace through heaters placed in the side flues of the boiler, so that the air absorbs the heat, which would otherwise be wasted, and reaches the furnace at an increased temperature of over 100deg. The firing is done by hand, and a system of hot-air jets over the furnace and in front of the fire-hole door prevents the admission of cold air, which reduces the efficiency of the furnace and makes smoke. The operation is extremely simple, giving the fireman absolute control of the combustion, which can be instantly adjusted to suit the varying loads. The chimney was not discharging any smoke, in spite of the fact that small Scotch coal was being hand-fired. The whole of the apparatus is of a most substantial manufacture and of simple design, so that there is nothing to get out of order or require skilful attention. The cost of the installation for our boiler seems high, but it can afterwards be extended to the other boilers at a correspondingly less price. The apparatus includes: (*a*) one double-inlet fan, driven by a single-cylinder double-action enclosed type engine; (*b*) two air-heaters for side flues of boiler, complete with air-tubes, piping from fan to heater and from heaters to front of boiler; (*c*) air reservoirs round furnace front, and front of furnace complete with door valve air distribution boxes and all mountings; (*d*) furnace bars, bearers, and bridges. The whole apparatus fitted to the boiler complete and ready for work costs £355. As the results of several tests made for comparison with oil fuel, our boilers gave an evaporation of 85lb. of water per pound of coal, whereas in the Admiralty test of the Howden system an evaporation of 12 3 was obtained as the result of a 13 hours' test from Liverpool to Queenstown on the Cunard liner "Saxionia." This is an increase of nearly 50 per cent. on the results obtained here. I do not anticipate being able to obtain such results, but there is no reason why we should not increase the evaporation by 2lb. or 3lb. of water per pound of coal. The boiler will consume some 900 tons of coal during the winter months, and an increased evaporation of 2½lb. of water per pound of coal will be equivalent to a saving of 250 tons of coal, costing us £1 per ton at the furnace, or £250 saving, so that the whole cost will be recouped at the end of 12 months. This is borne out by the actual results obtained at the last installation equipped by this firm. In our case the actual saving which will be effected is a secondary consideration in comparison with the necessity of having stand-by plant for the winter months, and in view of the results already obtained, I should advise the fitting up of No. 1 boiler with this system without delay. The conversion will require at least six weeks for completion, and as by that time the load will be nearing its maximum there is no time for making experiments.'" The committee recommend that the apparatus reported upon by the engineer be ordered and fitted to No. 1 boiler, at an approximate cost of £355. Application has been made to the Conservators of the River Thames for their sanction to the laying in the river bed of the suction pipes required in connection with the extension of the condensing scheme, which was decided upon in March last, and permission has been obtained on condition that the work be carried out and maintained to the satisfaction of the Conservators under the inspection of their engineer, and that the same will be allowed to remain during pleasure on the terms and conditions set forth in and endorsed upon the Conservators' license. In connection with certain electrical machinery about to be installed by Messrs. J. and H. Gwynne and Messrs. Joseph Baker and Son, and which will require to be driven by continuous current instead of single-phase alternating current as supplied by the committee, it will be necessary for a motor-generator to be installed at each of their premises, the estimated cost thereof being £350 each, for the use of which both firms are prepared to pay a rental, as if these transformers are installed a large amount of current will be consumed, which will greatly increase the output, and the committee recommend (*a*) that two transformers be purchased at an estimated cost of £350 each, and that it be referred to them to prepare specifications and obtain tenders; (*b*) that the annual rental to be charged for the use of the transformers be at the rate of 5 per cent. of the cost thereof.

PROVISIONAL PATENTS, 1903.

SEPT. 14.

19715. Improvements in electrolytic meters. Sydney Holmwood Holden, 18, Southampton-buildings, Chancery-lane, London.

19748. New or improved means for protecting the terminals of electric apparatus, and ensuring good electrical contact. William Peto, 43, Southampton-buildings, Chancery-lane, London. (Complete specification.)

19780. Improvements in or connected with electric lamps. Godfrey Bamberg, 173, Fleet-street, London.

SEPT. 15.

19801. An electrochemically-deposited jacket for explosion engines and the like. Willoughby Lake Baylay and William Ashbee Tritton, Thorndean, Anson-road, Tufnell Park, London.

19836. Improvements in insulated joints for railroad rail sections. Sydney Elliott Page, 28, New Bridge-street, London. (The Weber Railway Joint Manufacturing Company, United States.) (Complete specification.)

19877. Improvements in electromagnetic relay apparatus. Siemens Bros. and Co., Limited, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Siemens und Halske Aktien-Gesellschaft, Germany.) (Complete specification.)

19882. Improvements in electric fuses and the like. George Benson Bâby, 111, Hatton-garden, London.

19886. Improvements in electromotive force regulators. Benjamin Garver Lamme, Westinghouse-building, Norfolk-street, Strand, London. (Date applied for under Patents Act, 1901, Oct. 2, 1902, being date of application in United States.) (Complete specification.)

19887. Improvements in controlling apparatus for electric motors. Benjamin Garver Lamme, Westinghouse-building, Norfolk-street, Strand, London. (Date applied for under Patents Act, 1901, Sept. 29, 1902, being date of application in United States. (Complete specification.)

19894. Improvements in incandescent electric lamps. William Cowper Robison, 19, Holborn-viaduct, London.

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19896. Improvements relating to the driving of dynamos by steam-turbines. William Edward Evans, 27, Chancery-lane, London. (Gesellschaft zur Einfuhrung von Erfindungen m. b. H., Germany.) (Complete specification.)

SEPT. 16.

19927. Improvements in the construction of switchgears for electrical purposes. Henry William Clothier, 108, Gilda Brook-road, Eccles, Manchester.

19943. Improvements in alternating-current induction motors. Louis John Hunt and the Sandycroft Foundry Company, Limited, 6, Lord-street, Liverpool.

19961. An improvement in electric tumbler switches. Sir Hiram Maxim Electrical and Engineering Company, Limited, and James Harrington, Gillingham-street, Victoria, London.

19965. Improvements in and relating to electric lamps. Walter Charles Head, William Arthur Snape, and Robert Charles Volland, 20, Filey-avenue, Clapton, London.

19974. Improvements in electrical conducting trolley mechanism for electrical tramcars or the like vehicles. Frederick William Massey and Thomas Collins Perkins, Prudential-buildings, Corporation-street, Birmingham.

20000. Improved method of rectifying alternating electric currents. Godfrey Bamberg, 173, Fleet-street, London.

SEPT. 17.

20012. Improved cable terminal. Thomas Ballard and William Howard, 30, Conduit-road, Sheffield. (Complete specification.)

20017. Improvements in field-magnet bobbins specially adapted for small dynamos and motors. John Maclean, 100, Wellington-street, Glasgow.

20027. Improvements in and relating to electrical switches. Arthur Denby Smith, Highfield-lane, Keighley.

20043. Improvements in electric glow lamps. Jack Randall Crawford, Clun House, Surrey-street, Strand, London.

20047. Improvements in means for automatically lighting electric railway carriages, tramcars, and other places by supplementary currents of electricity in case of the accidental failure of the main current. John Robert Quain, 65, Chancery-lane, London.

20061. Improvements in receivers for wireless communication. George Morin, 53, Chancery-lane, London. (Complete specification.)

20072. Improvements in coin mechanism, especially applicable to electricity and other meters. Edward Du Bois, Norfolk House, Norfolk-street, Strand, London.

SEPT. 18.

20101. Improvements in the construction of armatures for dynamos and motors. John Maclean, 100, Wellington-street, Glasgow.

20128. Improvements in or relating to electric lighting. Benjamin Garver Lamme, Westinghouse-building, Norfolk-street, Strand, London. (Date applied for under Patents Act, 1901, Sept. 29, 1902, being date of application in United States.) (Complete specification.)

20137. Improvements in and relating to electric arc lamps. John William Ewart, 36, Chancery-lane, London.

20155. Improvements in electricity meters. Paul Rieunier, 6, Lord-street, Liverpool. Date applied for under Patents Act, 1901, Oct. 2, 1902, being date of application in France. (Complete specification.)

SEPT. 19.

20219. Improvements in or relating to electric traction and apparatus therefor. Wilfrid Swanwick Boult and Cedric Randal Boult, 111, Hatton-garden, London.

20230. Improvements in automatic circuit breakers. Earl Porter Wetmore, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

COMPLETE SPECIFICATIONS ACCEPTED.

To be published Oct. 8, 1903.

1902.

19999. Secondary battery elements and the process of producing same. Fiedler and Puchmüller.

20426. Portable testing and comparing instrument for electric incandescent lamps. McCandlish.

20502. Means for operating rail and conductor points from the vehicle on electric and other tramways and the like. Goord.

21201. Process and apparatus for the manufacture of electric accumulator plates. Adam. (Englemann.)

21604. Electric cord grip, lampholder, and shade carrier. Ioannidi and Hesford.

23328. Rope, chain, or belt driving or hauling gear. Spence and British Electric Plant Company, Limited.

24112. Alternate-current traction systems. Mordey and Hansard.

24220. Connections for electric conducting wires. Peto and Kent.

24755. Electric cables. Johnson and Bass.

24714. Electric switch-control mechanisms. Carolan. (General Electric Company.)

24943. Switches for starting electric motors. Highfield.

24986. Pendant incandescent electric lamps. Laidlaw and Scholes.

25195. Electrical influence apparatus suitable for the ignition of gases and inflammable vapours and for other purposes. Eckstein and Coates.

25783. Means of advertising on electric and other tramcars. Walkden and Patent Bottle and General Advertising, Limited.

25916. Electrical resistances. Lewis.

1903.

3837. Circuit breakers. Ball.

7701. Electric receiver clocks. Uytenbogaart.

7714. Monophase and polyphase alternating-current machines. Evans. (Allgemeine Elektricitäts-Gesellschaft.)

10788. Electric dynamos and motors. Edgerton and Bowers.

14286. Cases or covers for the protection of electrical apparatus. Dorman and Smith.

15623. Means for protecting the exposed or live parts of electric switches, cut-outs, or the like. McDevitt.

15810. Electrical fusible cut-outs. Dorman, Smith, and Baggs.

16100. Circuit-controlling devices, chiefly designed for use with electric flash signs. Lake. (Automatic Time Switch Company.)

17564. Junction or inspection boxes and like inspection fittings used with electric wiring. White and Waldron.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.		Last price
Commercial and Industrial.—	£		£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1	..	½-⅝ xd
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1	..	½-¾
British Insulated and Helsby Cables, Ord., 1-100,000	5	..	6-7 xd
—— 6 per cent. Cum. Pref., 1-100,000	5	..	5¼-5⅝
—— 4½ per cent. Mortgage Debentures	100	..	102-106
British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red.	100	..	104-106
British Westinghouse Elec. and Manuf., 6 per cent. Pref., 275,001-375,000	5	..	5⅝-5¾
—— 4 per cent. Mortgage Debenture Stock	100	..	100-102
Brush Electrical Engineering, Ordinary, Nos. 1-105,751	2	..	¾-1¼
—— Non. Cum., 6 per cent. Pref.	2	..	1-1¼
—— 4½ per cent. 1st Debenture Stock	100	..	97-100
—— 4½ per cent. 2nd Debenture Stock	100	..	85-90
Callender's Cable, Debentures	100	..	106-110
—— Ordinary	5	..	11¼-12¼
—— 5 per cent. Pref.	5	..	5¼-5⅜
Crompton and Co.	5	..	2-2¼
—— 5 per cent. Debentures	100	..	100-104
Edison and Swan United, "A" Shares, 1-99,251	3	..	¼
—— "A" Shares, 01-017,139	5	..	1¼-2⅛
—— 5 per cent. Debentures	100	..	77-82
—— 4 per cent. Deb. Stock, Red.	100	..	72-77
Electric Construction, Limited, Nos. 1 to 112,100	2	..	1⅝-1⅞
—— 7 per cent. Cumulative Pref.	2	..	2¼-2⅝
—— 4 per cent. Perp. 1st Mort. Deb.	100	..	98-101
Ferranti Limited, 5 per cent. 1st Mort. Deb. Stock, Red.	100	..	90-95
General Electric Company (1900), 5 per cent. Cum. Pref.	10	..	9½-10
—— 4 per cent. 1st Mort. Deb. Stock	100	..	97-100
W. T. Henley's Telegraph Works, Ordinary	5	..	14-15
—— 4½ per cent. Preference	5	..	5-5¼
—— 4½ per cent. Debentures	100	..	108-112
India Rubber, Gutta Percha, and Telegraph Works	10	..	18¼-19¼
—— 4 per cent. Debentures	100	..	100-103
Parker, Thos., Limited, Ordinary	10	..	14¼-15¼
Telegraph Construction and Maintenance	12	..	34-37
—— 5 per cent. Bonds	100	..	100-103
Electric Lighting and Supply.—			
Blackheath & Greenwich District Ordinary 1,201-101,200	1	..	⅜-½
—— 4½ per cent. Deb. Stk. Certs., Red. and Conv.	100	..	118-121
Bournemouth and Poole, Ordinary	10	..	12½-13½
—— 4½ per cent. Cum. Pref., 7,501-15,000	10	..	10-11
—— 5 per cent. Cum. Second Pref., 15,001-22,500	10	..	10½-11½
—— 4½ per cent. Debenture Stock, Red.	100	..	103-106
Bromley (Kent) Electric Light and Power Co., 4½ per cent. 1st Debenture Stock, Red.	100	..	102-105
Brompton and Kensington, Ordinary	5	..	10⅜-11⅛
—— 7 per cent. Preference	5	..	10½-10⅝
Calcutta Electric Supply Corp., Ordinary, Nos. 1-40,000	5	..	7-7¼
—— Nos. 20,001-30,000	5	..	7-8
Cambridge Electric Supply Company, Ltd., £10 Ord.	8	..	14½
—— " " £10 Ord.	6	..	10⅜
Central Electric Supply, Ld., 4 per cent. Guar Deb. Stock	100	..	107-110
Charing Cross and Strand, Nos. 1-70,000	5	..	9-9½
—— 4½ per cent. Cum. Pref.	5	..	5½-6
—— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000	5	..	4¾-5
—— 4 per cent. Debenture Stock, Red. (Prov. Certs.)	100	..	104-106
Chelsea Electricity Supply	5	..	5⅜-6½ xd
—— 4½ per cent. Debentures	100	..	108-111
City of London, Ordinary	10	..	10¼-11
—— 6 per cent. Cumulative Pref.	10	..	13-14
—— 5 per cent. Debenture Stock	100	..	122-127
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100	..	102-105
County of London and Brush Provincial, Ordinary	10	..	7¼-8¼
—— 6 per cent. Cum. Pref.	10	..	11¼-12¼
—— 4½ per cent. Debentures Prov. Certs. All pd. Red.	100	..	108-112
Edmundsons' Electricity Corporation, Ordinary, 1-50,000	5	..	6¼-7
—— 6 per cent. Cum. Pref.	5	..	6¼-6¾
—— 4½ per cent. First Mort. Deb.	100	..	107-110
Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-30,000	5	..	3¼-4¼
—— 5 per cent. Debenture Stock, Red.	100	..	86-88
Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000	5	..	6-6¼
—— 4½ per cent. First Deb. Stock, Red.	100	..	100-103
Hove Electric Lighting, Limited, Ord., 1-13,000	5	..	7¼-8¼
Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000	5	..	10¼-11¼
—— 4 per cent. Debenture Stock Red.	100	..	103-106

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Name.	Amount paid. £	Last price. £
Kensington and Knightsbridge and Notting Hill	100 ..	103-106
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10 ..	9⅜-10⅛
London Electric, Ordinary	3 ..	2-2¼
—— 6 per cent. Pref.	5 ..	5¼-6
—— 4 per cent. 1st Mortgage Debenture Stock, Red...	100 ..	100-102
Metropolitan, Ordinary	10 ..	17½-18½
——¼ per cent. First Mortgage Debenture Stock	100 ..	109-113
——3½ per cent. Mortgage Debenture, Red.	100 ..	97-100
Newcastle-upon-Tyne Electric Supply, Ordinary.....	5 ..	98-101
—— Preference.....	4 ..	100-103
Notting Hill Electric Lighting	10 ..	13-14
—— 4 per cent. First Mort. Debs., Nos. 1-500 (Reg.) ..	100 ..	99-102
Oxford Electric, Ordinary, 1-96 and 407-14,310	5 ..	5-5¼ xd
—— 4 per cent. Debenture Stock	100	98-101
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100 ..	100-102
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000 ..	5 ..	3¼-3⅜
—— 4 per cent. Debenture Stock	100 ..	88-90
South London, Ordinary	5 ..	3⅜-4¼
St. James's and Pall Mall, Ordinary, 101-20,080	5 ..	15-16
—— 7 per cent. Pref.	5 ..	8-9
—— 3½ per cent. Deb.	100 ..	98-101
Urban Electric Supply Co., Ordinary, 8-30,007	5 ..	5-5¼
—— 5 per cent. Cumulative Preference, 50,001-80,000	5 ..	5-5¼
Westminster, Ordinary	5 ..	13-14
—— 5 per cent. Cum. Pref., 110,101-138,251	5 ..	6-6½

Electric Railways.—

Central London, Ordinary.....	100 —	97-100
—— 4 per cent. Pref.	100 ..	99-102
—— ,, ,, deferred	100 ..	100-103
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)..	100 —	115-118
City and South London, Consolidated Ordinary	100 ..	58-60
—— 4 per cent. Debenture Stock	100 ..	116-119
—— 5 per cent. Pref. Stock '91	100 ..	127-130
—— ,, ,, ,, '96	100 —	126-128
—— ,, ,, ,, '01	100 ..	125-128
Liverpool Overhead, 5 per cent. Pref.	— —	13-13¼
—— Ordinary, 1-50,000	— —	7⅞-8
—— 4 per cent. Mortgage Debentures, Red., 1-1,700 ..	— —	102-104
Waterloo and City, Ordinary	100 —	94 97

Electric Tramways.—

Anglo-Argentine, 1-260,007	5 ..	4⅛-4¼
—— Permanent 6 per cent. Debenture Stock, 1888....	100 ..	125-130
Blackpool and Fleetwood Tramroad.....	10 ..	13½-14½
Brisbane Tramway Invest., Lim., Ord., 1-75,000	5 ..	2-3
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5 ..	4-4½
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100 ..	101-104
British Columbia Electric Railway Co., Ord., Nos. 1-20,000	100 ..	79-82
—— Non-Cum. 5 per cent. Pref., Nos. 25,001-38,600 ..	100 ..	91-94
—— 4½ per cent. 1st Mt. Debs., Nos. 1-6,250, of £40 each	40 ..	104-106 p.c.

Name.	Amount paid. £	Last price. £
British Electric Traction, Ord. 1-300,000 & 60,001-90,000..	10 —	12¼-13
—— 6 per cent. Cm. Pf., 30,001-60,000	10 —	11½-12
—— 5 per cent. Perpetual Debenture Stock	100 —	122-125
Buenos Ayres and Belgrano Tram., Ord., 1-100,000	5 —	2½-2⅝
—— "A" 6 per cent. Cm. Pf., 1-40,000	5 —	5-5½
—— "B" 6 per cent. Cm. Pf., 1-27,500	5 —	4⅝-5⅛
—— 5 per cent. Deb. Stock, Red.	100 ..	107-110
—— Prov. Cert., all paid	100 ..	99-102
Cape Electric Tramways, Nos. 1-480,000	1 ..	2½-2⅝
City of Birmingham Tramways, 5 per cent. Cum. Pref.....	10 ..	5-5½
—— 4 per cent. 1st Mortgage Deb., 1-3,000 (1917)	100 ..	99-102
Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red.	100 ..	102 105
Cork Electric Tramways and Lighting Co., Ordinary	10 ..	13-14
—— 5 per cent. Cum. Pref.	10 ..	11-12
—— Debentures	100 ..	96-99
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10 ..	12½-13½
—— 6 per cent. Pref., Nos. within 1-60,000	10 ..	15-16
—— 3½ per cent. Mort. Debs., 1-3,000, Red.	100 ..	94-97
Imperial Tramways Ordinary.....	all ..	22-22½
—— 6 per cent. Cum. Pref.	all ..	14½-15½
—— 4½ per cent. Deb Stock	100 ..	112-114
Isle of Thanet Electric Tramways and Lighting, 5 per cent. Cum. Pref., Nos. 30,001-60,000	5 ..	3¼-4½
—— 4 per cent. Debenture Stock	100 ..	92-95
Kidderminster and District Lighting and Traction, Pref...	5 —	3¼-4
London United Trys. (1901), 5 per cent. Cum. Pref.	10 —	11½-12½
—— 4 per cent. 1st Mt. Db. Stock, Red.	100 ..	104-106
Metropolitan Electric Trams., Deferred, 1 000 001-1,314,016	1 ..	3/16-5/16
—— 5 per cent. Cum. Pref., 500,001-814,016.....	1 ..	½-1⅛
New General Traction, Ordinary	5 —	⅛-¼
—— 6 per cent. Cum. Pref.	5 —	2-3
—— 5 per cent. Mortgage Debentures, 1-1,713 (Regd.).	100 ..	88-93
Oldham, Aston, and Hyde Tramway, Ordinary.....	10 —	10½-10⅝
—— 5 per cent. Cum. Pref.	10 —	11½-12½
Perth Elec. Tramways (W.A.) 5 per cent. 1 Mort. Deb. Stk.	100 ..	99-102
Potteries Electric Traction, Ordinary, 20,001-40,000	10 —	9-10
—— 5 per cent. Cum. Pref., 1-20,000	10 —	8¼-9½
—— 4½ per cent. Debenture Stock.....	100 —	103-106
South Lancashire Electric Traction and Power Company—		
—— £250,000 Ordinary	1 —	1
—— £101,132 6 per cent. Preference.....	1 —	1
—— £528,093 4½ per cent. Debenture Stock	100 p.c. —	100 p.c.

Telephones.—

National Telephone, Preferred	100 —	100-102
—— Deferred Stock	100 —	76-78
—— 6 per cent. Cum. First Pref.	10 —	13-14
—— 6 per cent. Cum. Second Pref.	10 —	13-14
—— 5 per cent. Non. Cum. Third Pref.	5 —	5-5¼
—— 3½ per cent. Deb. Stock, Red.	100 —	94 96
—— 4 per cent. Deb. Stock, Red.	100 —	101-103
Oriental Telephone and Electric Company	1 —	13/15-15/16

TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line	Traffic Returns for week: Ending	1903. £	1902. £	Increase or decrease: Week. £	Current year. £	Miles of single track open: 1903.	1902.	Accounts for past year: Ending	Total receipts £	Passengers carried.	Car miles run.	Receipts per: Pas-s'nger d.	Car mile. d.	Mile of track. £	Cost per car mile. d.
Aberdeen Corporation.....	Sep. 19	1,164	1,003	+ 161	+ 2,711	19¼	17¼	May 31	37,931	9,099,715	794,641	0·98	13·02	1,970	6·14
Ayr Corporation.....	,, 13	265	311	— 36	+ 8	8	6	Sept. 25	12,503	2,979,276	290,099	1·00	10·34	1,560	4·7
Birmingham Tramways	,, 19	5,095	4,915	+ 144	+ 8,438	6¼	6¼	—	—	—	—	—	—	—	—
Blackburn Corporation	,, 11	926	903	+ 23	+ 452	24	24	March 25*a*	40,964	7,234,106	826,558	1·36	11·87	1,705	7·44
Blackpool Corporation.....	,, 17	1,530	1,611	— 21	— 140	17½	16½	,, 31	211,163	6,169,121	784,443	1·52	10·8	—	—
Blackpool-Fleetwood Tramways	,, 19	1,082	1,144	— 62	— 109	16½	16½	Dec. 31	30,923	2,049,677	584,989	3·62	12·68	1,932	6·99
Bolton Corporation	,, 20	1,854	1,631	+ 223	+ 6,321	38	25	March 31	85,704	17,761,605	1,896,247	1·15	10·75	3,430	5·87
Bournemouth Corporation.....	,, 16	1,167	—	—	—	10½	—	—	—	—	—	—	—	—	—
Bradford Corporation	,, 20	3,930	3,359	+ 571	+11,457	41	—	—	—	—	—	—	—	—	—
Brighton Corporation	,, 20	985	998	— 13	+ 5,888	6½	—	,, 31	—	10,432,508	1,031,928	1·00	10·10	—	—
Bristol Tramways Company	,, 18	4,894	4,821	+ 73	—	51½	51½	Dec. 31	223,480	41,192,899	5,724,114	1·30	9·38	4,348	—
Burnley Corporation	,, 19	851	676	+ 175	—	—	—	—	—	—	—	—	—	—	—
Burton Corporation	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Cardiff Corporation	,, 19	1,997	1,580	+ 417	—	—	—	—	—	—	—	—	—	—	—
Carlisle Tramways Company....	,, 19	206	195	+ 11	+ 505	—	—	,, 31	—	2,216,583	320,129*h*	—	—	—	—
Central London Railway.....	,, 19	5,900	6,324	— 424	— 2,972*h*	6	—	,, 31	367,225	45,305,110	1,276,971*a*	1·87	66·6*a*	59,076	35·6*a*
City and South London Railway	,, 20	2,482	2,851	— 369	— 3,827	6⅜	—	,, 31	165,003*a*	19,069,319*a*	—	—	—	—	—
Cork E. T. and L. Company	,, 17	583	330	— 232	— 2,033	—	—	—	—	—	—	—	—	—	—
Darwen Corporation.....	,, 18	271	215	+ 56	— 178	7·23	—	March 31*g*	12,341	2,360,735	254,279	1·25	11·65	1,707	9·36
Dover Corporation	,, 19	258	251	+ 7	+ 57	3	—	—	—	—	—	—	—	—	—
Dublin & Lucan Electric Railway	,, 20	131	132	— 1	+ 84*h*	—	—	Dec. 31	5,796	364,796	102,087	3·81	13·62	859	7·68
Dublin U. T., electric cars.....	,, 18	3,844	3,793	+ 51	} —	46	46	March 31	126,121	24,553,133	3,429,356	1·23	8·82	2,741	5·06*h*
Dublin S. District, Electric	,, 18	955	912	+ 54											
Dundee City Tramways	,, 16	843	787	+ 56	—	22	22	May 15	35,874	9,084,522	752,814	0·93	11·276	1,630	—
East Ham Corporation	,, 19	708	526	+ 182	+ 5,387	10·75	7·52	March 31	25,341	9,971,337	650,224	0·61	9·35	2,357	—
Farnworth U.D.C.....	,, 9	142	142	—	+ 500	—	—	—	—	—	—	—	—	—	—
Glasgow Corporation	,, 19	14,558	12,936	+1,632	+23,598	124	101	May 31*g*	656,572	177,179,549	14,008,750	0·88	11·25	5,489 *b*	7·40*d*
Halifax Corporation.....	,, 9	1,496	1,438	+ 28	+ 3,596	30½	27¾	—	—	—	—	—	—	—	—
Huddersfield Corporation	—	—	—	—	—	34	35	March 31	56,631*h*	9,738,213	1,218,539	1·4	11·14	1,618	6·38
Hull Corporation, E. S.....	,, 19	1,803	1,714	+ 91	+ 2,154	19	19	,, 31	87,707*h*	21,065,999	2,218,696	1·00	9·49	5,004	5·07
Ilkeston Corporation	,, 16	162	—	—	—	—	—	—	—	—	—	—	—	—	—
Kirkcaldy Corporation	,, 16	165	—	—	—	—	—	—	—	—	—	—	—	—	—
Leeds Corporation	,, 19	5,493	5,228	+ 265	+ 8,134	77	—	March 25	262,656	57,239,779	5,773,651	1·11	10·91	3,283	—
Liverpool Corporation.....	,, 12	10,566	10,430	+ 136	+11,763	101	95	Dec. 31	504,304	108,906,472	11,705,425	1·11	10·34	5,000	6·88
Liverpool Overhead Railway....	,, 20	1,690	1,514	+ 176	+ 1,264	15½	15½	June 30	79,252	10,466,726	986,185*a*	1·82	19·30*a*	5,110	— *c*
Lowestoft Corporation	,, 19	262	—	—	—	—	—	—	—	—	—	—	—	—	—
Nelson Corporation	,, 19	88	—	—	—	3	—	—	—	—	—	—	—	—	—
Newcastle-on-Tyne Corporation	,, 19	3,395	2,931	+ 464	—	38½	36	March 25*g*	150,334	33,474,122	3,379,119	1·08	10·93	4,175	6·17
Portsmouth Corporation.....	,, 19	1,923	1,831	+ 92	—	29	29	Sept. 30	47,651	9,168,137	868,157	1·24	13·17	1,643	—
Rochdale Corporation	,, 21	138	133	+ 5	—	4½	—	March 31	5,416	925,281	127,456	1·38	10·27	—	7·66
Rotherham Corporation	,, 17	474	—	—	—	—	—	—	—	—	—	—	—	—	—
Salford Corporation	,, 21	4,088	2,810	+1,278	—	—	—	—	—	—	—	—	—	—	—
Sheffield Corporation	,, 21	4,572	—	—	—	53½	46½	Mar. 25*g*	216,709	56,812,049	4,926,083	0·904	10·428	7,510	7·0
Southampton Corporation	,, 17	1,060	1,109	— 48	—	11	11	,, 31	35,874	9,084,522	752,814	0·946	11·436	3,760	—
Sunderland Corporation	,, 20	1,834	1,121	+ 713	+ 913	18·48	17·18	,, 31	59,930	13,987,121	1,270,957	1·03	11·3	3,243	6·43
Wallasey U.D.C.	,, 19	750	647	+ 103	+ 2,351	10·5	10·5	,, 31*g*	31,307	5,690,378	654,550	1·32	11·47	2,981	6·97

* Includes maintenance of permanent way and proportion of profits paid to the tramway companies for term of unexpired lease. *a* Train mile
b Per mile of single track. *c* Include rail and tram. *d* including depreciation. *f* Including one section of horse traction. *g* 1903. *h* Half-year's figures.

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NOTES.

Junior Institution of Engineers.—Mr. J. Fletcher Moulton, K.C., M.P., F.R.S., has been elected president of this institution in succession to Colonel Edward Raban, C.B., R.E.

Electric Speed Trials.—The speed of 114 miles an hour attained on the Berlin-Zossen military railway at the beginning of last week is reported by Reuter to have been increased to 118 miles on Saturday. The trials, which are to be continued, are stated to have passed off without a hitch.

Rumoured French Combine.—Rumours which have been current as to a probable combination of the various large electrical manufacturing companies in France are officially denied by the French Thomson-Houston Company, who were supposed to be at the head of the scheme. The report is considered by the company to emanate from certain speculators who are interested in pushing up the price of the company's shares, and has no truth in fact.

The Faraday Society.—Arrangements for an interchange of publications between the members of the American Electrochemical Society and the Faraday Society have recently been made, so that, in addition to their own *Proceedings*, members of the Faraday Society will in future receive the *Transactions* of the American society free of charge. The exchange will take effect with vol. iv. of the American *Transactions*, containing the papers read before the recent meeting of the American society held at Niagara Falls.

West African Telegraphs.—Information brought to this country by the steamer "Akabo," of the Elder-Dempster line, states that the telegraph line between Lagos and Forcados is approaching completion. This line, which is being constructed overland from Lagos, will then put the whole of both colonies in West Africa in telegraphic and cable communication with each other and with the outside world. It is intended to extend the land line to the Old Calabar seat of the Southern Nigerian Government.

Literary Notice.—A new edition of "The Dynamo," in Whittaker and Co.'s specialist series, is in the press, and will be published shortly. Since the last edition the authors, Messrs. Hawkins and Wallis, have entirely revised this work, rewritten the greater part, and added a great deal of fresh matter in connection with the more recent types of multiphase continuous-current machines with slotted armatures, and alternators, single and polyphase. The book will be illustrated with diagrams and drawings of recent designs.

Atlantic Wireless Telegraphy.—The Cunard liner, "Lucania," is reported to have been in continual communication with land by wireless telegraphy during the whole voyage to New York last week. She also exchanged numerous messages with passing liners equipped with Marconi instruments. The following rates are quoted for communication by wireless telegraphy on the Atlantic: From ship to Marconi station, 6d. per word; from ship to passing steamer and thence to station, 6d. per word. The minimum charge by way of Crookhaven stations in the United Kingdom is 6s. 6d.

Liability of Telephone Companies.—The liability of telephone companies for defects in wires and instruments causing "misconnections" is to be called into question in an American lawsuit, in which damages are claimed from a telephone company because the instrument failed to work when used to call up the local fire station. This is believed to be the first case of the kind on record, and the decision of the Courts will be of general interest. The claim is made that damage was done by the fire, which, had the telephone been properly connected and in working order, would have been prevented.

London Traffic Enquiry.—The Royal Commission appointed to enquire into traffic conditions in London generally have, as recently mentioned in these columns, transferred their labours to American soil. The party arrived in New York last Saturday on the White Star liner "Arabic." It consists of Sir David Barbour (the chairman of the Commission), Lord Ribblesdale, Sir John Dickson Poynder, Sir Francis Hopwood, Sir Geo. Bartley, Mr. George S. Gibb, and Mr. Lynden Macassey (secretary). The Commission will at first confine their attentions to New York, but before returning to London they are expected to visit a number of other cities in the States.

Treatment of Cancer by Electric Osmose.—Dr. Clarence A. J. Wright contributes to the *Lancet* a long article in which he states that he has been successful in the treatment of cancer and other forms of malignant disease by electric osmose. Of 23 cases which he has treated by this method only five have proved really successful, but he claims that 22 per cent. of successes is sufficiently encouraging to recommend this method to the attention of the medical profession for a more extended time. Personally Dr. Wright believes that a "radioactive salt of strontium introduced into the tissues by cataphoresis by high frequency" will prove the desired panacea of all forms of malignant disease.

Technical Instruction in London.—The pioneer polytechnic in Regent-street commenced its twenty-second class session on Monday evening last. Some idea of the extent of the educational work carried on in this polytechnic may be gathered from the fact that last session 14,400 students attended classes and nearly £15,000 was paid in fees. A special feature of the work is the comprehensive courses of instruction at nominal fees arranged to meet the requirements of various trades and professions. For instance, excellent courses may be taken by students in electricity and magnetism in the evening, including laboratory work; also in telegraphy and telephony. A three years' training is provided for, and separate instruction is given to elementary and advanced students. Equally advantageous courses at nominal fees may be had in other branches of the engineering profession. Altogether the Polytechnic may well anticipate another successful session.

International Electrical Congress. — It is announced that an international electrical congress will be held in St. Louis during the week, Sept. 12-17, 1904, in connection with the World's Fair. The congress will be divided into three branches—a chamber of delegates appointed by various Governments, the main body of the congress divided into sections, and conventions of the various electrical organisations in the United States held simultaneously with the congress. In scope it is said the proposed congress will be far more comprehensive and influential than any previous electrical congress, and its transactions are expected to form a most valuable publication showing the development of all departments in the electrical field. It will be remembered that our Institution of Electrical Engineers is paying a visit to America in the autumn of next year, and part of the programme is to spend a few days at St. Louis. It is hoped, therefore, that a number of English electrical engineers will be able to take part in the above congress, and at the same time have

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the advantage of visiting the World's Fair when scientists and engineers from all over the world are gathered together within its immediate precincts.

Electricity in Weaving.—It seems that favourable results have been obtained by the introduction of electric power in the home weaving industry at Aurath, a Rhenish town, where formerly cottage hand weaving was extensively, though not very profitably, carried on. Contrary to what might be expected, it is said that since electric power has been introduced the weavers are far better off. Consul-General Schwabach in his report on the trade of Germany states that the weavers are employed by dealers, some of whom have also provided the new electric looms. These are paid for by means of small deductions from each delivery of goods until the cost is covered, when they become the absolute property of the weavers. The average price of a loom is £40, and the electric power per loom amounts to about £3 per annum. In addition to a much larger productive capacity, the use of electric power requires less exertion on the part of the operator and is a decided gain all round.

Municipal Testing Houses.—Testing houses have not yet become common adjuncts of municipal enterprise, although there are some few existing in provincial towns at the present time. Bradford may be quoted as an example of this. In that city the Corporation have for some eleven years conducted a municipal testing house, which yields in fees an average yearly revenue of something like £7,000. In this institution 150 persons are employed, and the mechanical equipment includes not only such as is necessary to test the strength of wool and fabrics, but also hydraulic apparatus for determining the resisting power of building materials and electric power for tests, involving the use of continuous and alternating currents under different conditions on specially delicate instruments and appliances. Manchester, which is in the van of municipal enterprise, is now proposing to establish such an institution, and there are signs of other municipal bodies following in the same line before long.

Books Received.—"Engineering Preliminaries for an Interurban Electric Railway" (McGraw Publishing Company, New York), by Ernest Gonzenbach. This work embodies the plans and recommendations made in a report on a proposed railway in the Western States, and serves as a good example of many roads now on paper, and which may soon assume tangible form. The book may prove instructive as showing the way in which certain conditions met with in the case referred to were successfully met, although it by no means covers the whole ground in the art of electric railway construction at the present day. "The Practical Testing of Dynamos and Motors" (The Scientific Publishing Company), by Charles F. Smith; 5s. The author proclaims this work to be an elementary introduction to the study of continuous-current dynamo machinery, and it is thus of special value to students who are beginning the study of electrical machinery. To a large extent the 230 odd pages comprising the volume are devoted to descriptions of experiments, and the use of mathematics has been avoided as far as possible, results and inferences being discussed in connection with curves obtained in the experiments. The book contains over 80 illustrations.

Advancement of Apprentices.—Our attention is called to a scheme for the advancement of apprentices in engineering shops which Messrs. Richardson, Westgarth, and Co. inform us they have adopted at their Hartlepool engine works. The idea is to award the apprentices marks in accordance with their industrial propensities and general conduct, and to reward them by a monetary consideration if they attain the required standard. The maximum number of marks it is possible for an apprentice to attain is 120—*i.e.*, 20 for each approved examination in science or in practical mathematics, 40 for regular timekeeping, and 40 for good conduct, perseverance, and progress in the workshops. An apprentice obtaining a total of 60 marks will have the sum of 6d. added to his weekly rate of pay for the ensuing year, and for marks in excess of 60 his rate will be proportionately increased. Full marks will entitle the apprentice to an increase of 1s. per week, but in any case there should not be much difficulty in an apprentice at least securing half that increase it he be only moderately industrious. Another inducement which the above firm is offering its apprentices to persevere is promotion in the workshops, which will be largely regulated by the number of marks obtained.

Calcutta Tramways.—Electric tram drivers in this country may be thankful sometimes that they do not live in India. The Calcutta electric tramways have only been running a few months, but in that time they have had more than their share of accidents. As they are more or less a novelty in India this may not seem surprising, and the blame cannot be lightly thrown on the management, which has street difficulties to face in Calcutta which would not be generally met with in European towns. *Indian Engineering* in its last issue informs us that a collision took place at 11 o'clock at night on July 15 between an electric car and a private carriage full of women and children. It does not seem to have resulted in any fatalities, but the driver of the electric car was hauled before the magistrates on a charge, presumably, of excessive speed. From our contemporary's report, it is not clear whether the charge was justified by evidence or not, but in any event the magistrate found the accused guilty, and dealt out the maximum punishment—namely, six months' rigorous imprisonment! Such a sentence, we presume, would only be justified in a case of gross and culpable negligence, but to us in this country it may well appear to be excessive, when it is considered that the accident occurred late at night and under circumstances which might conceivably have been out of the control of the individual concerned.

Iron and Steel Institute.—It has been decided to hold the next autumn meeting of the above institution in New York. The invitation came from the American members of the institute, and was formally tendered and accepted at the conclusion of the general meeting at Barrow-in-Furness. The dates arranged for the meeting are Oct. 24, 25, and 26, 1904, but after the business proceedings, which will occupy these three days, there will be an excursion to Philadelphia, Washington, Pittsburgh, Cleveland, Niagara Falls, and Buffalo, returning to New York on Nov. 10. During the trip night travelling will be avoided, and every endeavour will be made to obviate fatigue. The two Sundays will be spent at Washington and at Niagara Falls. The approximate cost of the stay in the United States is estimated at £25. For the convenience of members desirous of visiting the St. Louis Exhibition, arrangements will be made for a limited number to leave Pittsburgh for St. Louis and Chicago, reaching New York on the evening of Nov. 10. This trip will necessitate three nights being spent in sleeping cars, and the approximate cost will be £35. In order to carry on negotiations with the principal steamship companies so as to obtain for members the advantages of reduced rates, it is asked that members who propose attending the meeting will communicate with the secretary, Mr. Bennett H. Brough. at their earliest convenience.

Testing Steel Axles.—In a recent number of *La Energia Eléctrica* A. Sandarán describes a new method

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of testing the molecular state of locomotive axles and other iron and steel pieces, this method being based on the magnetic properties of iron and steel, and intended to reveal any injury these pieces possibly have undergone in operation. From the principles of magnetism it is inferred that, when testing an iron or steel piece before commencing work, the graphical representation of a magnetising cycle will afford an illustration of the magnetical properties of the piece concerned. Now the axles of locomotive and railway carriages, as well as other machine pieces, are exposed in operation to such vibrations and shocks as to become brittle, when the fracture will show a crystalline structure. At the same time the magnetic residual phenomena are diminished, the iron piece assuming the normal average state as corresponding with the magnetic force acting on it much more rapidly, its hysteresis thus being diminished, and the ascending and descending branches of the induction curve differing from one another to no material degree. Between the magnetising curves of an axle or another iron piece, as recorded at different periods of operation, there may thus be noted important differences, a magnetic investigation of the piece in question allowing of conclusions being made as to its present safety, and of stating whether any abnormal alteration, such as an internal fracture, has occurred.

Electricity in Agriculture.—Electricity as an aid to agriculture is being watched with keen interest at the present time. To the uninitiated the following notes as to the large amount of work it can be made to do in the agricultural field will prove instructive. It may not be generally known that three German companies—the Union, the Schuckert, and the Helios—own model farms on which most of the work is done by electricity. It is used both for lighting and power. The Helios Company's farm, Quednan, covers some 450 acres near Konisberg, and is in charge of Prof. Backhaus. There is a power-house equipped with a 50-h.p engine driving a four-pole dynamo and yielding a current of 90 amperes at a pressure of 500 volts. For lighting purposes a small two-pole dynamo has been installed, giving current at 30 amperes and 220 volts, or at 18 amperes and a pressure of 320 volts when used for charging a Pollak storage battery of 130 volts. Incidentally, electricity is also employed for cooking and heating purposes at the farm-house. The agricultural machinery is driven by three electric motors, one of 1½ h.p. being used for cutting vegetables. The other two are portable, and do odd work, such as driving mills and thrashing machines, crushing flax seed, pumping water, turning a circular saw, and so on. A feature of the agricultural implements is an electrically-driven plough. The same company own the Simmern farm, where in the power-house the Helios dynamos are driven by turbines of the Beché type. The experiments which are being tried in this case are aimed at dispensing with manual labour as much as possible, and two small portable motors are employed. One of 10 h.p. does the heavier work of the farm, and one of ¾ h.p. drives either a centrifugal cream separator or else a winnower in the wheat bin. In other ways on the other farms electricity is taken full advantage of, and its application is being tried to a number of farm implements which have hitherto been worked by hand.

Ventilation of Tube Railways.—Before Section G at the meeting of the British Association at Southport, Mr. J. W. Thomas made a highly interesting communication, in which he dealt with the all-important subject of the ventilation of tube railways. After considering the physical conditions essential to good ventilation in tube railways, the calculation is made that the forces brought into play by the moving trains and the natural heat of the tubes will be ample if properly directed. The author thus explained his meaning: In tube railways, if B is the centre of three stations, the down train moving from A to B will draw air from the A station into the tube and expel it in the B station, and the up train moving from C to B will draw air from the C station into the tube and expel it in the B station. Three stations are thus directly involved, and a triple-station arrangement will best fulfil the physical conditions. Owing to the elasticity of air, the outlets for expelling the vitiated atmosphere must not be situated far from the points of greatest compression, and should begin in the centre of each station underground and end in the open air above the station at the surface. For the same reason the intakes for fresh air should be close to the points where the sudden expansion of the air begins. These points are at the ends of the tubes which the moving trains enter. Doors can be fixed at the ends of the two tubes which the trains enter in each station, and closed behind the last trains at night, so that the fresh air brought into the end of the tube immediately beyond the doors will drive out the foul air into the next station by natural ventilating pressure. His conclusion is that the providing of fresh-air inlets inside the ends of the tubes which the trains enter, with an outlet shaft in the centre of each station, will enable the moving trains to draw in and expel enough air to keep the atmosphere in good condition even in hot summer weather. In addition to this, however, there are two auxiliary aids to ventilation which enable the station masters to make certain that the state of the atmosphere in the tubes are satisfactory: first, having inlets and outlets as above, the timing of the departure of the up and down trains as they move towards the same station will enable enormous volumes of air to be driven to the surface, and a corresponding volume will be drawn in; second, by closing the doors after some of the trains as they leave the stations fresh air must be drawn into the tubes.

Electrical Propulsion for General Transport.—Among the most interesting papers read before Section G of the British Association meeting at Southport was one by Mr. James N. Shoolbred, in which he considered the possibilities of electrical propulsion as the general means of transport. The tendency of the last few years has been, in England and elsewhere, to introduce electric tractive power—on tramways, on railways, on road carriages, on canals, in automobiles, and in other ways. But these various groups have each been acting independently of the others—isolated, and in some cases actuated thereto by motives of jealousy, or of hostility, due to the dread of conflicting commercial interests. Besides the above proposed applications for electrical traction, there have sprung up in various directions what may be termed "universal providers of electricity," under the head of electrical power schemes, etc., to acquire a right—nay, even a practical monopoly—over very large areas to provide a supply of electricity for, within certain limits, all purposes, whether for locomotion or for stationary purposes. It is only reasonable to suppose, says the author, that if, instead of a number of conflicting interests, the various parties could be made to combine and fuse together the several portions of their common work, so as to avoid a repetition, and antagonistic, in some cases, of some portions thereof, there might then arise mutual benefit as well as economy, not merely to the operators themselves, but also to the community at large. One difficulty lies in the conflicting interests and in the jealousy amongst the various classes of operators. But another danger, to the public more especially, lies in the monopoly which virtually might thereby be afforded to the operators. An attempt has been recently made by

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the Liverpool Corporation, the Mersey Docks and Harbour Board, and the South Lancashire Electric Tramways to give expression to this tendency for co-operation among the various workers; and there are indications in Yorkshire and elsewhere of similar tendencies coming into operation. Although the result so far of the attempt above referred to has been rather to accentuate than otherwise the difficulties which beset a united undertaking of such a character, yet the benefits which would ultimately accrue to the public (say, in cheapening the cost of transportation by a more comprehensive and united action among the workers) fully warrants their being discussed. In the paper particulars are proposed as would tend to such a joint action and to the benefits arising therefrom.

North-Eastern Railway Electrification.—It is fully expected that in about 12 months' time the present steam lines of the North-Eastern Railway in the neighbourhood of Newcastle and Tynemouth will begin to operate by electric traction. As our readers are aware, the conversion of the 37 miles of line involved in the scheme from steam to electric traction is being carried out, so far as the electrical equipment is concerned, by the British Thomson-Houston Company, who have made such good progress with the work that an important trial was enabled to be made with the new system on Sunday on a section of the line between Carville and Percy Main. The selection of that day for the first run of the electric system was a happy coincidence, for it was on Sept. 27, 1825, that the first passenger steam line in England was opened between Stockport and Darlington. We are informed that the trial, though of a purely informal character, was a very successful one, and that the officials of the railway were highly pleased with the results. The experimental train was made up of two motorcars with a trailer car between, and on one run a speed of 45 miles an hour was obtained, the train attaining a speed of 30 miles 30 seconds after starting from rest. We believe that, under normal conditions, the average speed will be about 30 miles an hour. It will be remembered that the system adopted is the multiple-unit, and British Thomson-Houston motors and apparatus will be used exclusively in the equipment of the line. The cars are of the open corridor type, and are mounted on two four-wheeled bogie trucks supplied by the Brush Electrical Engineering Company. Perhaps the most important result of Sunday's trial was on the point of acceleration. The motors clearly demonstrated their ability to attain a speed of 30 miles an hour in 30 seconds, which is the acceleration obtained on the Central London Railway. The motors, of which each motorcar is equipped with two, are each of 125 h.p., and are supplied with current from the rail conductor at 550 volts. When the line is in full operation there will be 30 trains in use, a train being made up of two motorcars and a trailer, with a carrying capacity of 200 passengers. The coaches will be both lighted and heated by electricity. The idea is to give a fast and frequent service in the districts around Newcastle and Tynemouth, in the hope of reviving traffic lost since the advent of the electric tramways. Within the next fortnight it is expected to make some further trials, by which time the electrical equipment will probably have been carried as far as Walker Gate on the Wallsend route.

Determining Latent Heat of Evaporation.—In the current number of the *Proceedings* of the Royal Society of Edinburgh there is printed a lengthy paper by Mr. A. Cameron Smith, B.Sc., in which he describes a direct electrical method of determining latent heat of evaporation at the boiling point. In this method the liquid of which the latent heat is to be determined is contained in a glass vessel which is suspended by a fine wire from the hook of a balance, and the amount of electrical energy is measured which is required for the evaporation of an observed mass. The electrical energy is supplied by a large current passing through a small resistance in the liquid itself. In order to reduce heat losses as much as possible, the vessel carrying the liquid and the resistance is completely surrounded by a double-walled shield, which is filled by the saturated vapour of the liquid itself. The estimation of the electrical energy supplied necessitates the measurement of the current, C (amperes), the resistance, R (ohms), of the heating coil, and the time in seconds, T, during which the current flows. It is expressed by $C^2 R T$ joules, and if M be the mass evaporated in grammes, the latent heat expressed in joules per gramme becomes $C^2 R T/M$. Enumerating the advantages of this method, the author states that in nearly all methods the total heat is measured and the latent heat deduced from an assumption of the mean specific heat In this method the latent heat is determined directly. Again, the latent heat is obtained by an electrical measurement, which may be made more accurately than is possible when the results depend on the reading of an ordinary mercury thermometer. As a result of several very trustworthy determinations with in the last decade, the value of J in electrical units for various calories is known to at least 1 in 2,000. The experiments made by the author have so far had the end in view of testing the reliability of the method, and for this purpose water has always been used, in order to enable a comparison to be made with Regnault's result. Taking this as 536·3 (calories at 15deg.), and Joule's equivalent J = 4·187 (calorie at 15deg.), this gives the latent heat in joules per gramme = 536·3 × 4·187 = 2,245·5. Compared with this, the numbers 2,249, 2,264, 2,266 have been obtained in the order given. These numbers seem to indicate a value somewhat higher than Regnault's, but they were obtained with forms of apparatus which subsequent experience showed to be unsatisfactory in several respects. It is hoped that with the present form more concordant results may be obtained. Experiments for this purpose are being continued.

Jungner-Edison Accumulator.—On account of the more or less mysterious particulars as to a new accumulator, designed, in Edison's opinion, to bring about a total revolution in the province of electric traction by accumulators, M. U. Schoop in a recent number of the *Elektrotechnische Zeitschrift* records the results of a comparative investigation of the familiar lead accumulator and Edison's alkali accumulator, this investigation being the more interesting as the Edison's accumulator has so far not been put on the market. The Swedish chemist, Dr. Jungner, as is known, has simultaneously with, and even most likely before, Edison been granted letters patent for a similar galvanic combination, based on the fact that nickel oxide fixed in a suitable way on a support constitutes an available depolariser. Whereas for purposes of transportation the present lead accumulator presents many drawbacks, the first of which is its heavy weight, local lead accumulators in connection with which both the weight and the space do not play but a secondary *rôle*, have arrived at so high a degree of perfection that no other type of storage battery is required for this case. The parallel between the lead and alkali accumulator, though not being complete, goes to show that nickel sheets or steel sheets plated with nickel in alkali solution when exposed to the effect of currents will not be altered in the least even after weeks, corrosive effects, as in the case of the lead peroxide plate, being never observed. The author, however, thinks it possible that the active masses as present in perforated cells in the

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form of compressed powders, devoid, it appears, of the adhesive properties of lead salts, should drop from their supports in course of time. A diminution in capacity, the author thinks, would be avoided by heating the electrodes. The alkali cell would finally be inserted into an automatic charging and discharging device, allowing of 200 to 300 discharges and charges being made during one month. Particulars as to these experiments will be published later on. As regards the life of lead accumulators, even in the best types as is known, the positive lead support is gradually destroyed by oxidation, the negative mass diminishing progressively in capacity. The demand for a satisfactory durability is, therefore, absolutely in disagreement with the demand for a small weight. On the other hand, it is inferred from the tables recording the experiments of the author that the alkali storage battery, beside some evident advantages, presents for the moment as many and as important drawbacks. The author, however, thinks this type of accumulator to be as capable of further development as the lead accumulator was in its earlier stages, so that all these drawbacks might in course of time become eliminated. From results of tests made on the Edison battery in this country which we have knowledge of, it is evident that this battery is doing good work, and that it is much more hardy in constitution than lead cells. Unfortunately the results cannot be made public at the present time.

Technical Education in America.—Early in the present year Dr. R. Mullineux Walmsley, the principal of the Northampton Institute, Clerkenwell, made an educational tour in America for the purpose of investigating the present conditions of higher engineering education there and its relations to the various industries for which the students are being trained. In view of the transitional condition of technological and all forms of higher secondary education in England at the present time, Dr. Walmsley's report, which has been issued this week by the governing body of the Northampton Institute, is of very considerable interest. During the tour, which occupied close on three months, the principal visited over 100 colleges, institutions, schools, and industrial works, and he has produced a report replete with the fullest information of what is being done in America in the interests of technical education. The document is so full of interesting matter that the short abstract we are able to give of it by no means does justice to the subject. There is, however, one point on which Dr. Walmsley's remarks particularly appeal to us, and that is with regard to the attitude of employers regarding the general value of the work carried out by the schools and institutions. Put briefly, it may be said that the large majority of manufacturers and employers regard the work done in the colleges as being of material and vital importance and absolutely indispensable to the development and progress of the engineering industry. What they want in America is "an adequate supply of trained and disciplined brains," and they are prepared to go to any length within reason to ensure the continuity of such a supply. Another direction in which the action of employers and manufacturers has materially helped the schools in their work is in the donation of engineering appliances upon a working scale, and the provision of facilities for the students to make real engineering tests outside the walls of the colleges. To sum up with regard to higher engineering education, the parents of would-be engineers, recognising the importance of a thorough training and its influence on the subsequent careers of their sons, are willing to incur the expense of continuing their training up to 22 or 23 years of age. The schools are numerous, well equipped, and fairly well staffed, and their curricula, on the whole, are well adapted to the requirements of the profession; and the employers and manufacturers are convinced of the importance of the training given in the schools, and for the present are willing and able to find places for and to give a fair chance to every graduate turned out, and also to render assistance in many ways. Dr. Walmsley's remarks on horological education may be taken as coming from a man who has a special knowledge of the subject. From what he has seen in America, he thinks it may be concluded that schools in horology which exist in the States have absolutely no appreciable effect upon the manufacturing industry. Dr. Walmsley promises a more technical report later on, and we shall watch for it with interest.

Tesla Split-Phase Motor.—An important and far-reaching decision has been given by the American Courts in some legal proceedings in which the validity of the Tesla split-phase patents was the question in dispute. The importance of these patents is great, as some of the most successful alternating-current meters and motors of small size are tributary to them. The defendants' device, against which the suit was directed, was the Sangamo electric meter, and the American Courts have decided that this is an infringement of Tesla's patents. We have been favoured with an official copy of the decision of Judge Archbold, who tried the case in the United States Circuit Court, from which we are able to gather that the principal defence was a publication by Ferraris in March of 1888 on the rotary field and of the means for obtaining polyphase from single-phase currents. The Tesla patents were not applied for until some nine months later, but the Courts held that the testimony in the case showed conclusively that Tesla had early in May, 1888, a complete grasp of the split-phase idea; and not only was the invention beyond question carried back by it to that period, but the patent not being able to be worked out in a day, ground was thus laid for an earlier date, if there were fair evidence to warrant it. The judge decided that there was such evidence showing that Tesla disclosed the principles of his invention to his patent agent at a date prior to April 22. The date claimed by Tesla of his discovery was September, 1887. On the question of infringement, the judge considered that the construction of the defendants' meter was in effect a motor in which the armature was operated upon by two independent interconnecting circuits produced by passing through them a divided and dephased alternating current derived from a single source, this apparently realising the patents in question. The short finding of the Courts, therefore, is that the Tesla patents for split-phase motors are valid and have been infringed. The most interesting part of Judge Archbold's judgment is that in which he discusses the contention raised by the defendants that a meter is not a motor, and that on this ground of itself there could be no infringement. The learned judge said that, "while the Tesla patents contemplate the production of power, they are silent as to the amount of it; and as a meter armature rotates against the action of a permanent magnet and turns a spindle which operates the registering devices, the production of some power is necessarily involved. It is somewhat aside from the question, but still it is a circumstance that Gutmann himself, in accordance with whose patents the meters in question are constructed, recognises and claims therein that this device may be used for power purposes also. No doubt the strict object of a meter of this class is to measure and record the element which passes through or actuates it—gas, water, the electric current, or whatever it may be; but where, as here, it is in mechanical construction, nothing more than an adapted motor with meter attachments, it cannot escape infringement on the plea."

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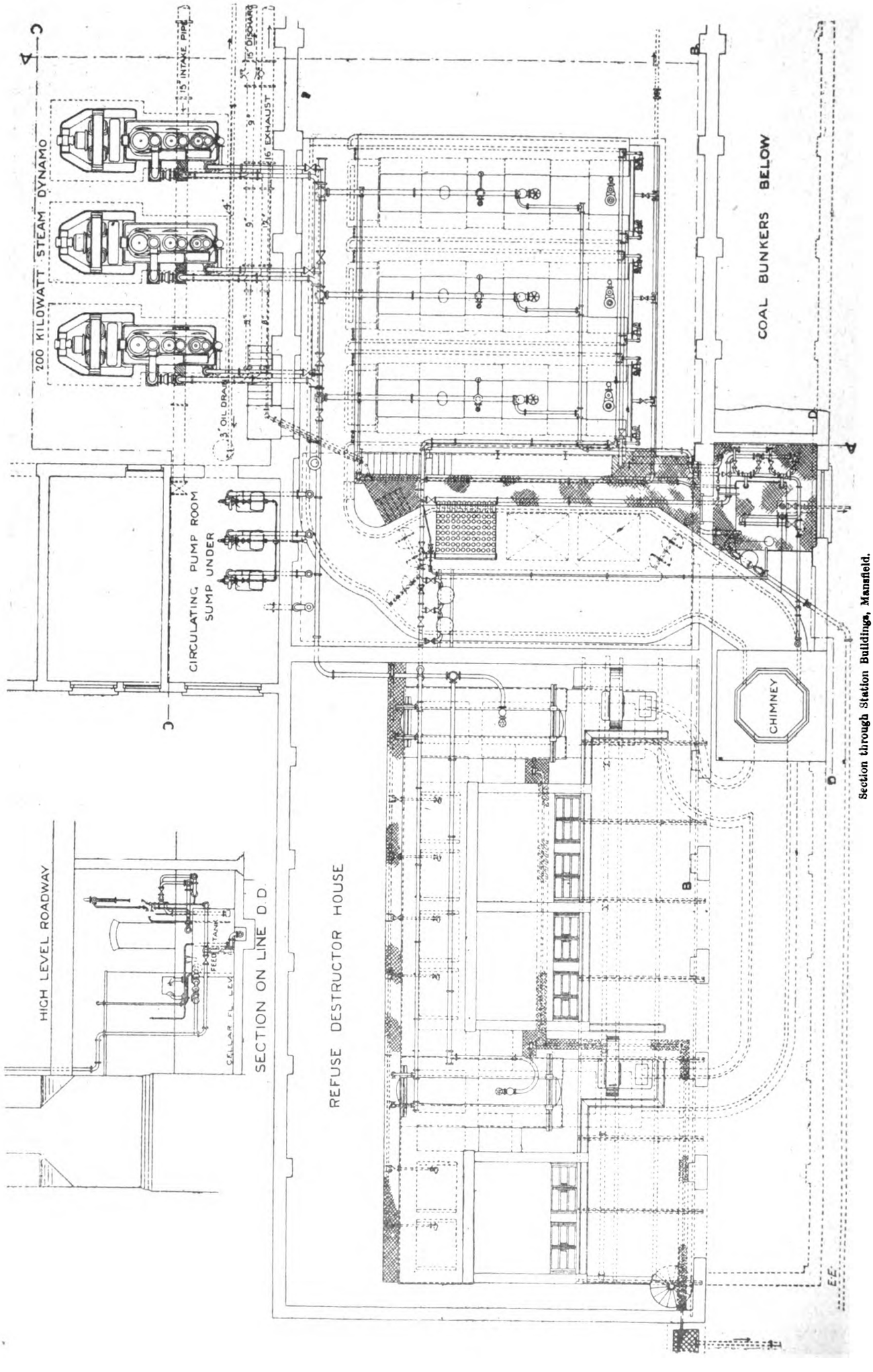
MANSFIELD ELECTRICITY WORKS.



Section through Station Buildings, Mansfield.

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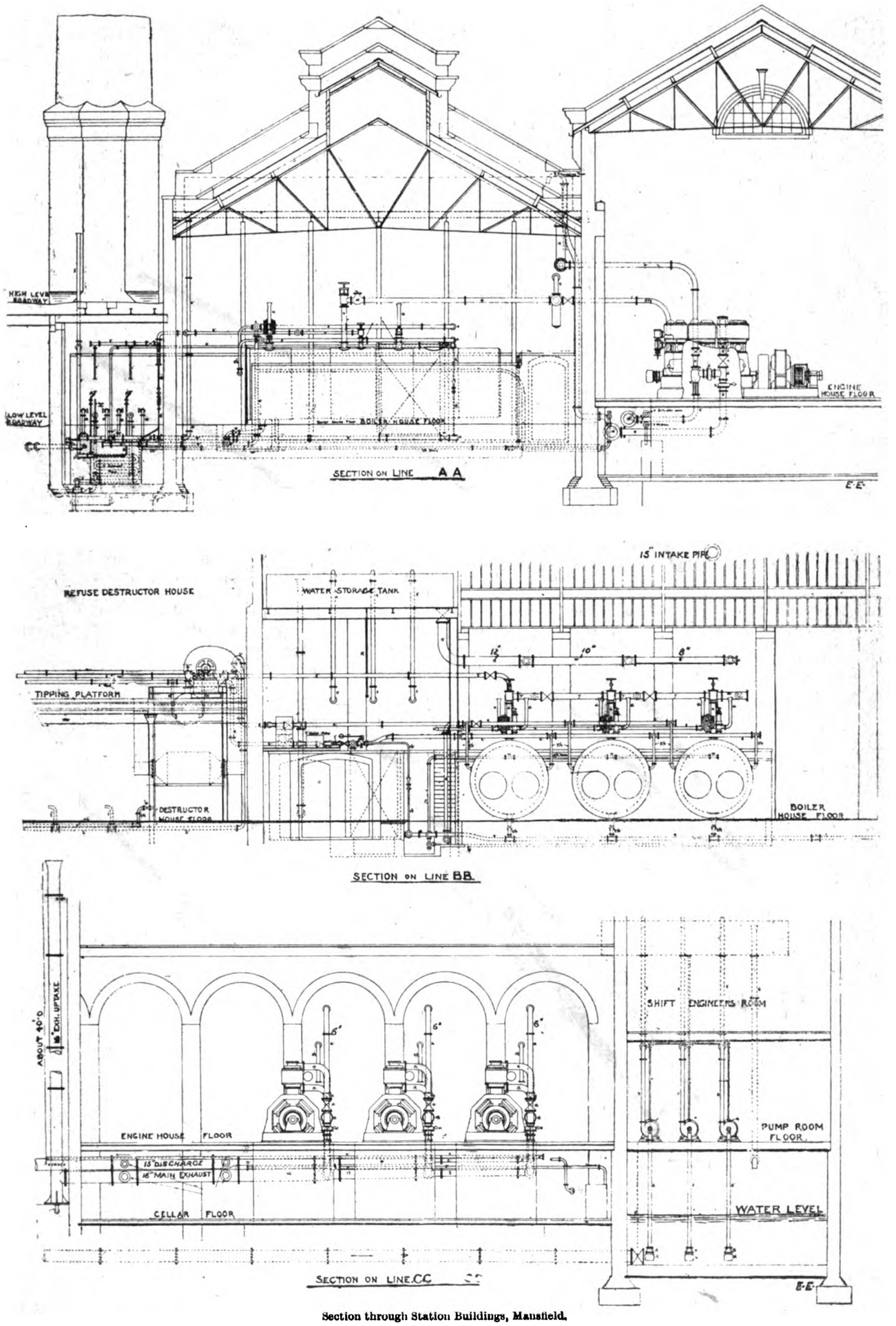
The thriving market town of Mansfield, which is situated on the fringe of Sherwood Forest, and within a few miles of the famous "Dukeries," is now in possession of thoroughly equipped electricity and refuse-destructor works. The town has a population of about 25,000, with a rateable value of over £70,000, and is growing rapidly.



Section through Station Buildings, Mansfield.

The electricity works have been erected on a portion of Burdan's Estate, at an approximate cost of £50,000. At

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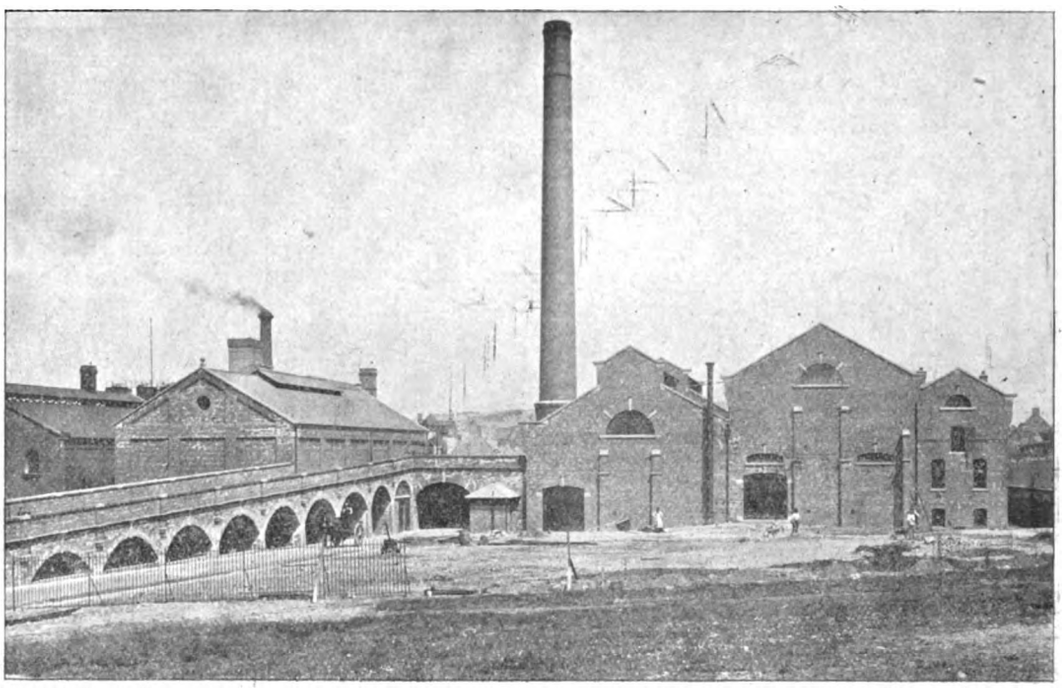
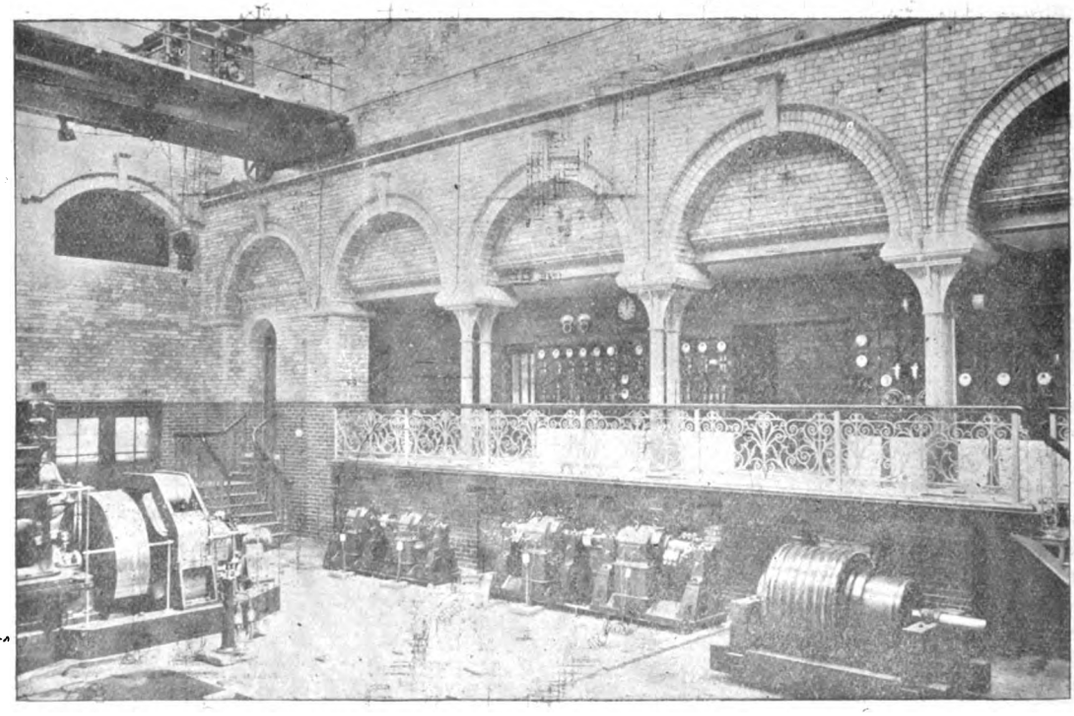
present the Corporation are providing a supply principally for lighting purposes, but the works have been designed to permit of further extensions in view of a contemplated project of electric tramways. Mr. Robert Hammond, M.I.C.E, has acted as consulting engineer, and Mr. R. Frank Vallance, the borough surveyor, was the architect. The buildings, which are constructed of brick with stone dressings, comprise engine-house, coal boiler-house, destructor house, and offices. The engine-room is 64ft. by 40ft. and 45ft high. The internal walls are of buff brick, with a green glazed dado above a brown glazed plinth. The coal boiler-house is 72ft. by 47ft. and 42ft. high, and the destructor house is 75ft. 6in. by 48ft. and 45ft. in height. The chimney stack is 150ft. high, and is of the special design of the Alphons Custodis Chimney Construction Company. Coal and refuse are brought to the works up an inclined roadway carried on arches.

The boiler-house contains three Lancashire boilers by Jno. Musgrave and Sons, Limited, of Bolton. Each boiler is 30ft. long by 8ft. in diameter, capable of evaporating 8,000lb of steam per hour. They are made of steel throughout, and are constructed for a working pressure of 160lb. per square inch. Each boiler is mounted with a complete set of Baldwin's patent "Safety" mountings, including an "Anti-Friction" high steam and low-water safety valve, in which the friction is reduced to a minimum by the lever coming in contact with the roller bearings; a "Self-Assisting" dead-weight safety valve and spring safety valve, combined on one base, the valves having bores of 2in. and 3in. respectively, and being designed so that the escaping steam assists the valve to blow off more steam without a corresponding increase in boiler pressure; a "Simplex" stop-valve, fitted with patent expansion seating and new grip handwheel, and coupled to an automatic isolation valve, which, in the event of accident or reduction of boiler pressure from any other cause, will automatically isolate the boiler; and a "Betall Accessible" check feed-valve, made of bronze, and arranged to be



View of Works, Mansfield.



Engine Room, Mansfield.

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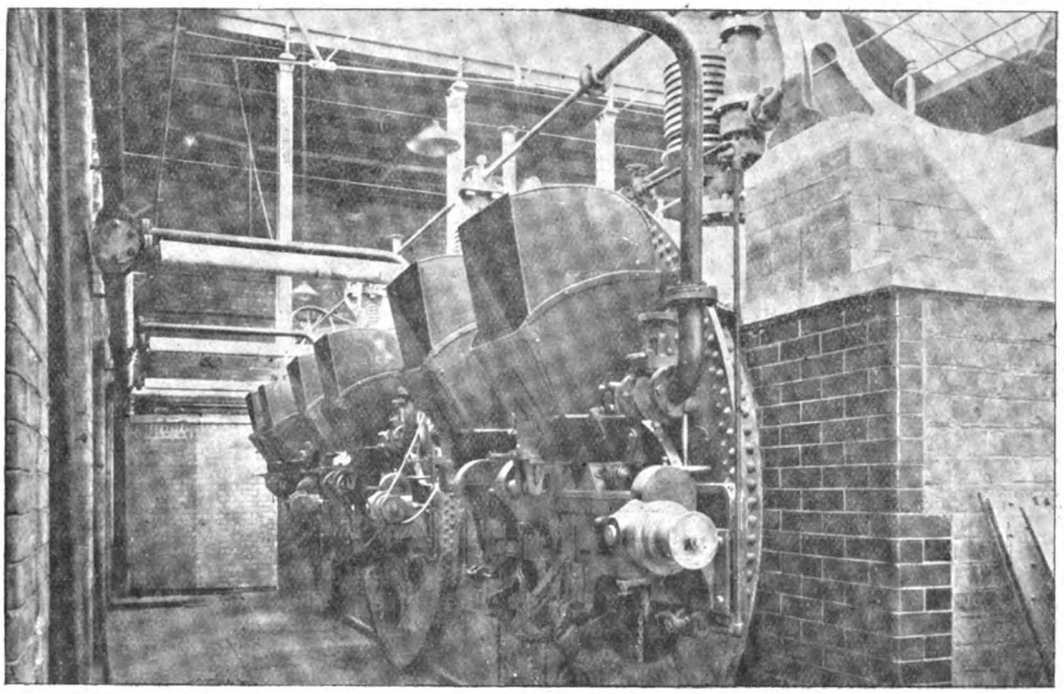
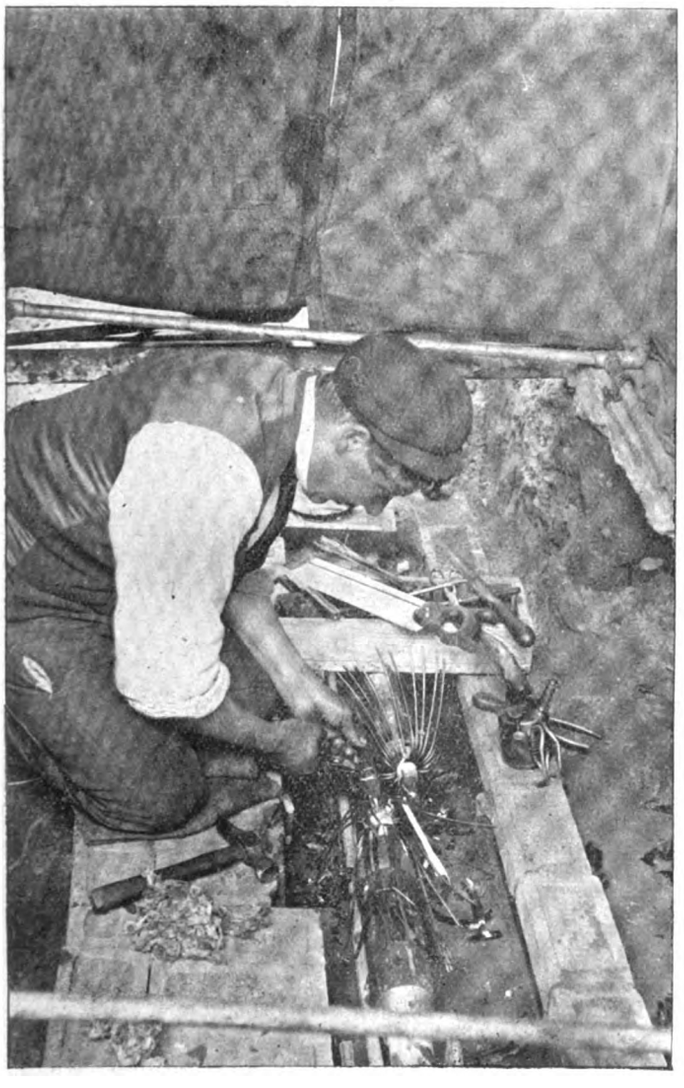
operated from the firing floor. This valve is accessible to the engineer when boiler is under steam, and the valve and seating is also removable and renewable when the boiler is working. The "Nomis" automatic water-gauges, which were also supplied by Messrs. James Baldwin and Co., Devonshire Brassworks, Keighley, are fitted with protectors The boilers are also fitted with Proctor's mechanical stokers. The dampers in the side flues are worked from the front end of the boilers, the balance weight being arranged to work in guides, which are graduated to show the opening in inches and feet. The products of combustion are taken through the economisers or a by-pass flue as required. Water is fed into the boilers by two compound double-acting ram pumps made by Messrs. J. and P. Hall, of Peterborough, with an injector as stand-by; and the feed water can be passed directly into the boilers or alternatively through a Green's economiser containing 96 tubes. A Westinghouse 5-kw. shunt-wound motor drives the shafting for the mechanical stokers and the scrapers for the economiser. The main steam and feed pipes are of lap-welded steel, and the whole of the pipe-work and tanks was entrusted to Messrs. Crompton and Co, Limited, of London.



Boiler Fronts with Stokers, Mansfield.



Making a Joint, Mansfield.

With regard to the engine-house plant, foundations are provided for three similar sets of generating plant, of which two are at present at work. These are triple-expansion engines with three cylinders, working on cranks set 120deg. apart. The normal speed is 360 revolutions per minute, and they are designed to develop 400 i.h.p. with 150lb. steam pressure. Coupled to the engines are multipolar compound dynamos, by Thomas Parker, Limited, Wolverhampton, designed for an output of 200 kw. to 300 kw., according to the conditions of loading. The flywheels are specially heavy, to provide for the fluctuations in the load experienced when supplying power to tramways. Link switches for equalising, compounding, or plain shunt running, with a regulator for altering the compounding, are mounted by the side of each machine. The engines are double-acting, and fitted with special forced lubrication arrangements for long continuous runs. The oil after being forced through the bearings is collected in the crank pit, from which it is pumped through a filter and used over and over again An overhead travelling crane spans the engine-room. It was made by Messrs. Carrick and Ritchie, of Edinburgh, and will lift a weight of 10 tons. A booster is placed in the engine-room, and provides the necessary additional pressure for charging the battery. It consists of two single horseshoe machines, coupled together and mounted on the same bed-plate. One machine runs as a motor, and obtains current from the 'bus bars at 480 to 500 volts. It drives the other machine, which is a generator, and is designed to give a current of 160 amperes at any pressure from 20 to 160 volts when running at a speed of about 800 revolutions. A balancer is also provided for equalising the pressure on each side of

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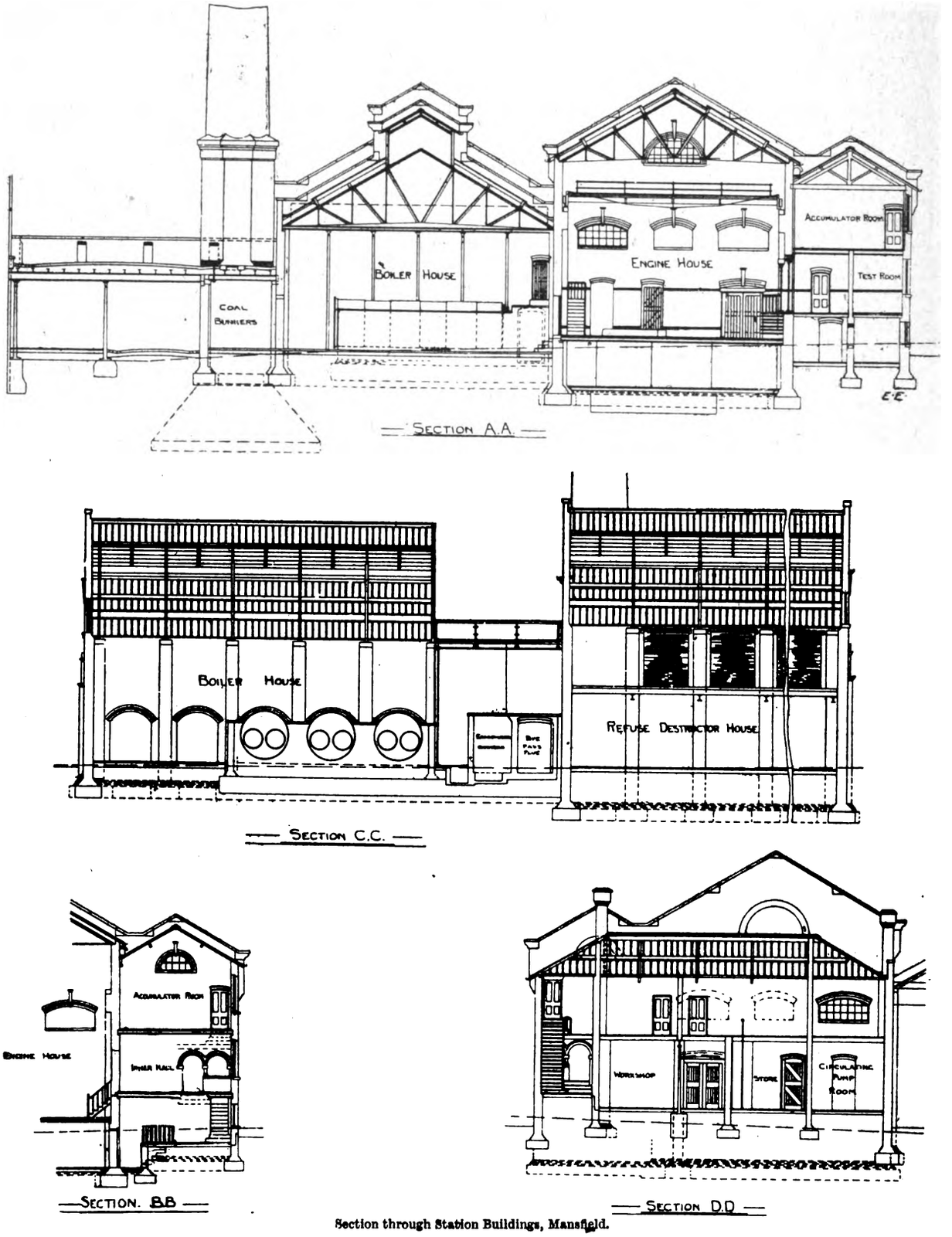
the three-wire system. It is arranged similarly to the booster, and is capable of dealing with out-of-balance loads up to 130 amperes. Water for condensing is obtained from the River Maun through a 15in. pipe, which runs from the dam through a special strainer into a tank below the level of the engine-room floor, whence it is pumped by three centrifugal electrically-driven pumps into a large tank over one end of the boiler-house, from which it gravitates through the condensers and is returned again to the stream. Each pump is calculated to deal with 20,000 gallons of water per hour, and the condensers are designed to maintain a vacuum of 24in. under normal conditions of atmosphere with the full load of the engines. They are of the ejector type, and supplied by Messrs. Ledward and Co., sub-contractors to Messrs. Johnson and Phillips, who are responsible for the condensing arrangement generally.

There are two separate switchboards in the engine-room. These were supplied and erected by Messrs. Bertram Thomas, Manchester, and are made up of enamelled slate panels framed in iron, and resting on white glazed brick plinths. One, the dynamo board, deals with the machines and battery, and the other, the feeder board, with the distributing arrangement. The dynamo board has six panels—one for the booster, two for the battery, and three for the dynamos. The feeder board has seven panels—four for feeders, two for works circuit and balancer, and one for the neutral wire. The various panels are fitted with full equipment of measuring and controlling instruments and apparatus. The pressure regulating resistances are mounted separately in front of the dynamo board, and controlled by wheel handles mounted on substantial pillars. The battery contains cells capable of maintaining a discharge of 100 amperes continually for 10 hours.

At present 13¾ miles of cables have been laid, including



Section through Station Buildings, Mansfield.

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four miles of public lamp cables, supplying 30 arc lamps for street-lighting. The Western Electric Company were the contractors for these cables, which have been laid on the solid system. About 180 tons of refuse is collected per week of six working days, and the object of the Corporation has been to thoroughly cremate without causing a nuisance, and in such a manner as to utilise the heat in raising steam for the electricity works. The destructor, by Messrs. Heenan and Froude, Manchester, has three cells with twin furnaces, with a burning capacity of 30 tons per 24 hours. Two water-tube boilers, each having 1,200ft. of heating surface, are combined with the cells. The buildings, with the exception of the chimney, were erected by Mr. John Greenwood, of Mansfield.

It may be added, in conclusion, that these works were formally opened on June 17 last, the ceremony being marked by appropriate civic dignity.

Mr. Ernest F. J. Holcombe Hewlett was born in Manchester in February, 1866; early education, Broomhouse School, Eccles; grammar school scholarship, 1878; technical education, Manchester technical classes; bronze medal, City Guilds Institute, 1882. He was apprenticed to the Edison Company, Manchester, in 1885, and remained six years, rising to the position of assistant manager. The principal works with which he was connected while with this company were the original Edison central station in Manchester and the Manchester Exhibition lighting, 1887. He left in April, 1891, to take charge of the electrical department of Messrs. Baerlein and Co., Lisbon, for whom he carried out several large plants for cotton mills,

E. HOLCOMBE HEWLETT, BOROUGH ELECTRICAL ENGINEER, MANSFIELD.

etc. In October, 1892, Mr. Hewlett joined the staff of Messrs. Siemens Bros., with whom he remained until July, 1893, when he was appointed clerk of works for construction of the electric lighting plant and mains for the Corporation of Hove. In January, 1895, he accepted the post of electrical engineer to the Rockhampton Gas Company, Queensland, where he carried out numerous improvements in station and plant and a number of contracts in various parts of the colony. In 1897 the Mount Morgan Goldmining Company appointed him consulting engineer, and in this capacity he designed and carried out a complete power, lighting, and tramways scheme for the large works of the company. This station was probably the first in the Empire to utilise the idea of automatic boosting in connection with a battery and variable load, the booster for the work being the first of its kind made by Messrs. Crompton and Co. Early in 1900 Mr. Hewlett decided to devote himself to consulting practice, and in this capacity reported to the Rockhampton municipality on tramways and Mount Morgan on lighting. In the latter part of that year family reasons compelled a return from the tropics to more temperate climes. Returning to England in February, 1901, he joined Mr. Robert Hammond, and in March assisted him at Hackney, and after other work went to Mansfield as resident engineer in May, 1902, and was taken over by the Council as borough electrical engineer on completion of the works. Mr. Hewlett has written several scientific and technical papers, among them being "A Problem in Coal-Pit Lighting," "The Rockhampton Electrical Undertaking," and "The Use of Electricity in Mines." He is a member of the Institutes of Electrical Engineers of England and America, and an ex-member of council of the Australian Institute of Mining Engineers.

Inter-Gang Match.—Last week there was a football match on Mr. E. Sutton's field, by Freshfield Station, between the workmen of Messrs. Dick, Kerr, and Co., Southport gang against Formby gang, the game ending Formby gang seven goals, Birkdale gang three goals.

THE BEXLEY ELECTRIC TRAMWAYS AND ELECTRIC LIGHTING.

Yesterday morning there were inaugurated the electric tramways of the Urban District Council of Bexley, and also the electric lighting system for the district. The area covered by the two systems is about 10 square miles, and there are at present about 15,000 inhabitants within it. The area touches on the one side the metropolitan borough of Woolwich, and on the other connects up to Erith. In fact, it is to Bexley that Woolwich looks to find building sites for its overcrowded inhabitants in the near future. When the Council, therefore, considered the carrying out of the electric lighting provisional order, they were advised by their consulting engineers, Messrs. Mordey and Dawbarn, that they would do well to make the tramway scheme the main portion of the undertaking and to work in the electric lighting as a subsidiary undertaking for the time being. The tramways which are now completed extend from High-street, Plumstead, to the Erith boundary. At the Plumstead end they connect up to the lines of the Woolwich and South-East London Tramway Company, but the gauge is not the same. The reason for this is that the lines of the above tramway company are to be converted for electrical working by the London County Council, who will alter the gauge to their standard. When this has been done it will be possible to arrange for through running right from London to the Erith boundary of Bexley.

Owing to the extremely scattered character of the residential portions of the area, the problem of adequately serving the whole district was by no means an easy one, having in view the comparatively small population and relatively small revenue which might reasonably be anticipated. The scheme which the consulting engineers have adopted is that of using direct current for the tramway work both for distribution and transmission, and the single-phase alternate-current system for the lighting. They have placed the works at Bexley, which is 1½ miles from the nearest point on the tramway, and rather more from the Bexleyheath lighting area. There are some high-class houses to be supplied in Old Bexley near the works, but in the future it seems likely that the bulk of the lighting will also be situated at very considerable distances from the works. This is so because it is at Bexleyheath that building work is mostly being carried on. We are informed that the consulting engineers placed the works at Bexley in order to be near the railway, and to have the advantage of condensing water, which is now obtained from the River Cray. Fig. 1 is an outside view of the works, which shows the substantial character of the buildings which have been erected. They have a handsome appearance, but money has not been wasted on ornamentation. They were erected by Mr. Arthur Faulks, of Loughborough.

The generating plant (Fig. 2) comprises at present only two engines, each capable of developing 150 kw. Each engine is, however, coupled to two machines, one being an alternator of 150 kw. capacity and the other a direct-current dynamo of the same capacity, both having been manufactured by Messrs. Dick, Kerr, and Co. By this arrangement only one engine is required to be run until such time as the combined tramway and lighting loads exceed 150 kw. The effect of this on the economy of the undertaking will be readily appreciated by all station engineers. The consumption of fuel is further reduced by the adoption of a high degree of superheat. The engines, which are of the enclosed vertical compound type, running at 375 revolutions per minute, were constructed by Messrs. Browett, Lindley, and Co., at Patricroft, and are fitted with Schmidt's patent reheater, by which the steam in passing to the high-pressure cylinder gives up a portion of its heat to the steam entering the low-pressure cylinder, thereby reducing the temperature of the steam as it enters the high-pressure cylinder to about 550deg. F., or a little below 200deg. superheat, whilst the steam itself has been superheated to 300deg. The governors are of a sensitive type acting on the high-pressure cut-off. They are fitted with arrangements for controlling the speed whilst running within a

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range of about 5 per cent. to facilitate paralleling the alternators.

In order to obtain the best possible load factor, a battery of 240 cells of the Hart Accumulator Company has been

50 amperes at 500 volts for eight hours, or 200 amperes for one hour.

Another piece of auxiliary machinery in the generating station proper consists of a rotary converter, the function

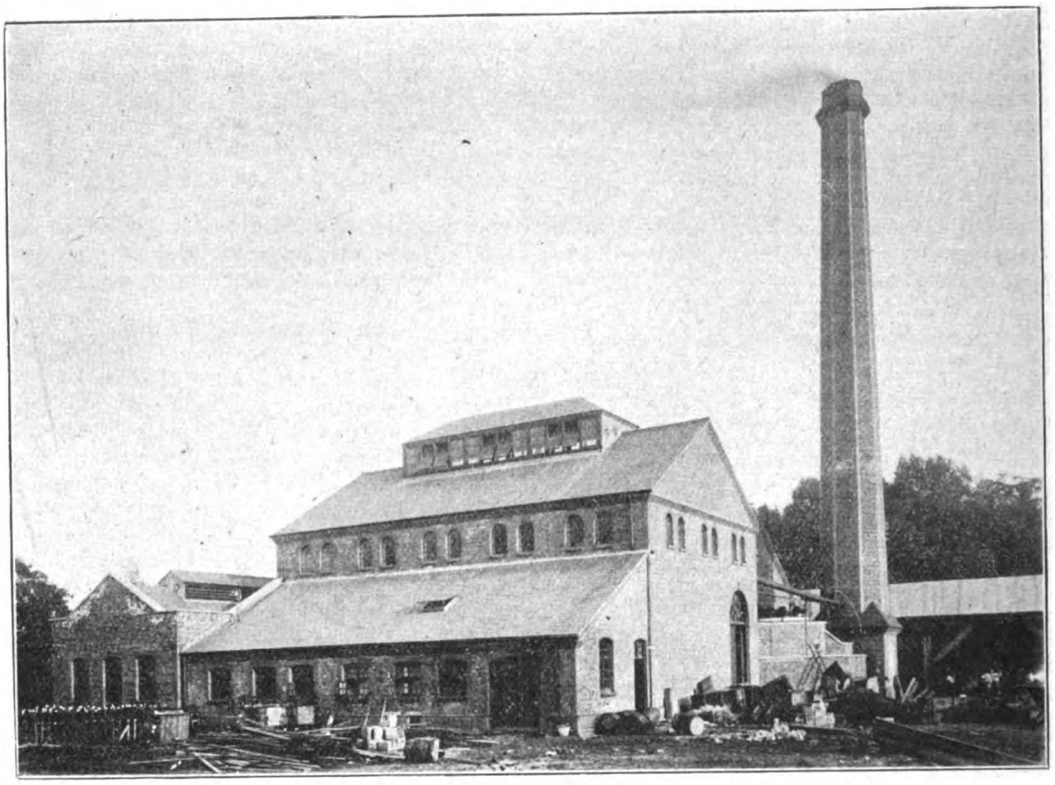

FIG. 1.—Exterior View of the Bexley Electricity Works.

installed, and is to be worked in conjunction with an automatic Highfield motor booster, which will have the effect of smoothing out, as it were, the great irregularities which are inherent to the demands for current by a small electric

of which is to supply the late night load for the lighting from the accumulators, and thus permit of the boilers and engines being shut down from about midnight until the tramcars are required to run in the morning. The switch-

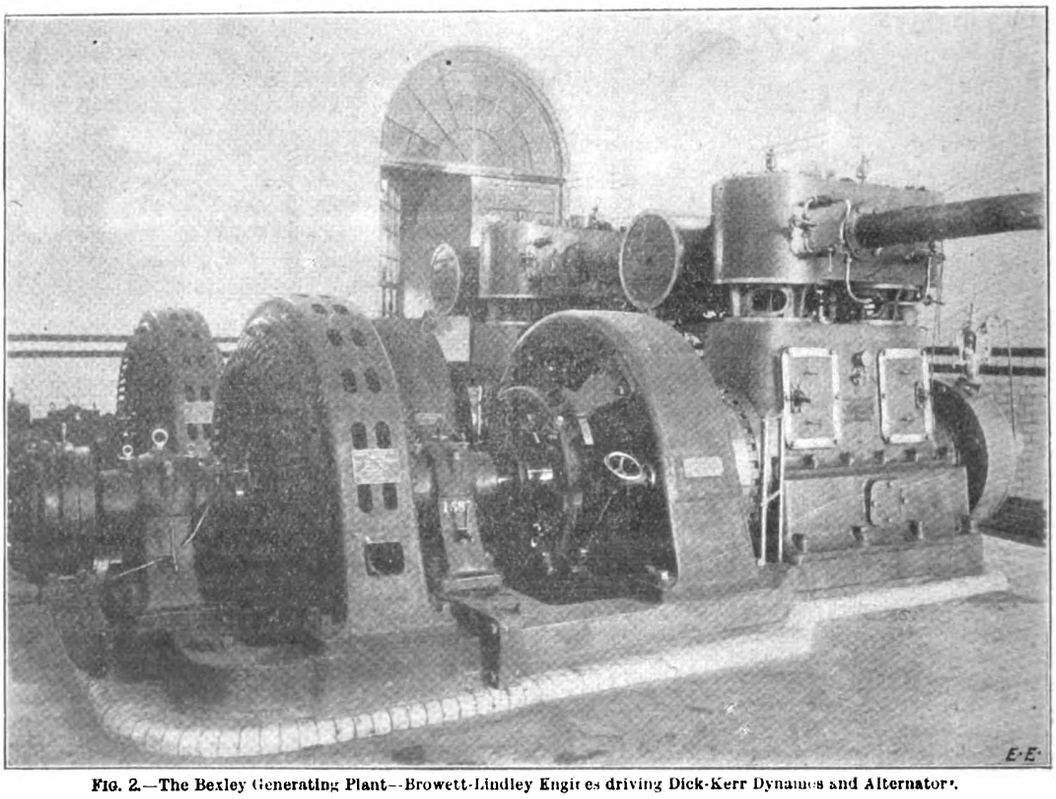

FIG. 2.—The Bexley Generating Plant—Browett-Lindley Engines driving Dick-Kerr Dynamos and Alternators.

tramway. Thus, whilst the current given to the tramways will fluctuate from zero to an amount considerably exceeding the normal full load of one engine, the engine itself will be subjected to a steady load a little in excess of the mean of these fluctuations. The accumulators are capable of giving

board (Fig. 3), supplied by Messrs. Johnson and Phillips, consists of a row of panels 29ft. long. Those which relate to the alternating-current work are of white marble, whilst, for the purpose of making a permanent distinction, the tramway panels are of polished black slate. The instru-

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ments are of the usual character, but on the alternating-current side the switch arrangements are such that any circuit can be instantly thrown over to either of two omnibus bars. Each feeder has been fitted with a meter.

The boiler-room (Fig. 4) contains three Lancashire boilers by Messrs. John Fraser and Son, of Millwall, with space for a fourth, and two Schmidt superheaters, supplied by Messrs. Easton and Co., of Erith, each arranged for a pair of boilers. The boilers are fitted with Benniss automatic stokers driven by a direct-current motor off the tramway omnibus bars, the hoppers of the stokers being automatically kept full by the inclined bunkers above them. The bunkers are arranged on a platform reached by an inclined roadway, which permits of the coal being shot directly into them from carts. The boiler-room contains the condensing plant, which comprises a Cole, Marchent, and Morley compound steam air-pump of the Edwards type. The condenser is of the simple jet type. A fuel economiser, constructed by Messrs. Arthur Lowcock, Limited, of Shrewsbury, has also been erected, in addition to a large feed-water tank. A Brunn-Lowener water softener has been supplied by Messrs. Lassen and Hjort. The heat required for this apparatus is supplied by turning into it the exhaust steam from the Weir feed pumps, of which one is a stand-by.

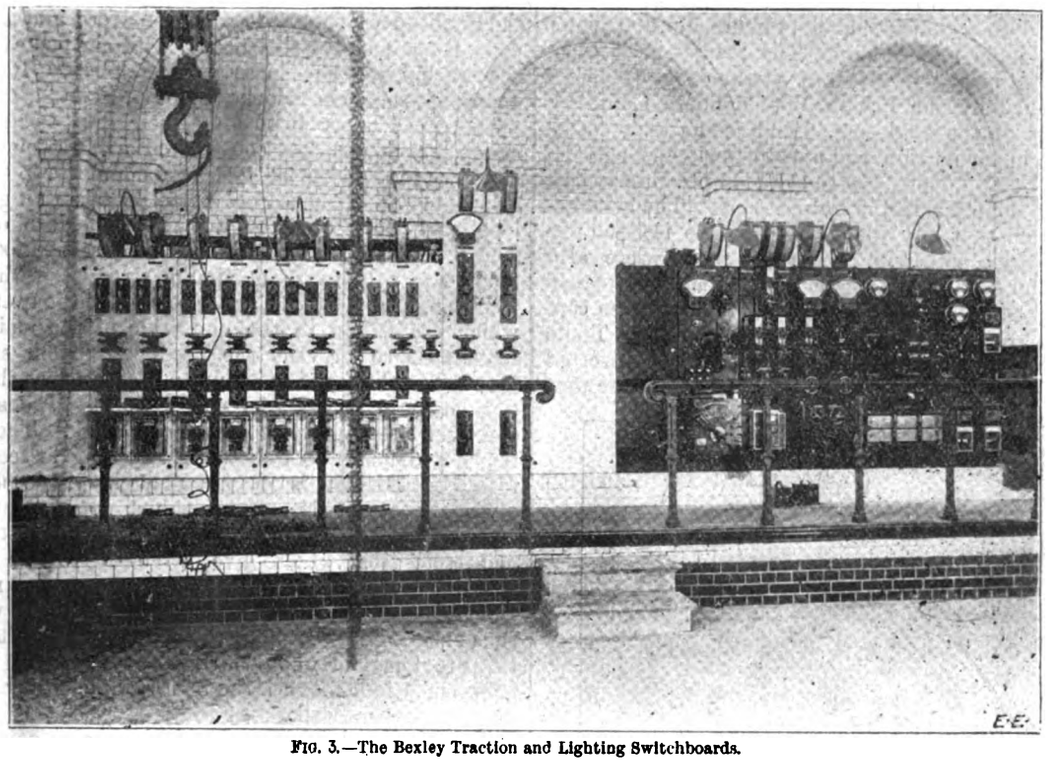

FIG. 3.—The Bexley Traction and Lighting Switchboards.

A fitters' shop is provided, easily accessible either from the engine-room or from the boiler-room. A suitable store room is also provided and excellent lavatory arrangements which include a bathroom. An engineer's office and the accumulator-room complete the building arrangements. The accumulator-room has been arranged to be entirely

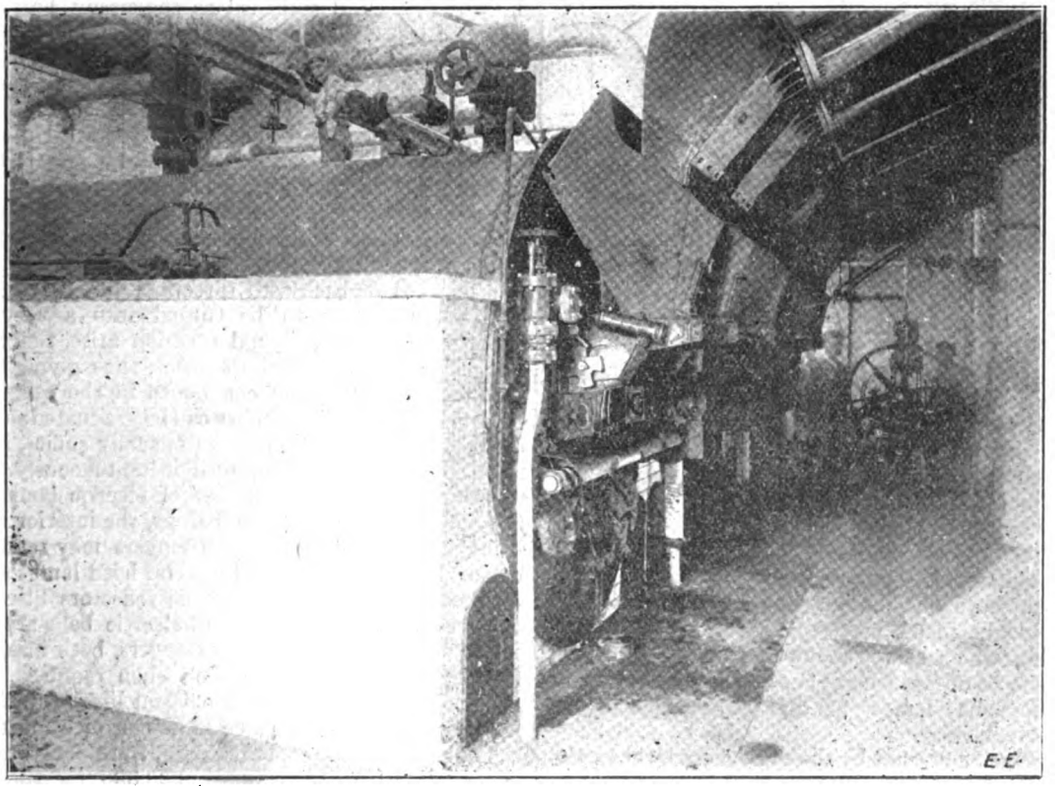

FIG. 4.—The Boiler House, showing the Fraser Boilers and Benniss Mechanical Stokers.

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shut off from the engine-room, and is only accessible from outside.

The whole of the cables have been supplied by the Anchor Cable Company, of Leigh, Lancs. The high-pressure cables, which are worked at 2,000 volts, are of the concentric type, insulated with paper and lead sheathed. They are laid in stoneware troughs filled in with bitumen. The low-pressure distributing cables are triple-concentric paper-insulated and worked at a pressure of 200 volts on each side of the middle wire. The transformers have in all cases been placed in cast-iron kiosks (Fig. 5) above ground, supplied by the British Westinghouse Company to the design of the engineers. Each contains a transformer in the upper portion and a set of switchgear in the base reached by two doors, one to the high-pressure switch and fuses and the other to the low-pressure. The arrangements are such that any distributor can be isolated by merely opening a switch. The transformers were also supplied by the British Westinghouse Company.

At each transformer an earth connection has been connected on to the middle wire, and the Board of Trade have required that a recording ammeter shall be inserted in each of these connections to earth. We presume that

FIG. 5.—View of the Bexleyheath Electric Tramway, with Lighting Transformer Kiosk in the foreground.

the earth connection has been made in order to bring the distributing system under the low-tension regulations of the Board of Trade. It remains to be seen how this earthing at a large number of points on the low-tension network will work in practice, and we shall not be surprised to hear that a portion of the returned current from the tramways is carried at times through the zero wire of the electric lighting system.

The tramway cables are insulated with vulcanised bitumen laid in wooden trough run in with bitumen. The length of high-pressure lighting feeders is about 10 miles, and the low-pressure distributors will, in the course of a few weeks, amount to 8½ miles, exclusive of the street-lighting cables, which serve about 260 lamps, of which about 110 are to be 60-c.p. Nernst lamps, and the remainder 32-c.p. incandescent lamps. These will light about 14½ miles of streets.

The car-sheds were erected by the same contractor as the generating station and are similar in general character. There are six tracks, providing for 18 cars. There is a paint shop, a blacksmiths' shop, and a carpenters' shop, as well as a messroom, an office, and a storeroom. The whole of the tracks are supported on brick piers in such a way as to leave the whole floor clear below the cars in order to facilitate inspection, cleaning, and repairs.

The tramway rails weigh 90lb. per yard and are of Belgian make, the contractors being Messrs. Alex. Penney and Co. The contractors for the permanent way were Messrs. G. J. White and Co.; the length of the route being about 5¼ miles of single track with passing places. The overhead equipment was carried out by Messrs. Dick, Kerr, and Co., who also supplied the cars.

The rolling-stock for the tramways consists of 12 cars of the double-deck, reversed-stairway pattern, and are mounted upon Brush Company's trucks. The car bodies have been constructed at the works of the Electric Railway and Tramway Carriage Works, Limited, Preston, for the contractors, the latter furnishing their own electrical equipments, which are also constructed at Preston. The cars have seats inside for 22 passengers and for 30 passengers on the roof, making a total of 52 in all, having an overall length of 26ft. 6in. and a maximum width of 6ft. 9in. The floor frames are built of well-seasoned oak of such sections as will ensure maximum strength with minimum weight. The platforms are supported on four steel angles, which are bolted to the underside of the main flooring; truss rods to prevent the car bodies from sagging are inserted in the framing in such a manner that they may be tightened up as necessity may require. The side frames and roof framing are of best English ash. The roofs are triple, and consist as follows: The ceiling as seen from the inside of the car is of three-ply maple veneer, which gives a very handsome appearance to the interior, and also serves to conceal the main framing, consisting of ash and steel ribs, which give strength to the structure. Above the framing is fitted a light wooden roof, upon which is laid a heavy canvas saturated with white lead, thus ensuring the roofs shall be entirely watertight. The third roof is laid upon thickness strips above the canvas before-mentioned, and is the flooring upon which the upper-deck passengers walk.

The electrical equipments of these cars consist of two motors mounted one on each axle, together with the necessary controllers and usual accessories, such as trolley circuit breakers, resistances, etc. The course of the current from the trolley wire to the rail is as follows: The trolley wheel fixed to the upper end of the pole collects the current from the wire, the current being led down the pole and standard to the circuit breakers by an insulated cable. From the circuit breaker it passes to the controller which is in operation, and thence to the resistances and motors in such a manner that the speed of the car can be regulated as desired. Each of the motors weighs approximately one ton, and several samples were picked out by the consulting engineers and tested at the makers' works to ensure that they came up to the guaranteed efficiency called for under contract. Each motor can develop 25 h.p. continuously for one hour if called upon. The controllers, besides operating the cars in a forward or backward direction, are so designed as to enable the motors to be turned into a very powerful electric brake, and, should occasion arise, the car can be stopped within a very short space, thus giving the motorman entire control and confidence in the carrying out of his work. The braking effect can be graduated so that while a moderate application only will usually suffice, if necessary the full effect may be applied instantaneously. The cars are illuminated by a number of electric lamps mounted in handsome polished brass fittings, the interior of the cars being so illuminated that passengers may read with the utmost facility at night. Powerful head lamps are fixed in separate fittings having parabolic reflectors fitted in front of the cars. Several circuits of electric bells are also fitted so that the conductor and passengers, both inside and out, can signal to the driver to stop when required. The cars are also equipped with very efficient lifeguards designed to pick anyone up who may be in danger of being run over.

The authorised capital expenditure for the combined scheme is £103,813—namely, £88,320 for the tramways and £15,493 for the lighting. The actual cost of the work now practically completed is well within these estimates. The capital charge for lighting is kept low owing to the electric lighting being treated as an accessory to the traction scheme. Thus under this heading only the cost of the electric lighting mains, the transformers, and the

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alternate-current plant in the station is included. The equivalent of about 2,000 8-c.p. lamps are now connected to the mains or applied for.

INDEPENDENT TELEPHONY IN GREAT BRITAIN.

BY GARDNER AND HOLME.

Since the passing of the Telegraph Act in 1899, giving Corporations powers to establish telephone exchanges, there has been considerable discussion on the capital cost, maintenance, and general construction of such systems, but until the exchanges had been established no actual figures were forthcoming. There are now from 20 to 30 exchanges established by Corporations, and it is proposed to give a series of articles on the construction, capital cost, and management of such exchanges. For the convenience of reference the subject will be treated under 12 headings.

(1) *Capital Cost.*—In any commercial undertaking there are three main considerations—viz., capital outlay, income, and expenditure. The capital cost of a telephone undertaking will be thoroughly gone into with the view of establishing a standard unit of construction on which to base estimates.

(2) *Maintenance.*—The cost of upkeeping a system when once established. Depreciation of a system.

(3) *Tariffs.*—Taking the capital cost and maintenance of a system, standard rates of subscription will be deduced.

(4) *Management and Switching Systems.*—The management and control of a system and the various methods of switching.

(5) *Underground Construction.*—The very latest method of carrying out this under direct supervision of the Corporation.

(6) *Overhead Work.*—Running of wire and making off. Erecting large poles, a point so far never touched on in any telephone book.

(7) *Junctions and Trunks.*—Methods of assembling material. Wayleaves.

(8) *Exchange Constructions.*—Modern test-room equipment. Fitting of switchboards.

(9) *Power Plant Construction.*—This latest development in telephone work will be thoroughly described. Management of accumulators.

(10) *Instrument Construction.*—Fitting of instruments and small boards.

(11) *Testing.* — Rapid testing apparatus for faults. Wheatstone bridge.

(12) *Private Installations.*

Capital Cost of a Telephone Exchange System.

To estimate the cost of a telephone exchange system, various local circumstances must be taken into consideration, as some towns are more concentrated than others, and the length of junction lines connecting the various exchanges together vary considerably. Then, again, the amount of spare plant to be laid down ready for extensions is an important item.

The Portsmouth Corporation has laid 90 per cent. spare duct accommodation when constructing their telephone system. There are three main items in the construction of a telephone system—viz., switchboards, instruments, and cables. The first two items can be extended as the demand for lines arises, but in the cables it is necessary to carry more wires than are for the time being required, as it is impossible to distribute the numbers of wires in any district to the number of orders received owing to telephone cables being made in standard sizes. Thus, if in one district there was a demand for 28 telephones, it would be necessary to carry 36 pairs of wires in the distributing cable. It must be borne in mind that each subscriber has a separate pair of wires from his office direct into the exchange. The question then arises how much spare duct accommodation should be laid down ready for drawing in new cables should it be found in the course of time that the demand exceeds the supply. If no spare duct accommodation was laid, and the cable wires all taken up, it would be necessary to take up the streets and lay another duct for perhaps a comparatively few new orders. But, on the other hand, the laying of a spare duct is a tax on present subscribers for the benefit of future ones, and so the question is a very important one.

It is found in actual practice that a main cable leaving the exchange, and filling a duct to its full capacity, costs the same as a three-way duct running the same distance. Taking a 312 pair cable as an example, running from the exchange for a distance of one mile and distributing down to zero, the cost would be about £2 per pair, and a three-way duct would cost the same, the total cost being £4 per subscriber. If, now, the demand for telephones was great—and with low rates independent exchanges have found their original subscribers doubled, and even trebled, in a very short time—and these ducts were filled up, and still a few orders remained, it would be necessary to lay another three-way duct and another 312 pair cable. In the first case, then, there would be one cable and a three-way duct at a total cost of £4 per subscriber. After opening the street a second time and laying one more cable and another three-way duct, there would be four cables and two three-way ducts at the following cost: four cables at £2 per pair, £8; two three-way ducts at £2, £4—total, £12. Three of these cables would be working, and consequently three times more subscribers, than when there was only one cable and a three-way duct, and so the cost per subscriber would be £12 ÷ 3 = £4, as in the first case, so that by laying 200 per cent. spare duct accommodation, the cost can be kept evenly distributed over a large expansion. This 200 per cent. does not, of course, represent money value in any way, but duct accommodation for wires, the cost of laying this 200 per cent. duct accommodation amounting only to some 9 per cent. on the capital outlay. Of course, a telephone engineer could reduce this on going into the local circumstances of a town and planning out the various routes, but this will be taken as a standard unit.

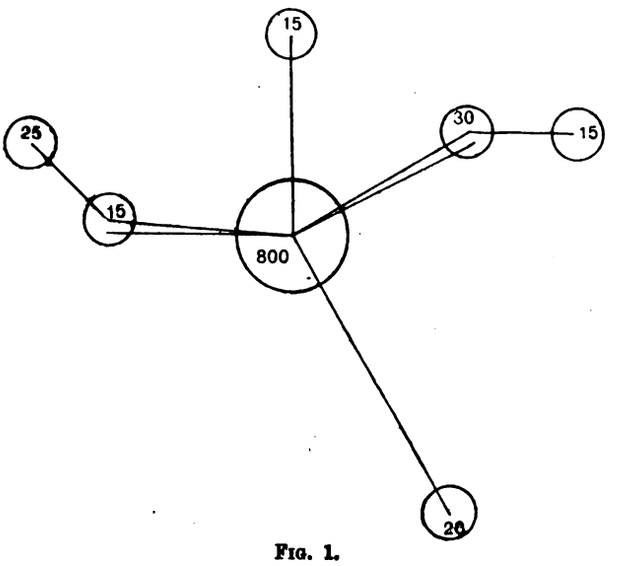

Fig. 1.

Having now arrived at standard units for the three principal sections of construction, it is possible to give a general idea as to the cost of constructing a system. We will take a telephone area of 100 square miles, with one central exchange of 800 subscribers and six village exchanges with 120 subscribers, connected to the central on junction pole routes of 20 miles, with 60 miles of metallic circuit (see Fig. 1). This works out:

920 direct lines, with 25 per cent. spare cable wires at £20 ...	£18,400
20 miles of junction route with 20 miles of metallic circuit...	1,000
40 additional miles of metallic circuit.....	480
200 per cent. spare duct capacity	800
	£20,680

This works out at gross £22. 10s. per direct line. In actual practice this has worked out at £21 at Portsmouth and at Glasgow at £29. The extra cost at Glasgow is accounted for by the laying of a larger proportion of spare ducts, and distributing the wires completely underground similar to gas and water, which, of course, greatly diminishes maintenance charges, as the wires are free

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from disturbance. This can only be done in large cities, the cost being prohibitive in a town of not more than 300,000 inhabitants.

The foregoing figures cover the cost of the very best material and workmanship, as Corporations have found that the first cost is the least. This question will be further discussed when we come to consider the maintenance of a system. The estimate does not include inside extension lines, as these in no way affect the standard unit; any number can be fitted to a system without using a single cable wire. An exactly similar competition to the one in England is now proceeding in America, where independent companies are springing up in every city in competition to the Bell Company, or monopolists, but in America no license is necessary to establish an exchange, independent companies have no Local Government Board enquiry, consequently the progress of independent exchanges is more marked. The independents also discover the same fact as the British Corporations—namely, that an efficient telephone line can be constructed for £20 to £25, the Jasper County Telephone Company having fixed over 1,000 phones with a capital stock of 100,000dol. The growth of independent telephones in America may be gauged from the one fact that in Chicago alone an independent company is laying down a system of 100,000 telephones, or about 50 per cent. of the telephones of Great Britain and Ireland in one city alone.

In the various discussions on the telephone question the main objection has been that a system cannot be established under £35 per line. We have, however, seen that up-to-date systems *have* been established in England and America at £20 to £25 per line. The cost of the National Telephone Company's lines, dividing the capital by the number of direct lines, works out at something like £35, but as that company have amalgamated with and purchased several rival concerns at more than cost price it is not a fair figure to work upon. It has also been stated that a telephone system is unique among commercial undertakings in so far as the capital account cannot be closed, and that the more lines added the more expensive they become on an average. This, however, is a very mistaken view, as most town councillors are aware that an electric light system and a growing tramway system cannot close their capital account, and that if they have a large increase in their traffic they must necessarily borrow more money—*i.e.*, add to their capital account.

With regard to the increased average cost of lines as an exchange extends, this is also an erroneous view, and founded on the one fact that a large multiple switchboard is more costly per line than a small multiple board. This can best be followed by Fig. 2. In order to enable an operator to have access to every subscriber's line, the whole of the subscriber's jacks on which the lines terminate are repeated about every 6ft. on the switchboard, and this is known as the multiple field. The local or answering field is divided up, so many lines to each operator; while the one operator answers in her local field (generally about 100 lines) she has access to all other subscribers' lines in the multiple field, and can consequently connect subscriber No. 1 with, say, No. 1,000 without leaving her position at the board. Taking the exchange of 800 lines controlled by eight operators, it will be seen that there are 2,400 multiple jacks and 800 local jacks. If, now, it is necessary to extend the system by 400 lines, owing to increased demand, it will be necessary to fit to the switchboard 400 local jacks, and one new section with 1,200 multiple jacks, and also 400 multiple jacks to each of the three existing sections, so that the operators at those sections may have access to the 400 new subscribers' lines, making a total of 4,000 new multiple jacks.

To summarise: in the first case there are 800 local jacks and 2,400 multiple jacks, or one local and three multiple jacks per line; in the second case there are 1,200 local jacks and 4,800 multiple jacks, or one local and four multiple jacks per line. It will thus be seen that in extending the system by 50 per cent. has added to the cost per line as far as the switchboard is concerned one multiple jack, or about 2s.! Against this must be set the saving in outside construction owing to the concentration of the lines, and it will thus be seen that an increase in business lowers the cost per line.

Having now arrived at the capital cost of a system, it will be necessary to carefully consider the cost of maintaining it in order to arrive at the tariffs to charge subscribers so that the exchange may be successful from a commercial point of view.

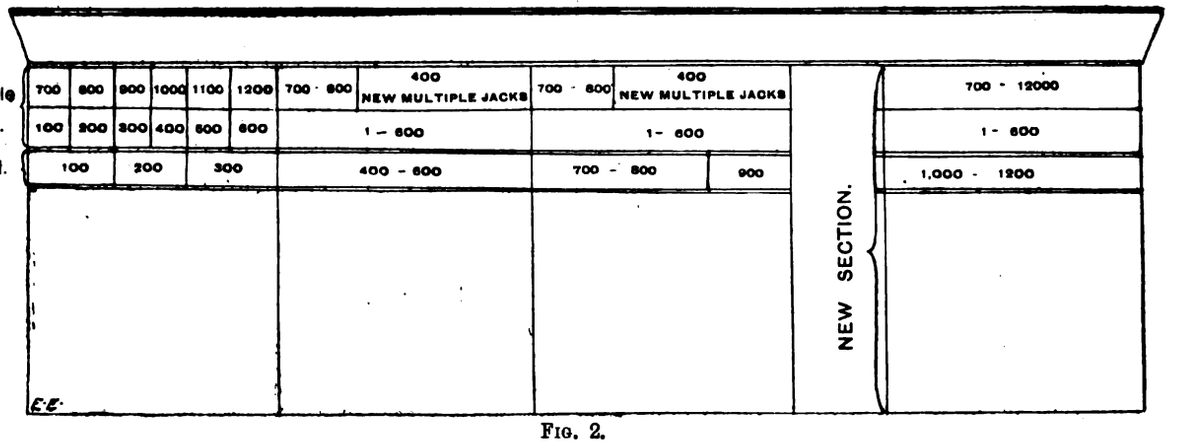

FIG. 2.

(To be continued.)

BRITISH TRADE AND THE COLONIES.

A scheme for expanding British trade in foreign and Colonial markets, and for further consolidating the relations particularly between Colonial buyers and manufacturers in the Mother Country, has been initiated by Mr. B. H. Morgan, recently trade commissioner to South Africa, and is receiving the support and assistance of the Board of Trade, the Foreign Office, and other Government departments. The proposal is that lectures shall be prepared by well-known engineers and experts in England, and forwarded by previous arrangements for reading before technical and trade societies, and other educational and trading bodies in British Colonies and leading centres of trade in foreign countries. The main object which the authors will bear in mind in the preparation of their papers will be to point out what progress has been made in Great Britain up to the present in the manufacture of all classes of machinery and goods, emphasising novel points of utility, design, and so forth. Recognising that the engineering industry is perhaps the most important in this country at the present time, the organiser of the scheme is giving it his first consideration, and has arranged for the preparation of the following lectures: "British Progress in Electrical Work," Sir William H Preece; "British Progress in Dynamo and Motor Construction," Mr. J. Swinburne; "British Progress in Mechanical Road Traction," Colonel R. E. Crompton; "British Progress in Steam Generation," Prof. W. Ripper; "British Progress in Steam-Boiler Construction," Mr. F. J. Rowan; "British Progress in Machine Tool Manufacture," Mr. John Ashford

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"British Progress in Municipal Engineering," Mr. W. H. Maxwell; "British Progress in Steam-Engine Construction," Mr. J. H. Dales; "British Progress in Gasworks Plant and Machinery," Mr. C. E. Brackenbury; "British Workshops and their Equipment," Mr. B. H. Morgan; "Pneumatic Tools and Appliances," Mr. C. E. Amos; "The Selection of Boilers," Mr. C. E. Stromeyer.

It will be seen from the above list that the scope of the subjects to be dealt with is extremely large, and the assumption is that the lectures must in consequence be more general in character than otherwise. However, with the Government and other influential assistance promised, it is hoped that the scheme will prove successful in its main endeavour to keep foreign and Colonial buyers in touch with the latest British manufacturing practice and bring about a still wider appreciation of British productions in the foreign and Colonial markets.

TRADE NOTICES AND NOVELTIES.

De Dion-Bouton Electrical Combinations.

The De Dion-Bouton motor is universally known in connection with automobiles, but its claim to equal adaptability for use as a stationary engine has not been pushed until quite

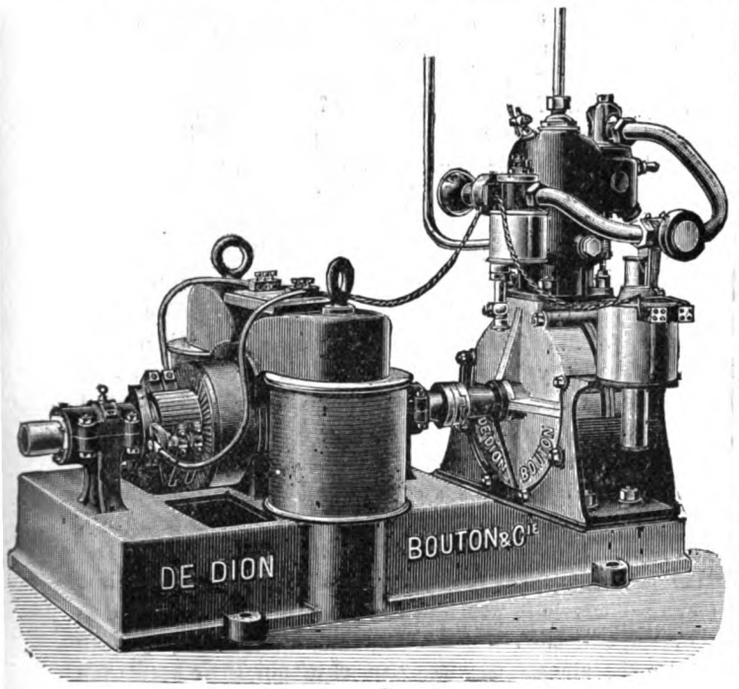

FIG. 1.

recently. Yet its advantages, particularly where compactness, lightness, simplicity, and economy are considerations, cannot be disputed. The principle of this motor is that of the Otto or four-cycle gas-engine, but it differs from the ordinary type of gas-engine in that it produces its own explosive mixture as required. Petrol is the usual fuel employed, the quantity consumed by the motor being less than one pint per horse-power hour. From the petrol tank the spirit flows to the carburettor, and from there the vapour produced passes automatically to the explosion chamber of the motor. The compact appearance of a De Dion-Bouton motor-dynamo combination is seen in Fig. 1 herewith. The motor is started by means of a handle placed at the end of the dynamo shaft, and attains an average speed of 1,500 revolutions per minute. With regard to the dynamo, there is no need for a rheostat, the fields being compound wound for constant E.M.F. with varying loads. An electric regulator is fixed to the motor, which governs the latter according to the power required. This regulator (see Fig. 2) consists of a solenoid, S, acting on a conical plunger core, N, which is guided by a tube. In order to complete the magnetic field of this solenoid, and to diminish the consumption of electrical energy in the regulator, the magnetic circuit of the solenoid is enclosed by a shell formed of two plates, F, F″, joined on the outside by the tube T. This arrangement presents the further advantage of guarding the apparatus from the influence of any magnetic fields which may be in the vicinity. The upper end of the core of the solenoid is attached by a chain, C, to the pulley, P, mounted on the plug, B, fixed in the pipe from the carburettor, and of which the opening, O, is in the passage of the explosive mixture coming from the carburettor. Therefore it is apparent that the rotary movement communicated to the pulley, P, will have the effect, according to the direction of the rotation, of increasing or reducing the opening through which the explosive mixture passes. A flat spiral spring, R, mounted on the other end of the axis of the plug, is fixed at one end to a cover, D, the position of which, in relation to the plug, can

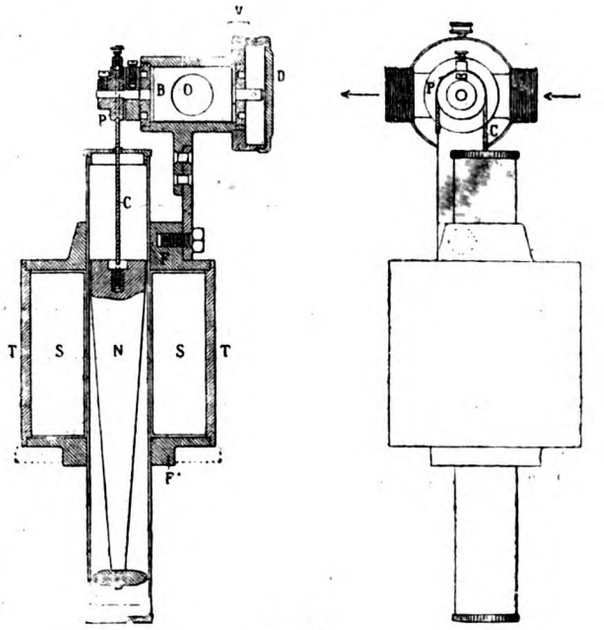

FIG. 2.

be varied by means of the screw, V, so that the tension of the spring can be varied; hence, also, the sensitiveness of the apparatus. The solenoid is of very fine wire, and possesses great resistance—about 2,000 ohms for a dynamo of 100 volts. The regulator is connected to the terminals of the dynamo, as shown in Fig. 3. On being started the dynamo excites itself, and the E.M.F. rises to its normal value. If the load is light, the motor tends to race; but as soon as the normal pressure is exceeded, the core of the regulator is attracted, acts on the pulley, and partly closes the opening through which the explosive mixture enters, thus reducing the power of the motor, and consequently the speed, until the E.M.F. of the dynamo has regained its normal value. When the current is utilised, the speed of the motor, under the action of the load, tends to diminish, the pressure becomes less, and the core of the solenoid ascends, thus permitting the inlet to open under the action of the spring. The regulation is effected in less than five seconds when passing suddenly from full load to running free or *vice versâ*. In short, the sensitiveness of the regulator is so great that the variations in tension do not exceed three volts. The amount of energy consumed in its working is about five watts. The regularity in working thus obtained renders the combination suitable for direct electric lighting, arc or incandescent. They are also admirably adapted for charging accumulators, especially for recharging the accumulators of electrical vehicles, and may be advantageously applied for searchlights. It may be added that these electrical combinations are supplied for outputs ranging from 1¾ h.p. to 8 h.p., the corresponding weights ranging from 450lb. to 775lb. Their installation may be effected in three ways: (1) on a fixed solid base; (2) on a

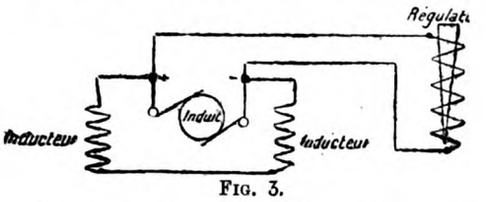

FIG. 3.

spring bed, which absorbs the vibrations; (3) on a small truck, in cases where a portable installation is required. Three sizes are stocked by De Dion-Bouton, Limited, 10, Great Marlborough-street, Regent-street, London, W., who also supply pump and belt pulley motor combinations of equally handy types.

"Stearn Lamps."

The Zurich Incandescence Lamp Company, 47, Victoria-street, Westminster, S.W., have recently issued a new catalogue of their "Stearn" English-made electric lamps. Included among the large variety of lamps listed are the firm's patent changeable voltage lamps, twisted flame lamps, small bulb lamps, tube lamps, and tramway lamps.

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TO CORRESPONDENTS.

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THE OTHER SIDE.

A letter in the *Times* of Tuesday last, signed "Croyden and Co.," is deserving of attention. It relates to the Marylebone embroglio concerning electric lighting. It suggests a method of procedure not quite in accord with the honourable traditions of English business. We have commented upon the case once or twice before, and should not again have touched it but for this preposterous letter. The tale is simple. Municipal authorities can (1) have their own electric lighting from the commencement; (2) let a private adventurer take up the lighting and do the best he can; or (3) at the outset let the private adventurer take the risk and show the possibilities of the business, then buy him out. The Marylebone people were of the cautious kind. They let outsiders take the early risks and prove the value of the lighting, and then said: "These adventurers are making too much money out of our necessities. We will oust them from our borders and take up the business ourselves. It is a good thing, and these monopolists must be put down." So Marylebone proceeded to get rid of the so-called intruders; but agreement was not easy, and the question was put to arbitration. The arbitrator gave his award, and that award was exceptional, because Marylebone proposed to take the strongest and best link out of the chain of the company's work. Then there was weeping and wailing at Marylebone. Why? Simply because the arbitrator gave the company a higher price than Marylebone wanted to pay. The suggestion of Messrs. Croyden and Co.—whoever they may be—is "compromise." Why compromise? The time for compromise was before the award; not after. If the award had been greatly in favour of Marylebone, and the company interested had suggested compromise, would the municipality have listened to it. They asked for justice, and when that is awarded, why kick? Surely it must have occurred to some of the august body that pure and unadulterated justice would not be exactly what they wanted and would land them in a close corner. It has—and in our estimation serves them right. We have no sympathy with a municipality that wishes to take advantage of a pioneer company. The latter risks everything, the former risks nothing. The Marylebone Council may say it was wrongly advised, but technical advice is not much needed in such a matter as they had to decide. The members knew or could easily have known the amount of money spent within their borders—the amount spent for immediate return and that invested for future developments. They could have gauged that return and the future prospects as well as anybody else, and their own commonsense ought to have told them that it is seldom you get a good thing at half price. However, they persisted in their endeavour to get rid of the company, with the result that the award caused absolute terror. The suggestions have been "repudiate," "compromise." Repudiation is not under discussion, but the suggesters of compromise say the time is inopportune for the borrowing of money. The man who starts bargaining should think of the getting the money before he starts, not after the bargain is settled. Suppose money had been cheap, not dear, would there have been the talk of compromise then? But the most delightful part of the suggestion is that the company should wait for payment till, say, 1931. Meanwhile, it should carry on the business really for the benefit of the municipality, so that, as the writers of the letter naïvely put it, "there would be handed over to us in 1931 a business many times larger than the present business for only £200,000 more than we shall have to pay in a few months if the company enforce their rights." We may well ask, "Suppose the concern does not increase according to the

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expectations of Messrs. Croyden and Co. by the year 1931? What is there to prevent further attempts at repudiation or compromise?" Business men, as a rule, do not attempt to make bargains which shall for performance depend upon the state of the money market. Does it not strike Messrs. Croyden and Co. that the receiving company will have something to say in the matter of deferred payment? If money is dear, it is of greater value to them now than if they waited for cheapness. As for suggesting they should become lessees on the following terms, it would be rather a suicidal policy for the company. This is the plan suggested:

"It would be well if they were formally to become lessees of the Borough Council at a fixed annual rent, say £5,000, which the Council might invest every year to form a fund towards repayment of the depreciated value of the extra capital."

"Now, how would such a scheme work out? We have been told that the company have already spent in the borough about £600,000. If even as much as that had to be spent again during the next twenty-eight years, the sum repayable by the Borough Council at the end of that time, less, say, 2 per cent. per annum for depreciation, would be about £400,000, towards which the £5,000 suggested as a rent would, if invested at 3½ per cent., amount in that time to over £200,000, leaving only about £200,000 to be found for the capital in addition to the present debt of £1,300,000. In other words, there would be handed over to us in 1931 a business many times larger than the present business for only £200,000 more than we shall have to pay in a few months if the company enforce their rights. What a relief this would be to the ratepayers."

What is the company to rent? Its own concern, compulsorily bought, but not paid for, to forego some of its annual profit in order to defer a present payment for nearly thirty years. Yes, Marylebone has been ill-advised throughout the whole of this business; but if good advice is obtained, even now the final result may be better than it looks. The advice tendered by Messrs. Croyden and Co. is bad—very bad, without a single redeeming feature.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

OIL-BREAK SWITCHES.

SIR,—Messrs. Ferranti's letter in your issue of the 25th inst. corrects a statement made by me in a paper read before the British Association, and they have been good enough to send me a photograph of the Bankside switches of 1895, which is most interesting.

With regard to the question of priority, I cannot do better than to refer Messrs. Ferranti to an article by Mr. Eborall in the current number of *Engineering*, where, in a footnote on page 410, he states, "So far back as 1891 Mr. G. W. Partridge got out a design for such (*oil break*) switches, which were made and put in service in 1892." To Mr. Partridge be the credit.—Yours, etc.,

Wallsend, Sept. 26. W. B. WOODHOUSE.

INTERMEDIATE SWITCHES AND WIRING.

SIR,—With further reference to the above subject and my letter of the 17th inst., it has just occurred to me that an excellent opportunity now presents itself, while intermediate wiring is receiving general attention, to *deprecate* the two-way and intermediate circuit connections sometimes thonghtlessly advocated in some technical books and journals as being more economical in wire than the ordinary two-way and intermediate wiring circuits, as you have lately illustrated.

An economy in the cost of wire is certainly made in the simple two-way wiring, or if the lamps to be controlled can be arranged near together in the immediate wiring circuit, as both circuit arrangements necessitate the lamps being *between* the two common contacts of the two-way switches. Such being the case, there would be no saving when lamps used, say, in staircase lighting require to be controlled from the various floors.

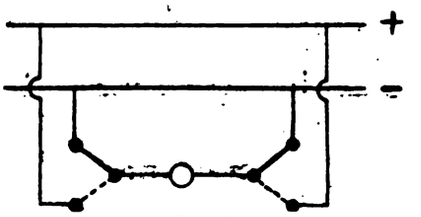

FIG. 1.

In adopting such circuit arrangements it is obvious, however, that serious trouble can occur, while unprotected terminals of opposite polarity are on the same base, particularly with such a universal adoption of metal covers for switches as present practice calls for.

In the type of two-way lever switch with a bearing plate forming a common terminal for both ways, and a contact arm attached to same, making contact alternately with the

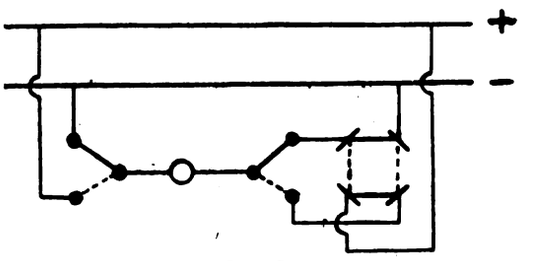

FIG. 2.

two ways, a further danger may develop, particularly if the distance between the two ways is inadequate, if the switch is called upon to carry more current than it was designed for, or if any lagging occurred in the action of the oscillating contact arm, as an arc might be drawn across, following the contact arm, and short-circuit the line.

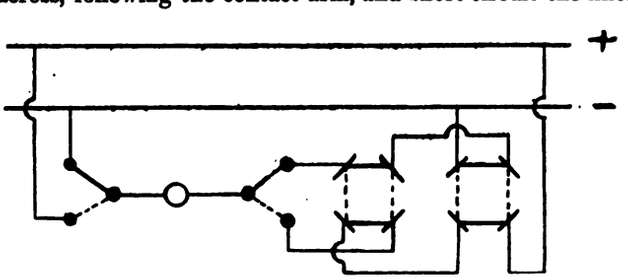

FIG. 3.

The first three diagrams in "F. T. C.'s" answer in your issue of Sept. 11, p. 400, show diagrammatically the oscillating lever type of switch I am referring to best, the intermediate switch of his Fig. 3 being no exception if wired up on the plan which invites trouble. Diagram 1

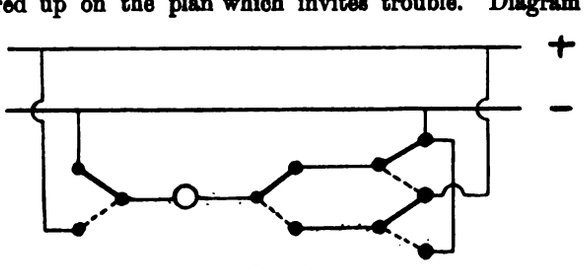

FIG. 4.

shows the plan *to be avoided* for two-way wiring; Diagram 2 shows that for controlling lamps from three points, also to be avoided; Diagram 3 shows that for controlling lamps from four points, also to be avoided; Diagram 4 shows the

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lever type of intermediate switch, as shown diagrammatically by your correspondent "F. T. C.," also to be avoided.

In the ordinary arrangement for two-way and intermediate wiring—luckily the methods usually advocated—all switches are on one pole and consequently safe.

A little care in adopting the right methods will make all the difference between satisfaction and failure.

Cases of failure have occurred where manufacturers have been blamed, when on investigation the cause of such failure rests with the contractor having adopted the faulty method.

My object in drawing attention to this matter is to prevent others falling into similar error, with resultant loss of prestige with their clients and general disinclination to adopt these convenient wiring methods.—Yours, etc.,

Sept. 29, 1903. A. P. LUNDBERG.

ALUMINIUM.

SIR,—Will you kindly allow me space to correct an important error in the note upon "Aluminium Conductors" appearing in your last issue. You state that:

"The wires experimented with by Mr. Kershaw have a very considerable percentage of other metals—about 5 per cent., whereas those exposed by Prof. Wilson in London were much more pure."

If you will refer to the tables printed with my paper, you will find that this statement is absolutely erroneous. The worst wire (No. 1) contained 3·06 per cent. of iron and silicon, while the best wire (No. 4) contained only ·54 per cent of these two impurities.

As regards the correctness of my conclusions regarding the resistance offered by commercial aluminium to atmospheric exposure, I may refer you to the September issue of the *Engineering Magazine* (p. 876), where you will find independent proof that even in America engineers are beginning to recognise that aluminium requires protection in certain atmospheres.—Yours, etc.,

JOHN B. C. KERSHAW.

The West Lancashire Laboratory, Waterloo, Liverpool, Sept. 26, 1903.

ELECTROSTATIC MULTIPLIERS.

SIR,—On p. 440 of your issue for Sept. 18 there is a reprint of a British Association paper by Prof. Marchant and Mr. W. G. Worrall on "The Use of Capacities as Multipliers in connection with Electrostatic Voltmeters on Alternating-Current Circuits." I think it may be of interest to the authors to know that the method they describe was in regular use in the testing room at the British Thomson-Houston Company's factory in London some four years ago. Also, in the high-potential tests made on the main feeders of the Central London Railway, a condenser-multiplier was used with the Kelvin electrostatic voltmeter for measuring the applied pressure. This multiplier consisted of two sheets of micanite, built up alternately with three sheets of thin iron, the constant being about 2 : 1.—Yours, etc. R. H. CLINKER.

257, Clifton-road, Rugby, Sept. 29, 1903.

SYNCHRONISING DEVICES.

BY F. H. DAVIES.

A review of the various methods used for finding out the exact moment of synchronism when paralleling two alternators makes plain the fact that the necessity of good synchronising has at last become fully recognised, and also that a great deal of ingenuity has been expended in evolving new and more satisfactory methods. In the old days of belt driving synchronism was often performed in a very haphazard manner. It was found that the machine would generally pull itself in quickly and easily by slipping under the belt, and as long as the plant was not damaged no one troubled about the effect on the lights. With the advent of the high-speed engine and direct coupling, primitive methods through their inadequacy began to fall into disfavour, and the alternating-current motor, and particularly the rotary converter, with its sensitiveness to any disturbance in the circuit, have finally made good synchronising indispensable.

The earliest method, which is practically the simplest, had many disadvantages. Perhaps the use of the past tense here is incorrect, as this system is still to a limited extent in use in small installations in this country, and to a greater extent in America. Its best days are, however, certainly over, and we may be excused in looking on it as a thing of the past. A diagram representation is shown in Fig. 1. Alternator A_1

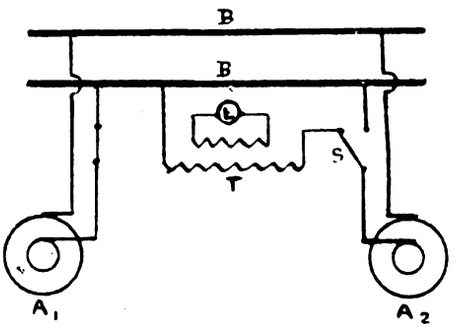

Fig. 1

is connected to the 'bus bars, B B, and is running the load. A_2 is being synchronised, and the main switch is closed on the synchronising contact only. T is a small synchronising transformer, the secondary of which is closed on the lamp, L. When the machines are dead out of phase they are practically in series with the transformer, and consequently the lamp lights brilliantly. A_2 is now speeded up and the volts regulated, and the lamp begins to flicker. The nearer A_2 gets to synchronism, the longer become the periods of light and darkness, and when these periods extend over about three seconds each, the main switch is closed during the dark interval, as then the machines are in phase—that is, the E.M.F.'s oppose one another, and consequently no current passes through the primary of the transformer. A very bad point in this method is that it is impossible to tell by the lamp when the current in it is really at zero. As is well known, a lamp may be run at quite a high percentage of its proper voltage and still look black, especially in daylight; the consequence of this is necessarily bad synchronising, excepting when the right moment has been hit by a fluke. Another point which applies to all synchronisers using lamps is that the light of a lamp when just switched on lags considerably behind the current, owing to the filament having to heat up; it is consequently necessary to allow for this, and to an extent that only experience can dictate.

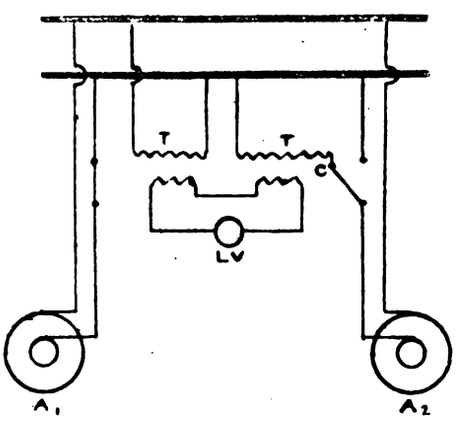

Fig. 2.

The above arrangement introduces the human element to a too great degree, and therefore the chance of trouble through carelessness or ignorance; it gives but the baldest assistance to the operator, and with such aid, to obtain even fair results, it is necessary for him to have had considerable experience with the identical apparatus, machines, and the man at the engine stop-valve. A great improvement on this system is the one shown in Fig. 2. Two transformers, T T, are arranged with their secondaries in series, and closed on the lamp or voltmeter, L V. The primary of one is fed

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from the 'bus bars, and therefore from the running machine, A_1. The primary of the other is connected to the incoming machine, A_2, through the contact, C, upon which the main switch rests temporarily. It stands to reason that when the machines are out of phase, the currents in the primaries are in opposite directions; therefore the E.M.F.'s in the secondaries also oppose, and the result is no current through L V. On the other hand, when in phase the currents help one another, and L V either lights up or shows full voltage, as the case may be. The machines being in synchronism, the main switch is now closed. This system is improved by the substitution of one transformer, with two primary windings and one secondary for the two shown on the diagram. The action in this case is very similar, with the exception that the opposing forces when the machines are out of phase are magnetic instead of electric. The two primaries being wound in the same way, naturally produce no resultant magnetic flux through the secondary when the currents in them are in opposition, and *vice versâ* when in the same direction.

Synchronisers of this type are greatly in use at the present day, and are fairly satisfactory when operated by experienced men. The hot-wire voltmeter has replaced the lamp, as it affords a better indication and has a smaller lag; they are, however, frequently used in combination for several reasons. The lamp when placed in close proximity to the voltmeter—say directly underneath it, as is the case in the Ferranti synchroniser—to a certain extent assists the eye in judging the correct moment to close the switch. It is also sometimes used for getting the machine roughly into phase, the lamp being switched out and the voltmeter on when the oscillations have become very slow; the reason for this being that rapid oscillations of the voltmeter needle and frequent banging against the stops quickly deteriorates the instrument. The lamp as a guide for the engine-driver is better than a voltmeter, as it can be seen from a distance in any direction. The type of lamp preferable for this purpose is a low candle-power high-voltage, as the filament is fine, and the light consequently has a smaller lag behind the E.M.F., owing to quick heating up. The voltmeter should be of the hot-wire type, with specially light parts in order to reduce the inertia and lag to a minimum; it should, however, be as strongly built as is consistent with lightness, as the strain of frequent oscillations is great. Synchronisers of this kind, while very satisfactory, leave a great deal to the experience of the operator. For instance, they give no indication as to whether the incoming machine is fast or slow, and unless the synchronising voltmeter is watched most carefully from the start, it may be necessary to specially speed the machine up or down to ascertain how things stand. Necessarily this means a waste of time that in emergency, or with a quick rising load, cannot be afforded. In order to simplify matters generally, and to provide a means of exactly determining the state of affairs, Messrs. Everett and Edgcumbe evolved their present well-known type of synchroniser, which is certainly a great step in the right direction, as it provides a clear indication of the exact moment of synchronism, and shows whether the incoming machine is fast or slow and by how much. It consists to all intents and purposes of a small two-phase motor, the rotor and stator of which are each provided with a two-phase winding; the stator is connected to the 'bus bars, and the rotor to the incoming machine. When the machines are in synchronism the two magnetic fields rotate at the same speed; there is consequently no tendency of the rotor to move, and in this case the needle of the instrument, which is fixed to the rotor, remains steady at the position indicating synchronism. If, however, the frequencies are different, there is naturally a difference between the speed of rotation of the two fields, and consequently the rotor rotates in one direction or the other, according to whether the speed of the incoming machine is high or low. One revolution of the rotor—and therefore the needle—is equal to a difference of two complete cycles per second. A lamp is provided on top of the instrument, and indicates by flickering in the usual manner. In order to do away with shouting and signalling from the switchboard to the engine, the instrument is provided on the dial with an arrangement of red and green lights which can be seen from some distance, and which automatically show, in addition to the needle, whether the incoming machine is fast or slow. This effect is produced by a movable shutter, which works in connection with the needle and obscures either the red or the green light as the case may be.

As stated above, the action of this synchroniser is dependant on the rotation of two magnetic fields, for which, of course, a two-phase current at least must be employed. To simplify the connections when used on a two-phase circuit, and to adapt the instrument to use on a single or three-phase circuit, the two-phase currents are produced from one-phase by the insertion of a choking coil in one of the circuits of both the rotor and stator, and a non-inductive resistance in the other, the function of this latter being to equalise the currents in the two coils. For polyphase working, therefore, the instrument is simply inserted in one phase, and so only two transformers are required—one for the 'bus bars, and one for the incoming machine. It would, of course, be possible in the above case to take all the phases into the instrument, and so produce the rotating field without the aid of resistances, but this would mean an increase in the number of transformers and complications in the connections. It is claimed for this instrument—and apparently very justly—that it almost entirely eliminates the human factor, and therefore risk from inexperience or nervousness.

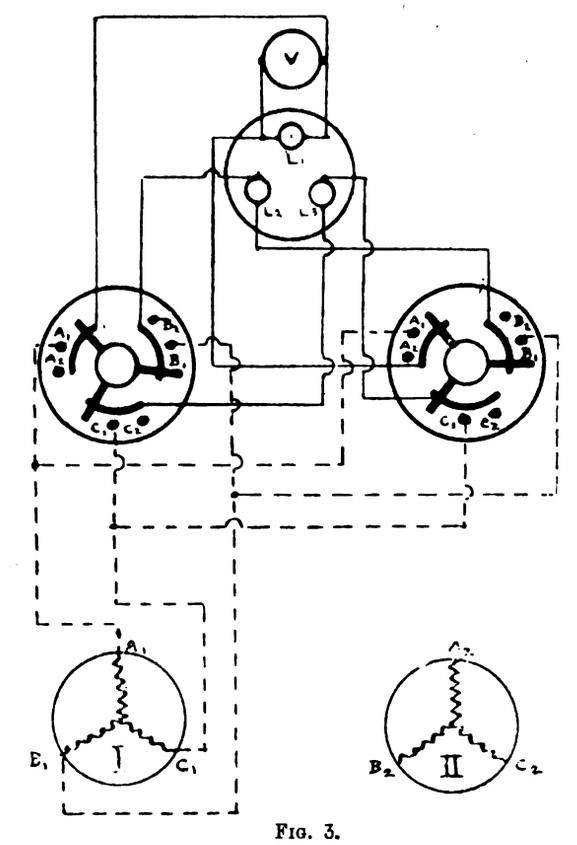

FIG. 3.

A very interesting and ingenious device for synchronising three-phase alternators has been brought out by Messrs. Siemens and Halske. It cannot be said to be as satisfactory as the Everett and Edgcumbe instrument, but it is greatly in use and very pretty in its action. The diagram of connections for two machines is as shown in Fig. 3, the synchronising transformers being left out for simplicity. I. and II. are two three-phase alternators, the terminals of which are connected to their respective contacts on the two three pole switches; it will be noted that these contacts are in parallel. The three main contacts of these switches are connected (as shown) to the three lamps, L_1, L_2, L_3; L_1 is shunted by a voltmeter for greater accuracy. Supposing alternator I. is running the load, and alternator II. is to be put in parallel. The voltages of the two machines are first made equal, the left-hand switch which, as shown, is in the "off" position, is put on to the contacts A_1, B_1, C_1, and therefore connected to alternator I. The right-hand switch is put on contacts A_2, B_2, C_2, and so connected to alternator II. The lamps will now begin to blink, not all at once, but in a certain order—from left to right if the incoming machine is slow, and *vice versâ* if fast. When the rate of the extinctions shows that the machines are running at practically the same speed, and at the moment that the lamp L_1 is dark or the

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voltmeter, V, shows zero, the switch is closed. The voltmeter is provided to increase the sensitiveness of the apparatus for the afore-mentioned reasons. This arrangement, owing to the number of transformers required, is costly, and its indications are rather confusing when compared with the revolving pointer of the Everett-Edgcumbe instrument.

Sundry other devices of a more or less ingenious nature have been proposed for determining the moment of synchronism. One, the static instrument of Prof. Ayrton, is beautifully simple, and might, if properly exploited, turn out of practical value. The connections are as shown in Fig. 4. The apparatus consists of only two parts—R, an extremely high resistance connected to the outer of the incoming machine, A_2, and to the inner 'bus bar; E, a gold-leaf electroscope connected to the inner of A_2 and the outer 'bus bar. The switch is closed when the leaves are together, and the method of working is obvious from the diagram. As this device does not necessitate transformers it is very cheap, and on the face of it seems trustworthy. It is, however, difficult to speak of the practical utility of such ideas unless

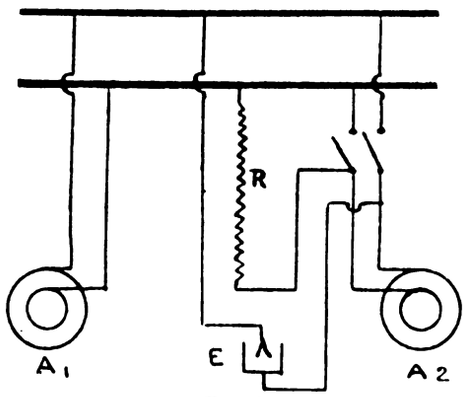

FIG. 4.

they have been tried under working conditions, which is not the case with the above.

PERSONAL.

The Bristol Electrical Committee propose to increase the salary of the deputy electrical engineer (Mr. H. Herbert Couzens) from £300 to £350.

We regret to learn of a serious accident which occurred to Mr. William C. Hart, an electrical engineer of the Plymouth Corporation. Whilst he was placing a new overhead wire in position in Westwell-street he was knocked down from a ladder tower and received injuries to his limbs and concussion of the brain.

Mr. T. Vickers, C.E., who for over two years has had the management of the special track construction works of Messrs. Askham Bros. and Wilson, Sheffield, has resigned and joined the tramway department of Hadfield's Steelfoundry Company, Sheffield. Mr. Vickers is well known among municipal engineers, having held for some time several public posts previous to joining Messrs. Askham.

We understand that Mr. Stephen Sellon has resigned his position as chief engineer to the British Electric Traction Company, and will practice as consulting engineer at 36, Victoria-street, Westminster.

Mr. J. Fletcher Moulton, K.C., M.P., F.R.S., has been elected president of the Junior Institution of Engineers in succession to Colonel Edward Raban, C.B., R.E.

Mr. Ivon Braby, M.I.E.E, having accepted an appointment on the staff of Messrs. Frederick Braby and Co., Limited, has resigned his position as joint managing director of Braby and Tomlinson, Limited.

Mr. William Cramp, A.M.I.E.E., late lecturer on electrical design at the Central Technical College, has joined the Crypto Works Company, Limited, 29, Clerkenwell-road, E.C., as electrical expert. His first duties will be to supervise the manufacture and development of repulsion motors of his own design for monophase working, and up-to-date continuous-current enclosed motors.

The Postmaster-General has appointed Mr. C. H. Bundy to be assistant secretary to the Post Office on the retirement of Mr. G. W. Smyth, C.B.

Mr. Percy W. Naylor has been appointed clerk at the Gravesend electricity works.

Mr. J. Dugdale, who has for some years been traffic superintendent of the Sheffield Corporation tramways, left the city on Wednesday to take up the position of general manager of the Oxford tramways. The tramway employés presented him with a tea and coffee service on tray. Two gatherings were arranged in order to meet the convenience of men on both morning and afternoon duty. Umbrellas, suitably inscribed, were presented to Mr. and Mrs. Dugdale by the tramways police staff.

QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any questions should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

623. What is to be said for and against putting wiremen on piece-work: (1) on skeleton houses in Simplex conduit; (2) in houses already finished in casing or Simplex?—F. B C.

624. I wish to construct a transformer, the primary voltage of which is 2 000, and the secondary 25 volts, frequency 60. It is imperative that the secondary circuit consists of *one* turn only. Can this be done? Give particulars of design.—J. G.

ANSWERS.

Question No. 615.—Information is required as to the best method of automatic signalling for electric tramways. The system must be equally applicable for use by day or night. Preference would be given to a method by which the current supply to the car it is desired to stop is cut off entirely, so that the car can no longer proceed, and is not merely detained by signals which might or might not be regarded by the driver.

Best Answer to No. 615 (*awarded* 10*s.*).—It is difficult, if not impossible, to definitely fix upon any particular system of automatic signalling as being the most suitable to meet all the requirements of electric tramway working. Of course, in this country there has been as yet no need for any complete system of block signalling owing to the restrictions laid in all the tramway areas upon the speed at which cars may run. At such speeds, of course, running "on sight" has been in all cases the rule. It seems to the writer that at present, in this country at any rate, signalling is only necessary on our street tramways where single track with turn-outs is worked. Various systems of signalling are in vogue for this kind of work, practically all depending upon the trolley wheel of a car entering a section of single track making contact between the trolley wire and a metal bar about 2ft. long placed alongside the overhead at such a distance that the trolley wheel can touch it, thus closing the circuit of a solenoid at the next turn-out ahead. This solenoid works a plunger which sets a semaphore at "danger" for any car approaching this turn-out in the opposite direction, this semaphore being reset to "clear" by a similar method when the car reaches the turn-out ahead, and is thus clear of the section of single track. If block signallling be required, the car can be arranged to operate the signals behind it as well as those in advance (these latter being only necessary in single-track working), thus protecting itself from a following car. Of course, red and green lights are provided for night working, the lamps being switched on simultaneously with the semaphores—red, of course, indicating "danger" and green "clear." On certain of the American interurban roads this system has worked very successfully; it can be easily applied to any overhead trolley tramway where narrow streets and sharp turnings necessitate the use of single track. An arrangement somewhat on the lines of the above is working satisfactorily on a South Coast town tramway system.

Probably the best method of automatic signalling where it can be applied is that termed the "track-circuit" system, with either the "electro pneumatic" or an "all-electric" arrangement for working the signals. The disadvantage of this system is that it involves the loss of the running rails as a means of conducting the return current from the motors in the case of an electric railway, though a well-known American elevated railway retains one rail per track for this purpose. For the purpose of "track-circuit" signalling the running rails are insulated in sections against

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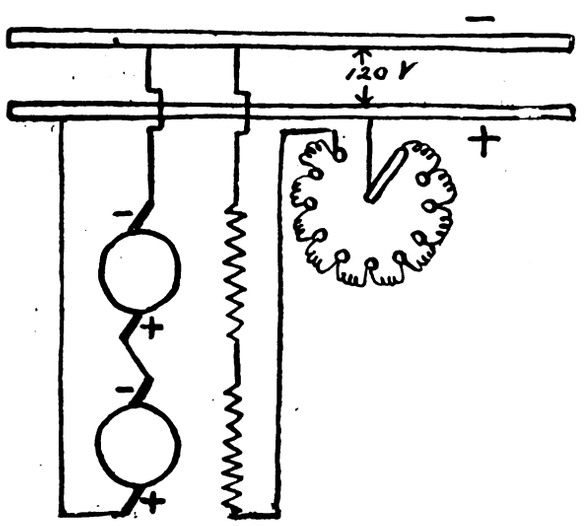
low-voltage current (from 10 to 100 volts). This method is only applicable to railways (either steam or electric) that possess their own right of way and having rails laid on wooden sleepers so that rail insulation is possible. When a train or car enters on a section, its wheels make circuit from rail to rail through the axles. In this circuit is an electromagnet which works a compressed-air motor, consisting of a cylinder and piston, which sets the signal at the entrance to the section occupied at "danger." This is reset at "clear" when the train leaves the section at the other end. In connection with this system it is a simple matter to provide an automatic device at each signal which will pull up a train should the driver fail to obey a signal set at "danger." This is done by interlocking with the signal a trigger which is fixed just outside one of the running rails. This trigger projects upwards when the signal is at "danger," and should a train advance under those circumstances the trigger strikes an aircock on the train air-pipe, opening it, and putting on the brakes. The overload circuit breakers then open and cut the current off from the motors. This is probably the only method successfully adopted as a safety stop, and, of course, cannot well be applied to an ordinary street tramway, nor could the "track-circuit" system of signalling be adopted on such a road for obvious reasons. Thus a trolley contact system is the only one apparently available for a street tramway.

When the electro-pneumatic system is adopted, compressed air for working the signals is supplied by electric air compressors feeding into a main pipe placed along the line, but a leading railway company in this country is experimentally storing liquefied carbonic acid gas at a pressure of about 800lb. per square inch in two portable cylinders at each signal along the road, one cylinder to be recharged while the other is in use; each cylinder is to suffice for about 8,000 operations of the signal.

Of course, the ideal system for safety is the one in which, when anything goes wrong with either the signalling circuit or the pneumatic signal motor, the signals affected will immediately set themselves at "danger," so that the worst thing that can happen in the event of a failure is only a stoppage of trains.—D. J.

Question No. 616.—I have four dynamos, shunt-wound two-brush type, each giving an output of 65 volts 300 amperes. What minimum alterations in windings are necessary to give 120 volts. Would compounding the fields be satisfactory? Give sketches, calculating formula, etc.

Answer to No. 616 (*awarded* 10*s.*).—As it is possible to obtained the required 120 volts without altering the present winding, we will consider this before calculating radical alterations. If the dynamos are connected up two in series as per sketch, the resulting voltage will be 130 at



the 'bus bars; this can easily be reduced to 120, either by running the machines a little shower or by inserting resistance in the shunt circuit. The ordinary connections of the shunt windings are altered, the shunts being in series as well as the armatures. To arrange for each dynamo to give 120 volts, it will be necessary to take several tests and measurements. As the question assumes the dynamos to be similar, presumably the same alterations will be required for each; it will, however, be as well to check the figures for each machine as far as possible. By placing an ampere-meter in the shunt circuit, and by noting number of turns when unwinding bobbins, the number of ampere-turns under present conditions will be obtained. Take readings of speed and volts on open circuit and at various loads. The E.M.F. of a dynamo depends on the number of lines of force cut by the armature winding per second; these lines of force are created by the ampere-turns of the magnet winding. We have

$$E = \frac{N\,n\,w}{10^8}$$

where E = E.M.F. generated by armature;
N = total number of lines passing through armature;
n = revolutions per second;
w = total number of conductors on armature
10^8 = a constant, to change absolute into practical units.

To get N we must wind the magnets with a number of turns of wire through which a current is passed. The current flowing multiplied by number of turns gives the ampere-turns of the winding.

$$N = \frac{1{\cdot}25 \times \text{A.T.} \times \text{area of magnets} \times \mu}{\text{length of magnetic circuit}}$$

where A.T. = ampere-turns;
μ = permeability of the magnets at the given density.

By noting number of turns on the armature, its speed and voltage, and allowing for drop in volts due to the shunt current which passes through the armature, the open-circuit readings will give the number of lines passing through armature. The number of lines through the armature will will be less than that through the magnets, owing to leakage. The leakage factor varies for different dynamos from about 1·2 to 1·4. It is then a matter of simple proportion, supposing speed and strength of field are kept the same, to find how many turns are required on the armature to give 120 instead of 65 volts. A fair average density of lines is about 80,000 per square inch for mild steel, and half that quantity for cast iron. Having determined the number of ampere-turns from these data for the new voltage, the next thing is to find the size of wire. To find the most suitable size, we have to consider how much we can afford to lose by resistance. For instance, suppose we only have one layer for the shunt winding, the loss

$$\frac{E^2}{R} = \frac{120^2}{\text{resistance of shunt}}$$

would be prohibitive. A formula giving approximate rise of the winding in degrees Fahrenheit is

$$\frac{\text{Watts used in winding} \times 100}{\text{Area of surface in square inches}}$$

This must be considered when calculating the area of the wire from

$$a = \frac{l \times p}{r};$$

where a = area of wire;
l = length of mean turn;
p = resistance in ohms of unit cube;
r = resistance of mean turn;
$= \frac{\text{volts at terminals}}{\text{ampere-turns}}$.

The same commutators might be used, as although the volts will be more per section, the energy causing sparking will be about the same. Although general practice would be from 60 to 80 sections for 120 volts, the present commutators, unless the number of sections are below, say, 30 or 40, should be used, as new ones would mean a considerable addition to the expense. It may be found better to have fewer turns on the armatures and run quicker, or have stronger fields or *vice versâ* than the first calculations would indicate. The brushes would have less to do, owing to the reduction in the current. Compound winding is

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used to balance armature reactions and the drop due to resistance, thus keeping the voltage constant at varying loads. The amount of series winding to be added is found by running the machine at different loads and noting drop in volts as load is increased. The series winding must provide a sufficient number of magnetic lines to make up for this loss.—M. M.

Answer to No. 616 (*awarded* 7*s.* 6*d.*).—It will be necessary to rewind both the armature and the field completely. The new armature winding should consist of twice as many turns as the present one, and of a wire of about half the sectional area. The existing commutator can be used in again, as there is very little fear of sparking, due to doubling the number of turns per section, at so low a voltage as 120. The new field winding may be either shunt or compound. If shunt, the number of turns per pole must be doubled and the section of the wire halved as compared with the present shunt. If a compound winding is preferred, a preliminary test should be made with the unaltered machine. A reading of the shunt amperes required to give 60 volts on open circuit should be taken, and also of those required for about 61 or 62 volts with 300 amperes in the armature, the additional volt or two being necessary to allow for the drop which will occur over the series winding. Calling the first shunt current C_1, and the second C_2, the number of ampere-turns per pole to be given by the new shunt winding will be $C_1 T$ (where T is the number of turns on each of the existing coils) and the total ampere-turns per pole (shunt + series winding) required at full load will be $C_2 \times T$. The difference between these two values is the number of ampere-turns per pole to be given by the series winding.

The correct sectional area of the shunt wire can be found by the formula

$$\text{Area of wire in square inch} = \frac{\cdot 0000077 \times L \times C_1 \times T}{V},$$

where L is the mean length of one turn of the winding in inches; and

V is the number of volts across one coil (*i.e.*, 60 volts of the machine has two coils in series or 30 volts if it is a four-polar machine with four coils in series).

The nearest standard size of wire to this should be employed. The total depth of wire (shunt and series winding) put on each coil should be about the same as that of the existing shunt. The series winding should work at a current density of about 1,000 amperes per square inch, and the number of turns required is, of course, directly obtained by dividing the number of series ampere-turns, found as above, by the total current (150 to 160 amperes in this case). As a check on the correct total amount of wire to put into each coil, the total watts (shunt and series) calculated with the new winding should be equal to the watts with the existing shunt winding, in order to ensure the same temperature rise.—Q.

Answer to No. 616 (*awarded* 7*s.* 6*d.*).—With the amount of data given it would be difficult to pass an opinion as to whether the desired result will be accomplished with the same machines. In all classes of machine design, if the output of a machine is to be increased, other factors relating to the output must be increased in *proportion*. Hence it will be impossible to obtain 300 amperes at 120 volts from the machines when run at the same speed as for generating 65 volts, no matter what alterations be made to the fields. (This is, of course, based on the assumption that the magnetic circuit of the machines in the first case is worked at a density corresponding to the current practice.) Probably the best and most satisfactory way of obtaining the 120 volts would be to couple two of the machines in series and excite the shunt fields in series from the 'bus bars, a field rheostat being inserted to adjust the voltage to 120.

The brief example given below will clearly show why it is impossible to use the same frame and armature for 120 volts. It will be convenient to give here the general formula for E M.F.:

$$E = \frac{4\,T.N.M}{10^8},$$

where E is the E.M.F. generated in the armature (in volts);
T the number of turns in series between the brushes;
N the number of magnetic cycles per second; and
M the magnetic flux linked with each of the T turns.

To ensure for all cases a correct interpretation of this formula, it will be desirable to consider some of the terms more in detail:

T = turns in series between brushes
= total *turns* on armature divided by number of paths through armature from negative to positive brushes;
N = number of magnetic cycles per second
$$= \frac{\text{revolutions per minute} \times \text{number of } \textit{pairs} \text{ of poles}}{60}.$$

It should also be noted that for a ring armature M = half flux from one pole-piece into armature, and for a drum armature M = total flux from one pole-piece into armature.

For the case under consideration we will assume that, for practical reasons, it is inadvisable to increase the speed of the machines; and hence, in the above formula, T and N will be constant, and if E is to be increased M the flux must also be increased.* The question states that the machines are of the "two-brush type." Presumably it is meant that there are two brush spindles. In this case the design would probably be of the two-pole variety. For the purpose of this example, we will assume that the machines run at 800 revolutions per minute when generating 65 volts, and that this speed cannot be increased. We will also assume that T equals 60. Applying the above formula we find that to generate 65 volts M = 2 megalines, and for 120 volts M = 3·75 megalines. The density in the armature core in the first case (for 65 volts terminal pressure) may be taken as 70 kilo-lines per square inch (at which density the M.M.F. required is 15·5 ampere-turns per inch length of magnetic path). The section of iron required in the armature will thus be 28·6 square inches. Now, in the second case this section has to carry 3·75 megalines, and the density becomes 130 kilo-lines per square inch. At this density about 800 ampere-turns are required per inch magnetic path, the iron being well saturated. A step further will serve to convince that the desired result cannot be obtained with the present machines. We will assume the leakage coefficient in the first case to be 1·3 and in the second case to be 1·6. Hence, flux to be generated in pole core equals 2·6 megalines in the first case and six megalines in the second. If the pole cores be of wrought iron and worked at a density of 60 kilo-lines per square inch, in the first case, the section required is 43·5 square inches and the density in the second case becomes 140 kilo-lines per square inch. It is evident, without carrying this example further, that it will be impossible to make up the required ampere-turns by any spool winding, and compound winding is entirely out of the question. The use of a compound winding on a machine is to supply the extra ampere-turns required at *full* load, to make up for the "C R drop" in the armature and the increased density in the magnetic circuit.

The mechanical design of the machines at once imposes a limit to an increase in speed, which would also be inadvisable from an electrical standpoint, on account of sparking troubles, resulting from the high frequency of commutation. If new machines are to be constructed (which is the only satisfactory solution to the problem), the writer would recommend that they should be of the multipolar type—a four-pole design being preferable. By adopting this type, the reactance voltage of the coils undergoing commutation may be made so low that the machines might easily stand 25 per cent. overload without sparking. The armature should be of the slotted type, with a multiple-circuit winding. There should be one turn per commutator segment, and the conductor should have a section of about 0·042 square inch, four conductors being placed in one slot. The number of poles should be a multiple of the number of slots. In the present case the number of slots should be divisible by 4. The average "pitch" of the winding should

* The rate of increase of M with regard to E will depend on the initial stage of magnetisation and quality of material constituting the magnetic circuit. At high densities leakage will modify very considerably the results.

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TABLE A.

I. Part of machine.	II. Material.	III. Density in kilo-lines per square inch. From	To	IV. Ampere-turns per inch of magnetic path. From	To	V. Length of magnetic path, inches.	VI. Ampere-turns required.
Armature	Sheet iron or steel	70	75	15	16 5	$\frac{d_1 - d_2}{4 \times \text{number of poles}}$*	$\frac{d_1 - d_2}{10} \times$ Column IV.
Teeth	Ditto	110	120	25	150	Length of tooth	Column V. × Column IV.
Air-gap	Air	35	45	—	—	Radial depth of gap	·313 D L.†
Magnet core	Cast steel or wrought iron	60	80	19	32	Length of pole	Length of pole × Column IV.
Yoke	Cast steel	60	75	19	25	$\frac{d_3 - d_4}{4 \times \text{number of poles}}$‡	$\frac{d_3 - d_4}{10} \times$ Column IV.
	Cast iron	35	55	70	190	Ditto	Ditto

* d_1 = diameter of core at bottom of slots; d_2 = internal diameter of core. The rule can be put into another form; thus $\frac{\text{average circumference of core discs}}{2 \times \text{number of poles}}$.

† This formula gives the ampere-turns required for the air-gap direct. D = density in kilo-lines per square inch, and L = radial depth of gap in inches.

‡ d_3 = external diameter and d_4 internal diameter of yoke (assuming the circular form); or the rule may be put $\frac{\text{average circumference of yoke}}{2 \times \text{number of poles}}$.

$\frac{c}{4}$, where c is the number of face conductors. If there be 160 conductors on the armature, the average pitch will be 40 and the front pitch should be 21 and the back pitch −19. The number of turns in series between the brushes will be $\frac{c}{8}$, since there are four paths through the armature. The armature core should be worked at a density of 70 to 75 kilo-lines per square inch, and the teeth should be proportioned that the tooth density is of the order of 110 to 120 kilo-lines per square inch. The density in the air-gap should be from 35 to 45 kilo-lines per square inch, an average value, of course, being taken which will correspond to the saturation of the teeth. The accompanying Table A may be of use in designing. The leakage factor will be from 1·15 to 1·2 for a four-pole design, and an average value should be taken. The total ampere-turns needed *per pole* will be found by totalling the various quantities in Column VI. The current for the shunt excitation would be from 3 to 5 per cent. of the total current generated. In making calculations for the spools, overall dimensions will have to be assumed from which the mean length of one turn may be estimated. The following formula, which the writer has found to be of great service in spool calculations, may then be applied:

$$W = \frac{31 \times \left(\frac{\text{ampere-feet}}{1{,}000}\right)^2}{\text{watts}}$$

in which W = weight of copper in the spool in pounds;
ampere-feet = ampere-turns × mean length of one turn (in feet);
watts = watts consumed in the spool at 20deg. C.

An example will best illustrate the application of this formula. Suppose that the total of Column VI. comes to 4,000—*i.e.*, 4,000 ampere-turns per spool are required. Assume that the mean length of one turn is 2ft. Then

$$\left(\frac{\text{ampere-feet}}{1{,}000}\right)^2 = \left(\frac{4{,}000 \times 2}{1{,}000}\right)^2 = 64.$$

Assume that the spool has a radiating surface of 200 square inches, and after due considerations, as to ventilation, it is decided to permit 0·6 watt per square inch of radiating surface.

Therefore, watts = 200 × ·6 = 120 per spool.

Hence, $$W = \frac{31 \times 64}{120} = 16\tfrac{1}{2}\text{lb.}$$

The length of wire may be estimated from the dimensions, and the weight per thousand feet can readily be calculated. A reference to a wire-gauge table gives the size of the wire, and this must be checked for the required number of ampere-turns. For the methods followed in the calculation of the reactance voltage, such works as those of Messrs. Parshall and Hobart should be consulted. (See "Electric Generators," p. 175, and "Traction and Transmission," vol. iv., p. 143.).—A. DOVER.

Answer to No. 616 (*awarded* 7*s.* 6*d.*).—The voltage obtained from any dynamo depends on the number of conductors on the armature, and on the speed of rotation and on the strength of field (from the fundamental principle discovered by Volta that a difference of potential of one volt was obtained at the ends of a wire when that wire cut 10^8 C.G.S. lines of force in one second), consequently to obtain 120 volts out of the 65-volt dynamos referred to in the above question, either the speed will have to be almost doubled, or else the armature core rewound with twice as many conductors as there are on at present. The field could not be strengthened to obtain the necessary increase in volts owing to the heating of the field coils and the saturation of the iron. As no mention in the question is made as to the present speed of the dynamos, we shall have to assume some speed. Supposing that the speed is about 400 revolutions per minute on full load, then possibly this speed could be increased to about 750 revolutions per minute if the machines are belt driven by altering the size of the pulleys. This would be the best plan if it is possible, but if it is not, the armatures will have to be dismantled and rewound with double the number of conductors of about half the present sectional area of copper, as the current for the same kilowatt output will be practically halved at 120 volts. This alteration to the conductors will necessitate doubling the number of turns per section, as is shown diagrammatically in Fig. 1, the

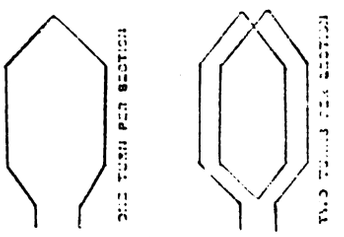

FIG. 1.

same commutators being used again. As the field windings will have to be rewound to suit the higher voltage, it is possible to compound wind them, and it will be advisable to do so if the dynamos are for lighting purposes and not for battery charging, as is explained later on. To find out the amount of series and shunt windings required, saturation curves should be made on the present 65-volt dynamos as follows: Run the dynamos up to the normal speed, and then, by means of an adjustable rheostat in series with the shunt winding, alter the strength of the field, and note the corresponding changes in the volts at the dynamo terminals. By taking two tests—(1) at full load, (2) at no load—curves can be plotted as shown in Fig. 2. From these curves it is seen that to obtain a

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terminal voltage of 60 volts, 4,000 ampere-turns are required at no load and 5,000 ampere-turns at full load, showing that the shunt winding must be wound for 4,000 ampere-turns and the series winding for 1,000 ampere-

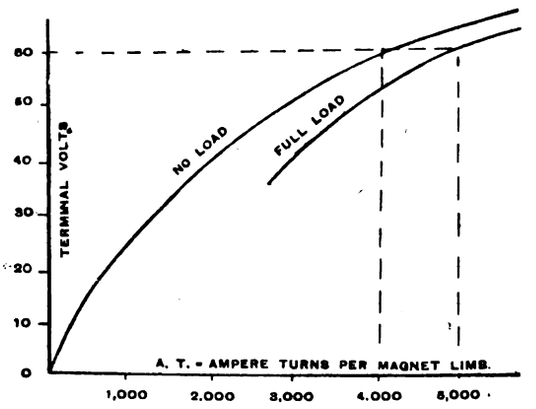

FIG. 2.

turns—of course, the actual number of ampere-turns are assumed and are only used for the sake of clearness—and if the armature is rewound with double the number of conductors, with the same ampere-turns the terminal voltage will be 120 volts instead of 60 volts.

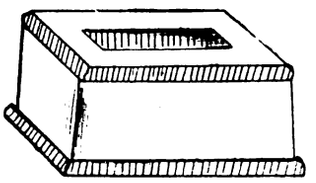

FIG. 3.

The following formulæ can be used for calculating the number of turns of shunt and series winding, etc. Assuming that the ordinary type of wooden flanged former is used as is shown in Fig. 3, the area of shunt wire

$$\frac{\cdot00028 \times \text{mean length of one turn} \times \text{ampere-turns per limb}}{36 \times \text{volts across one limb}}$$

$$\text{Number of turns in one layer} = \frac{\text{length of winding}}{\text{covered diameter of wire}} = x$$

$$\text{Number of layers} = \frac{\text{depth of winding}}{\text{covered diameter of wire}} = y$$

$$\text{Total number of turns on each former} = x \times y = z$$

$$\text{Resistance (in ohms) of each former (hot)} = \frac{\cdot000028 \times z \times \text{mean length of one turn} \times \text{number of formers}}{36 \times \text{area of wire}}$$

Weight of wire on each former = $\cdot32 \times z \times$ mean length of one turn × number of formers × area of wire = lbs.

The sectional area of the series winding should be such that the current density does not exceed 1,000 amperes per square inch when the full-load current is passing through it.

The total radiating surface = length of winding × peripheral length round the outside of the coil × the number of formers.

The total heating on the shunt winding and series winding combined should not exceed ·6 watt per square inch of radiating surface.

The advantage of compounding these dynamos lies in the fact that, when the shunt winding has reached its maximum temperature after a few hours' run, the terminal voltage will be almost constant at all loads without any adjustment of a shunt regulating resistance. But if the dynamos are to be used for battery charging, the shunt winding must be made strong enough to give the full charging voltage alone without the series winding, as this latter would have to be cut out during the charging. A compound-wound dynamo cannot be used for battery charging, because the battery will drive the dynamo as a motor, a strong current passing round the series winding if the battery voltage happens to rise above the dynamo voltage.—P.

BRIGHTON ELECTRICITY ACCOUNTS.

Below we give an abstract of the statement of the above accounts for year ended March 31 last, on which date the capital expenditure totalled £466,746.

Dr. Revenue Account.	£	s.	d.
Coal or other fuel	20,432	12	1
Oil, engine-room stores, etc.	1,899	3	10
Wages at generating station	6,265	14	4
Repairs and maintenance	2,853	9	10
Wages of linesmen, fitters, and labourers	1,034	18	5
Repairs of mains, etc. (£652. 13s. 9d.), less £627. 13s. 4d., amount charged to Tramways Department for removing and overhauling mains	25	0	5
Repairs of transformers, meters, etc.	1,780	19	0
Outlay for works	2,311	8	10
Bedford-street storeyard	191	14	4
Public lamps—street installations	786	7	9
Attending public lamps, etc.	3,509	4	10
Rates	1,243	13	11
Salaries—engineer's department	3,091	17	3
Collectors, etc.	375	0	0
Stationery and printing	386	3	9
Registrar of stock, etc.	366	10	8
General establishment charges	311	12	0
Insurances	179	18	8
Law expenses	4	6	6
Amount transferred to provide for bad debts	158	17	6
	47,208	13	11
Balance carried to net revenue account	35,184	5	11
	£82,392	19	10

Cr.	£	s.	d.
Sale of current per meter	58,033	4	6
Public lighting	10,351	17	5
Tramways	9,218	6	3
Rentals of meters	1,847	18	0
Rentals of motors and fans	235	0	8
Works executed	2,545	6	6
Interest on cost of main	43	0	0
Rents	116	3	3
Miscellaneous	2	3	3
	£82,392	19	10

General Balance-Sheet.

Dr. Liabilities.	£	s.	d.
Redeemable stock	343,280	9	4
Debenture debt	39,605	0	0
Premiums on stock issued	14,760	10	4
Floating liabilities	26,646	18	0
Balance at credit of revenue account	7,984	13	9
Balance at credit of reserve fund	3,606	11	3
Surplus account	64,603	2	7
	£500,487	5	3

Cr. Assets.	£	s.	d.
Capital outlay—amount expended for works	459,177	9	9
Stores on hand	1,377	15	4
Sundry debtors for current supplied	31,436	7	1
Other debtors	17	0	2
Engineer's advance	50	0	0
Cash in treasurer's hands	1,230	11	10
Investments	7,198	1	1
	£500,487	5	3

Statement of Electricity Generated, Sold, etc.

Quantity generated in B.T. units			7,698,806
Quantity sold	Public lamps	928,834	
	Tramways	1,578,639	6,904,521
	Private consumers by meter	4,397,048	
Quantity used on works			379,990
Total quantity accounted for			7,284,511
Total quantity unaccounted for			414,295

Number of public lamps: 372 arc lamps, 1,419 incandescents.

APPOINTMENTS VACANT.

Resident Electrical Engineer, Leek Urban District Council, £150 per annum. See advertisement.

Assistant to attend to electrical plant, Honley District Council.

Assistant for private plant in London, £2 per week. See advertisement.

Engineer to superintend mainlaying. See advertisement.

Superintendent of Electric Lighting, etc. The Crown Agents for the Colonies will receive applications for the appointments of (1) superintendent of electric lighting, and (2) assistant electrical engineer, under the Public Works Department of the colony of Lagos. Salaries £400 and £300 per annum respectively, appointments for two years' service in the colony. Four months' leave on full pay in this country at the end of each 12 months' continuous service if returning to the colony, and two months if not returning to the colony. Half salary

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on the first voyage out, but on subsequent voyages full salary will be paid. Applications by letter, stating age and experience, and accompanied by copies of not more than three recent testimonials, will be received by the Crown Agents for the Colonies, Downing-street, London, S.W., up to Oct. 7. The following reference should be quoted on the top left-hand corner of letter of application, M.1,751.

Mechanical Engineer to superintend machinery, Commissioners of the Port of Calcutta, Rs.1,000 per month, Oct. 15. See advertisement.

Improver, as switchboard attendant, Coventry. Applications by Oct. 8, to Manager, Electricity Works.

Junior Assistant Engineer, Aldershot. Applications by Oct. 10 to F. Garside, Electricity Works.

Clerk of Works, Heston and Isleworth, to superintend building of electric light station. Application by Oct. 8 to Mr. H. J. Baker, Town Hall, Hounslow.

LEGAL INTELLIGENCE.

ELECTRIC TRAMWAYS TRUST.

In the Vacation Court on Wednesday, before Mr. Justice Bucknill, the petition of Mr. W. Bratby for the winding up of the Electric Tramways Trust, Limited, was mentioned.

Counsel for the petitioner said that originally this was a petition for a compulsory winding-up order presented to Mr. Justice Walton on 9th ult. His Lordship made an order continuing the voluntary winding-up under the supervision of the Court. He also directed the appointment of an additional liquidator to act with the existing liquidator. The petition, however, did not ask for a supervision order, and in accordance with the practice of the Court it was necessary to amend the petition, to ask for a supervision order, and to readvertise it. That had been done, and the petition now came on as amended. The company appearing and consenting, his Lordship made the order asked for, directing that the costs be paid out of the assets of the company.

COMPANIES' MEETINGS AND REPORTS.

DICK, KERR, AND CO.

The ordinary general meeting of the shareholders in this Company was held at the Cannon-street Hotel on Tuesday, at noon, Mr. Claud T. Cayley presiding.

The **Chairman**, in moving the adoption of the report (which appeared in our last issue) commented first on several items in the balance-sheet. He said the liabilities of the Company had been increased, owing to the absorption of the English Electric Manufacturing Company, Limited, works at Preston. The works had been taken over as a going concern, and as from March 31 last had been entirely under the management of this Company. Having drawn attention to the fact that since the last balance-sheet the directors had increased the reserve fund by £70,000, making the total reserves £161,559. 11s. 2d., he showed that, adding to this the carry-forward from this year of £35,544. 18s. 7d., they had a total of £197,104. 9s. 9d. On the assets side the capital expenditure had increased, due to the purchase of the works at Preston. Incidentally, he drew attention to a paragraph in the auditors' report, which stated that the plant and machinery had been amply depreciated. Contracts due for work, stock of materials, etc., were in excess of last year; but up to June 30 they held certificates from the various corporations and companies amounting to considerably over £300,000, and these certificates were as good as cash, and since then most of this money had been received. Proceeding to discuss the question of the absorption by this Company of the English Electric Manufacturing Company, he stated that these works were capable of turning out the largest direct-current and three-phase generators yet designed, together with all sizes of traction and stationary motors, controllers, etc. It had been found necessary to make a large addition to the present buildings to cope with their present contracts, and they expected that the new buildings would be ready for occupation in about a month from now. He thought it might be stated that since the brief period they entered the electric traction field they had completed and had in course of construction permanent way, overhead lines and cables, rolling-stock, and electrical equipment, generating plant, including steam-engines, boilers, and generators, and general engineering, amounting, in round figures, to something like £7,500,000. In addition to the home contracts which they were carrying out, they were at the present time engaged in the construction and equipment of tramways in Mandalay, Singapore, Hong Kong, and Tokio, and they had also supplied machinery for and equipped important undertakings in South Africa, and had in hand important contracts in South America, Australia, and Canada. The home business included large contracts for machinery, permanent way, rolling-stock, and equipments for London and various cities and towns in the provinces. Their works at Kilmarnock were fully employed in their own special manufactures, and were likely to be for some time to come. They were principally engaged in the manufacture of narrow-gauge rolling-stock, points, and crossings for portable railways, turntables, and special work for tramways. After a sympathetic reference to the late Prof. Sydney H. Short, who was the technical director of the English Electric Manufacturing Company, the chairman passed on to say that the business of the Company had grown so much of late years that their offices at 110, Cannon-street had been found far too small. They had been fortunate, however, in securing offices in a new building in Abchurch-yard, a few yards from the present offices, which would meet all their requirements for some time to come. Their address, therefore, from Oct. 1 would be Abchurch-yard, Cannon-street, instead of 110, Cannon-street. The shareholders probably had seen a paragraph in some of the papers to the effect that this Company was at the head of a combine which proposed consolidating several other concerns of a similar nature. He desired emphatically to state that there was not a word of truth in the statement referred to, and he trusted that the same publicity would be given by the Press to this denial as had been accorded to the statement in question.

Mr. R. H. Prestwich seconded the resolution, which was carried unanimously, without comment.

Mr. Claude T. Cayley having been re-elected a director, the election of Messrs. Richardson, Prestwich, and Lingard, who had been directors of the English Electric Manufacturing Company, to seats at the Board of this Company was confirmed.

The proceedings closed with a vote of thanks to the chairman, directors, and staff.

MERSEY RAILWAY.

The half-yearly ordinary general meeting of the proprietors of this Company was held at Worcester House, Walbrook, E.C., on Tuesday, Mr. J. Falconer presiding.

The **Chairman**, in moving the adoption of the report (*vide* last issue), referred to the electrification of the railway, which was completed on May 4 last. He said that under their old system—steam—the greatest of all difficulties was that of ventilation. The condition of the tunnel now, as regarded atmosphere, was absolutely perfect and quite healthy. The temperature was equable, the air always fresh, and the old steam-driven fans which had to be kept going continuously had been replaced by lighter electrical fans, which only required to be used occasionally, and which could sweep the whole tunnel in a very short time. Previously, the lighting of the stations was a source of considerable difficulty on account of the state of the atmosphere, but now they were brightly lighted so that anyone could read with comfort. The tunnel itself had also been equipped with electric light on both sides from end to end, so that anyone passing through it could see clearly where they were going. With regard to the train service, at the present time they undoubtedly provided the most speedy means of communication between the points served, and the comfort of the line generally could not, he thought, be surpassed. As regards the safety of the service—a matter which was paramount in connection with such a line—he believed it to be the safest means of transit in or about Liverpool or Birkenhead. It was too early yet to tabulate the figures or even to form a reliable estimate of what they would be under the new conditions. The accounts before them only represented two months' working from the commencement of the new undertaking; but, so far as the receipts were concerned, it was gratifying to find that the tide had turned. For years they had had a steady ebb of their receipts; but since the change there had been a steady flow. He did not, however, wish to mislead the shareholders by suggesting that they had reached anything like the result hoped for—a result to be of any value to the ordinary shareholders. As regards the working expenses, it was impossible from a few months' operations to arrive at any results which could be taken as an indication of what might be expected later on. Experience had satisfied the Board that electrical traction was undoubtedly the right method of working the railway, and they had every reason to believe that they would be rewarded by the results. Referring to the question of a connection between the Company's undertaking at the low-level station and the Cheshire Lines on the Liverpool side, he said that the Great Central Railway, which had had for about 18 years the power to construct such a connection, had in the course of this year applied to Parliament for a renewal of their powers. With this in view, the Board had obtained sanction to have inserted in the Bill special provision that, in the event of the line being constructed to connect the lines of the Cheshire Railways, it should be so constructed as to enable it to be worked by electricity—an important provision for the Mersey Company should the Great Central Company resolve to carry out their powers.

The report was unanimously adopted.

ELECTRIC RAILWAY AND TRAMWAY CARRIAGE WORKS.

The annual general meeting of the shareholders in this Company was held at Preston on Thursday last week, Mr. George Richardson presiding.

The **Chairman**, in moving the adoption of the report, said they had had a very fair year, and orders had been received from almost all parts of the world, including Buenos Ayres, Hong Kong, and Rhodesia, while at home orders were in hand from East Ham, Burnley, Colchester, Swindon, Leicester, Bolton, Birmingham, and Northampton, and other places. The works had been kept in a very efficient state. So far as the revenue account was concerned, the profits for the year amounted to £19,426. 18s. 7d. after paying debenture interest and charging £5,096. 3s 9d. to depreciation, the net profit thus being £16,594. 14s. 11d. The directors proposed to carry £2,000 to the general reserve fund, and to recommend a dividend of 8 per cent., less income tax, for the year, absorbing £12,000, and to carry forward £5,426. 18s. 7d. to the next year's account. This would make their reserve fund for depreciation on buildings, fixed plant, and machinery, £10,500, and the additional general reserve fund to £6,000. Since their works were opened on March 23, 1899, orders had been executed to the extent of £665,000. Referring to statements that negotiations had been entered into regarding the consolidation of the British electrical industry, and that Messrs. Dick, Kerr, and Co., who were

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intimately acquainted with the Electric Works, Limited, were at the head of the movement, the chairman said he had heard of no such negotiation. The Company was in no way connected with Messrs. Dick, Kerr, and Co. He denied everything leading people to think that the Company was entering into any combination. There was not a particle of truth in the statements published.

Alderman Copland seconded the motion, and it was adopted unanimously.

A vote of thanks to the directors, manager, and staff for their services during the year closed the proceedings.

DIRECT WEST INDIA CABLE.

The report of the directors for the year ended June 30 last states that the net result of the year's working is a profit of £1,430, as compared with £4,789 for the previous year. This reduction in the Company's income is chiefly due to the interference with traffic beyond Jamaica as the result of the recent decision in favour of the Cuba Submarine Telegraph Company in their suit with the West India and Panama Telegraph Company. An interim dividend of 3 per cent. has already be paid, and it is now proposed to make a further equal payment. The amount to the credit of revenue account is £30,612. Offers for the sale of debentures to the trustees were invited in December and June last, and £8,497 was paid for £8,500 of debentures, which amount has been written off capital expenditure.

CAPE TOWN CONSOLIDATED TRAMWAYS AND LAND.

The report of the directors for the period ended Dec. 31 last states that the final section of the Camps Bay Tramway Company, Limited (namely, the Kloof line) extending from the terminus of the Cape Town Tramway Company's system in Burnside-road down to Camps Bay, was opened on Nov. 10, 1902, thus completing the tramway system as originally designed. The total length of track now in operation is about 9½ miles, and while the directors look forward to a permanent increase in the traffic and receipts as the development in both the Oranjezicht Estates and the Cape Marine Suburbs proceeds, they have thought it advisable, during such period of development, to grant to the Cape Electric Tramways, Limited, a lease of this Company's tramways for three years from Jan. 1, 1903, on mutually advantageous terms. The profit and loss account shows a credit balance of £873.

NEW COMPANIES REGISTERED.

Hodge and Co., Limited.—Capital, £25,000. Objects: to adopt an agreement with A. E. Hodge and G. W. Elliott for the acquisition of the business of gas engineers and contractors, and chandelier, gas, and electric light fitting manufacturers, now carried on by them at 100, Hatton-garden, E.C.

Electro-Post Railway Company, Limited.—Capital, £100. Objects: to construct, repair, maintain, and operate installations, cables, wires, and other works of every kind for the generation, supply, distribution, and employment of electricity for motive power, lighting, heating, or other purposes

Tonyrefail and Gilfach Goch Electric Light Company, Limited.—Capital, £3,000. Objects: to carry on at Tonyrefail, Gilfach Goch, and elsewhere in Glamorgan, the business of an electric light company, electricians, mechanical and general engineers, suppliers of electricity for light, heat, motive power, or otherwise, etc. Registered office: 138, High-street, Tonyrefail.

Whitehead Electric Supply Company, Limited.—Capital of £10,000. Objects: to carry on the business of an electric light company at Whitehead, co. Antrim, and for adopting and carrying into effect an agreement between the National Electric Wiring Company, John McLaughlin, Alfred E. Wilson, Otto Weisener, and Alfred Hugh McKibbin. Registered office: 8, Garfield-street, Belfast.

CONTRACTS FOR ELECTRICAL SUPPLIES.

Luton.—The Guardians invite tenders for lighting the new tramp wards by electricity.

Manchester.—The Corporation require tenders for a 32-ton electric lift. Tenders by Oct. 5.

Macao.—The Colonial Office at Lisbon invite tenders for the electric lighting of Macao. Tenders by Oct. 21.

Lisbon.—The Public Works Department require tenders for the public electric lighting of Macao. Tenders by Oct. 21.

Paris.—The Post and Telegraph Department, 103, Rue de Grenelle, require switchboards for telegraph and telephone offices by 15th inst.

Bucharest.—The Government Railways require tenders for the installation of electric lighting and plant for their workshops. Tenders by Oct. 10.

Pietermaritzburg.—Tenders are invited by the Natal Government Railways Electrical Department for additional plant for the power station at Pietermaritzburg.

Dover.—Tenders are invited for an electrically swung bridge at the harbour. Tenders close in about 10 days. Particulars may be obtained from the Harbour Board.

Swansea.—The Corporation invite tenders for the supply, delivery, fixing, and connecting of ducts, troughs, cables, wires, street boxes, etc. Tenders by Oct. 31. See advertisement.

Leeds.—The City Council invite tenders for one or two complete sets of steam or electrically driven surface condensing plant. Tenders to Mr. W. J. Jeeves, town clerk, by 9 a.m. on Oct. 7.

Transvaal Colony.—The Chairman of the Tender Board, Pretoria, requires tenders for installing and working the electric lighting of Potchefstrom for about five years. Tenders by Oct. 30.

France.—The Prefect of the Isère requires tenders for laying and working two tramway lines, about 49 miles. Tenders by 15th inst Particulars may be obtained from the Prefecture of the Department.

London, N.E.—The Bethnal Green Borough Council invite tenders for clearing the site of proposed electricity works. Specification may be obtained from the Borough Surveyor. Tenders by 4 p.m. on 13th inst.

London.—The Directors of the Metropolitan Railway Company invite tenders for the erection of a repairing shed and shops for electric rolling-stock at Neasden. Specifications, etc., after 5th inst. Tenders by 19th inst.

Dublin.—The Port and Docks Board invite tenders for the supply of a 100-ton electric crane. Specification can be obtained at the office of the engineer to the Board, Mr. John P. Griffith, M.I.C.E., Eastwall, Dublin. Tenders by Oct. 5.

Blackpool.—The Corporation invite tenders for the supply of arc lamp carbons for the ensuing year. Specification, etc., may be obtained on application to Mr. Charles Furness, borough electrical and tramway engineer, Electricity Works, Blackpool.

Liverpool.—The Tramways Committee invite tenders for the supply of ticket punches from Jan. 1, 1904. Specification, etc., may be obtained from the General Manager, Corporation Tramways, 6, Sir Thomas-street. Tenders by 10 a.m. on 14th inst.

Gravesend.—The Town Council invite tenders for a generating set, pump and air compressor, etc., in connection with their electricity works. Particulars may be obtained of Mr. C. F. McInnes, A.M.I.E.E., Electricity Works. Tenders by 10 a.m. on 5th inst.

Manchester.—The Paving, Sewering, and Highways Committee invite tenders for laying underground telephone pipes, with other appurtenant works. Specification, etc., may be obtained at the City Surveyor's Office, Town Hall. Tenders to the Chairman by Oct. 8.

Grimsby.—The Corporation invite tenders for the electric lighting of the new buildings forming the extension of the police department. Specifications, etc., may be obtained from Mr. W. A. Vignoles, M.I.E.E., Electrical Works, Doughty-road. Tenders by noon on 2nd inst.

Shanghai.—The French Colony propose to instal motor-propelled tramways. Tenders may be sent by Oct. 31, 1903, to Secrétariat de la Municipalité Française de Shanghai. Particulars may be obtained from l'Office National du Commerce Extérieur, Rue Feydeau, 3, Paris.

Canterbury.—The Urban Sanitary Authority invite tenders for the supply of 2,220 yards of ·4 square inch t c/c cable. Specification may be obtained from the Engineer, Electricity Works, Canterbury. Tenders by 10th inst. to the Town Clerk, Burgate-street. See advertisement.

Russia.—The Russian Minister of the Interior has sanctioned a plan for the reconstruction of three lines of municipal tramways—namely, those in Newsky, Sadovaïa, and Wassiliostrow districts. Each car is to provide for two classes of travellers, and will accommodate 52 persons.

Salford.—The Tramways Committee invite tenders for the installation of electric light at their central car depôt in Frederick-road, Pendleton. Specifications and plans may be obtained from the General Manager, Tramway Offices, 32, Blackfriars-street. Tenders by 5 p.m. on 19th inst.

East Barnet.—The Urban District Council will receive proposals for carrying out the provisions of their electric lighting order within the Council's district. Further particulars upon application to Mr. Henry York, the Council's surveyor, Council Offices, Station-road, New Barnet. See advertisement.

Brighton.—The Town Council invite tenders for the (1) supply of steel girder tramrails, fishplates, etc.; (2) tramcars; (3) points and crossings and other fittings. Specifications, etc., may be obtained from Mr. Francis J. Tillstone, town clerk, Town Hall, Brighton Tenders by 10.30 a.m. on Oct. 5.

Barrow-in-Furness.—The Education Committee invite tenders for the electrical lighting of the chemical laboratory in the higher-grade school. Specification, etc., may be obtained on application to Mr. W. Hutchinson, secretary to the Education Committee, Town Hall. Tenders by 12 noon on 5th inst.

Great Western Railway.—The Directors invite tenders for about 90 tons of steel bridge girders and other steel and iron work of British manufacture. Specifications, etc., may be obtained at the office of the Engineer between the hours of 10 a.m. and 4 p.m. Tenders by Oct. 6 to Mr. G. K. Mills, Paddington Station, London.

London.—The Directors of the Metropolitan Railway Company invite tenders for the supply of electric lighting sundries and iron signal and telegraph wire and telegraph battery jars and zincs, G.P. wire, etc., during 12 months ending Oct. 31, 1904. Forms of application on and after 5th inst. Tenders by 10th inst.

Johannesburg.—The Municipality require tenders for gas generating plant or for steam generating plant and for gas motors or steam motors, with electric generators and accessories. Particulars may be obtained from the Town Clerk, Johannesburg, or from Messrs. Mordey and Dawbarn, 82, Victoria-street. Tenders by Oct. 19.

Manchester.—The Tramways Committee invite tenders for the supply of a car-wheel grinding machine, radial-arm drilling machine,

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planing machine, gap lathe, and other machine tools. Specifications, etc., may be obtained from Mr. J. M. M'Elroy, general manager, Tramways Department, 55, Piccadilly, Manchester. Tenders by 10 a.m. on Oct. 6.

London, N.—The Shoreditch Borough Council invite tenders for pulling down and rebuilding 3, Hoxton-square, N., to be used as stores for the electricity department. Specification, etc., may be inspected and bills of quantities obtained at the office of Mr. J. Rush Dixon, A.M.I.C.E. Tenders to the Town Clerk's Office, Town Hall, Old-street, E.C., by Oct 6.

Swansea.—The Corporation invite tenders for (1) laying of permanent way, including rail bonding; (2) rails and fishplates; (3) steel tiebars, bolts, and nuts; (4) points, crossings, cast-steel curved rails, and special work; (A) overhead electrical equipment; (B) ducts, troughs, cables, wires, section and other boxes, etc. Tenders by Oct. 31. See advertisement in last issue.

King's Norton and Northfield.—The Urban District Council invite tenders for the overhead construction of about three miles of electric tramway. Specifications, etc., can be obtained from the Council's engineer and surveyor, Mr. A. W. Cross, 23, Valentine-road, King's Heath; or Mr. J. H. Gadsby, 20, Victoria-street, Westminster, S.W. Tenders by 12 noon on 10th inst.

London, S.E.—The London County Council invite tenders for the supply, delivery, and erection in the electricity generating station to be established by the Council at Greenwich of four 5,000-h.p. vertical-horizontal steam-engines, each suitable for driving a three-phase generator. Particulars, etc., may be obtained at the County Hall, Spring-gardens, S.W. Tenders by 10 a.m. on Oct. 6.

London, W.C.—The Directors of the Savoy Hotel, London, invite tenders for the purchase of two Lancashire and two Cornish boilers, working pressure 150lb.; at present in use in connection with the electric lighting and heating of the Savoy Hotel. Further particulars can be obtained at the offices of the engineers, Kincaid, Waller, Manville, and Dawson, 29, Great George-street, Westminster.

Salford.—The Tramways Committee invite tenders for the supply and delivery of planing, turning, boring, drilling, grinding, milling, screwing, punching, and shearing, and wood-working machinery, power hammer, shafting motors, etc., at their central car depôt, Frederick-road, Pendleton. Specifications, etc., can be obtained from the General Manager, 32, Blackfriars-street, Salford. Tenders by Oct. 19.

Oldham.—The Electricity Committee invite tenders for arc and incandescent lighting and power circuits in Greenhill station, comprised in specification No. 9. Copies of the specification, etc., can be obtained from the Resident Engineer. Specifications can be seen at the offices of Messrs. Kennedy and Jenkin, 17, Victoria-street, Westminster, S.W. Tenders to be sent to the resident engineer, Mr. S. Wilmott Newington, by Oct. 6.

Birkenhead.—The Education Committee invite tenders for the wiring of the Laird School of Art in Park-road for electric light, and for extensions to the electric light wiring of the Holt School of Science and Art. Plans can be seen and specifications, etc., obtained on application to the borough electrical engineer, Mr. William Bates, A.M.I.C.E., Electrical Engineer's Office, Craven-street. Tenders to reach Mr. Robert T. Jones, secretary, Education Department, Town Hall, by 9 a.m. on Oct. 9

Harrismith (South Africa).—The Town Council invite tenders for the following electrical machinery and accessories f.o.b. and alternatively erected in Harrismith, Orange River Colony, South Africa: two water-tube boilers and one 25-kw and two 80-kw. steam alternators, with ejector condensers, switchboards, pipework, and other accessories. Specifications, etc., may be seen and obtained at the offices of Messrs. Mordey and Dawbarn, 82, Victoria-street, Westminster, S.W. Tenders to Messrs. Webster, Steel, and Co., 5, East-India-avenue, Leadenhall-street, London, E.C., by noon on 19th inst.

Great Western Railway.—The Directors invite tenders for the supply of telegraph instruments, telegraph apparatus, copper wire, G.P wire, etc., telegraph ironwork and tools, telegraph drysalteries, electric light carbons, incandescent electric lamps, iron rivets, bolts and nuts, etc., fishplates, and bolts and nuts for permanent way, and telegraph poles and yellow pines, etc., from Dec. 1 next to Nov. 30, 1904. Samples, etc., may be seen from 6th to 15th inst., at the office of the Stores Superintendent, Swindon. Specifications, etc., may be obtained at the office of the Stores Superintendent. Tenders by 19th inst. to Mr. G. K. Mills, secretary, Paddington Station, London. See advertisement.

RESULTS OF TENDERS.

Tynemouth.—The contract for the storage battery has been placed by the Corporation with the Electrical Power Storage Company, Limited.

Metropolitan Electric Supply Company.—The company have placed an order with Messrs. Dick, Kerr, and Co., Limited, for eight 500-kw. motor-generators.

Bexhill.—The tender of Messrs. Babcock and Wilcox, at £528. 7s., for pipework in connection with the new boiler for the electric light works has been accepted.

West Bromwich.—The tender of the British Insulated and Helsby Cables, Limited, in connection with the street-lighting scheme is recommended for acceptance.

Preston.—The Town Council have accepted the tender of Messrs. Thos. Croft and Sons, Limited, for the erection of a chimney stack at the electrical power station for £911.

Aberdeen.—The tender of Mr. James Leith, jun., amounting to £825, has been accepted for the making of the extension of the tramway line from Whinhill-road to Holburn-street.

Sunderland.—The order for the storage battery for Ryhope Asylum has been placed with the Electrical Power Storage Company.

Brighton.—The Electrical Power Storage Company, Limited, of 4, Great Winchester-street, London, E.C., have received the order from the Corporation for the extension of their storage battery.

Aberdeen.—The tender of the Clyde Structural Iron Company, Clydeside Ironworks, Glasgow, has been accepted for the ironwork in connection with the new car-sheds and workshops at Dee Village.

Bath.—The Town Council have accepted the tender of Messrs. J. G. Statter and Co., at £1,544, for extension of switchgear, subject to the provision of circuit breakers of the British Thomson-Houston make.

Manchester.—Edgar Allen and Co., Limited, have received another contract from the Corporation for the supply of their cast-steel points and crossings fitted with hardened cast-steel renewable centres for the tramways.

Aston Manor.—The Council have accepted the tender of Messrs. Johnson and Phillips, Old Charlton, for motors of the following b.h.p:—enclosed: 50, 75, 100, 150, 200, 250, 300; semi-enclosed, 150, 200, 250, 300; open, 250.

Carlisle.—Messrs. Hemingway and Pitt, of Richmond and Victoria-street, S.W., have secured the order for the electric lighting of the County and Station Hotel. Upwards of 500 lights are being installed, complete with all fittings. This same firm are also carrying out the lighting of the additional buildings at Richmond Union Infirmary, and the lighting of Weir Bank, Teddington, for Mr. W. H. Phillips.

St. Pancras.—The Borough Council at their last meeting, against the recommendation of their Electricity Committee, accepted a tender of the Western Electric Company at £6,683 for 56,100 yards of electric cables, although it was £700 more than a tender received from a German firm. It was urged that the money would be spent largely in wages for British workmen, and that the conditions which handicapped the British as against the foreign manufacturer should not be allowed to operate to the former's disadvantage.

Whitechapel Union.—The following tenders for the installation of the electric light in a section of the infirmary have been referred to the Electrical Standardisation Institution for report:

J. Defries and Sons, Limited, 146 and 147, Houndsditch, E.C.	£126	10	0
Cecil Cooper and Co., 14, Gloucester-road, Kensington	193	10	0
P. H. Allin and Sons, 50, Burleigh-street, Cambridge	157	0	0
Cairns and Co., 91, Queen Victoria-street, E.C.	147	0	0
J. Bakewell and Co., 46, King William-street, E.C.	120	10	0
Ward Bros., Bevois House, 28A, Basinghall-street, E.C.	165	0	0
Peplar and Keats, 12, Market-place, Alexandra-street, Southend	102	16	0
Brush Electrical Engineering Company, Victoria Works, Belvedere-road, S.E	260	0	0
Smeeton and Page, 63, Queen Victoria-street, E.C.	151	0	0
Simmonds Bros., Limited, 4, 6, and 8, Newton-street, High Holborn	199	0	0
C. E. Zimdars, 327, Gray's-inn-road, W.C.	150	0	0
F. J. Coleby and Co., 7, Thayer-street, Manchester-square, W.	165	0	0
Thompson Bros. and Co., 44, Old Town-street, Plymouth	200	10	0
E. F. Heath, Sanders, and Co, 47, Dawes-road, Fulham, S.W.	200	0	0
Mercer, Rance, and Co., 166, Iverson-road, West Hampstead	163	3	6
Fothergill and Co., Limited, 53, Victoria-street, Westminster	235	0	0
J. Richmond and Co., Limited, 30, Kirby-street, Hatton-garden, E.C.	228	10	0
Sherman, Redfern, and Muston, 16 and 17, Devonshire-square, E.C.	217	0	0
Société Gramme, 144, Gray's-inn-road, W.C.	123	13	0
W. C. Martin and Co., 116, Victoria Dock-road, E.	165	0	0
F. Troy and Co., 194-6, Finchley-road, South Hampstead, N.W.	180	0	0
Whittaker Bros., Limited, 204, Wolverhampton-street, Dudley	135	0	0
Electric Motor Supply Company, 54, Hound's-gate, Nottingham	159	0	0
A. H. Marshall and Co., 270, High-road, Leytonstone, E.	370	0	0
H. F. Joel and Co. and T. Potter and Sons, 44, South Molton-street, W.	143	0	0
Hubber and Son, South-street, Exeter	153	0	0
May and Calder, 4, Newington-causeway, S.E.	172	5	6
Watkin Bros., Limited, West Bridge Works, Northampton	131	17	3
Bromley and Batstone, Buchanan-buildings, Holborn, E.C.	166	0	0
W. G. Murrin, 111, Aslett-street, Wandsworth	240	0	0
R. H. and J. Pearson, Limited, 141-145, High-street, Notting Hill gate	174	0	0
J. Wilson, Ferrier Works, North-street, Wandsworth	185	5	0
Dudley Electrical Company, 53, High-street, Dudley	155	0	0
W. S. Wilson, 18, Derby-road, Watford	116	0	0
Wells and Co., 56, Paddington-street, W.	163	0	0
H. J. Rider and Co., 27, Chancery-lane, W.C.	162	10	0
J. E. Spagnoletti and Co., Goldhawk-road, W.	173	0	0
Jackson Bros., The Laurels, Broadway, Plaistow, E.	198	18	0
Nunn, Watts, and Co., 82, Mark-lane, E.C.	183	0	0
J. A. M. Smeaton, 25, Victoria-street, S.W.	112	0	0
Smith and Holeman, 97, High-street, Peckham, S.E.	125	0	0
W. Mackie and Co., 122 and 124, Golden-lane, E.C.	192	17	0
H. E. Flood, 96, Geldeston-road, Clapton, N.E.	188	5	6
Johnson Bros., 168, Whitechapel-road, N.E.	215	0	0
Humphrey, Woodger, and Co., 45, Purves-road, Kensal Rise, N.W.	276	11	0
D. Assersohn, 20, Commercial-street, E.	167	0	0

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Holyhead.—The Urban District Council have accepted the following tenders for works and plant for electric lighting: National Electric Construction Company, plant, mains, etc., £7,000; Meldrum Bros., Manchester, destructor, boiler, etc. £3,333, buildings and steam mill £3,000, erection of chimney £617, alterations to buildings, £290.

Derby.—Edgar Allen and Co., Limited, who recently took over the business of Askham Bros. and Wilson, Limited, have secured through the contractors (Messrs. J. G. White and Co., Limited) the contract for the supply of cast-steel points with renewable centres of their imperial manganese steel and iron-bound crossings of the latest American type with renewable centres, also in their manganese steel, for the Corporation tramways.

Wellington (N.Z.).—The Corporation have accepted the tender of Macartney, M'Elroy, and Co., Limited, for the new tramways, less the power-house, at £113,883. 19s. 7d., and that of the Electric Construction Company, Limited, at £26,956. 17s., being £24,611. 19s. for supplies and £2,345 for erection of power-house. The sub-contractors to these contracts are: permanent-way section — rails, MacLellan and Co., Glasgow; special work, Hadfields, Sheffield; overhead material, made specially for Macartney-M'Elroy; poles, Stewarts and Lloyds; brakes, Westinghouse Company; cars, British Electric Car Company; wire, J. A. Roehlings and Co.; cables and conduits, Callender's Cable and Construction Company; trucks, Brill and Co.; motors, General Electric Company. The power-house section—crane, Jessop and Appleby Bros.; steam-engines, Belliss and Morcom; dynamos and motors, the contractors, Electric Construction Company; condensers, Korting and Co.; feed-pumps, Weir and Co.; economisers, Green and Co.; superheaters, Easton and Co.; mechanical stokers, Erith's Underfeed Stoker Company; boilers, Daniel Adamson and Co.; coal-handling plant, New Conveyor Company; switchboard, the contractors, Electric Construction Company; steam piping, Aiton and Co. Six tenders were received for the contracts in globo, and were as follows: Dick, Kerr, and Co., £170,560. 11s. 10d.; Blackwell and Co., £159,444. 2s. 1d.; British Westinghouse Company, £157,054. 11s.; Brush Manufacturing Company, £165,984. 10s. 8d.; White and Co., £153,918. 4s. 3d.; Macartney, M'Elroy, and Co., £147,436. 5s. 5d. In all 77 tenders were submitted.

BUSINESS NOTES.

LIGHTING AND GENERAL.

Fochriw.—The Postmaster-General has been petitioned for a local telegraph service.

West Bromwich.—Application is to be made for sanction to borrow £1,000 for electric street-lighting.

Stourbridge.—An electric lighting installation is to be provided at the workhouse at a cost of £2,700.

Radstock.—The Urban District Council have decided to apply for an electricity supply provisional order.

Reading.—The important question as to how the streets are to be lighted in the future is still undecided.

Hackney.—Two extensions of electric lighting mains are to be made at a cost of £95 and £100 respectively.

Southgate.—Application is to be made by the Urban District Council for an electric supply provisional order.

Hebburn.—A number of large arc lamps have now been erected in Hebburn New Town, and are lighted each night.

Aston Manor.—The Urban District Council's electric power and lighting station was formally opened on Tuesday.

St. Marylebone.—An application from Post Office authorities to lay telephone wire pipes, etc., in various streets of the borough has been agreed to.

Dartford.—The Guardians have now decided to light administrative buildings to be erected as an extension to the present workhouse by electricity.

Dundee Asylum.—Mr. Richardson, the city electrical engineer, has been asked to report regarding the supply of electric light for the asylum from the town's mains.

Perth.—The question of the street-lighting will shortly be discussed by the Perth Town Council. This year there is an increase of £500, owing principally to a large increase in the number of lamps.

Brighton.—The municipal telephone service will start with 1,200 subscribers, being double the number fixed by experts as the minimum requisite before the project was launched. Further applications are coming in daily.

Dublin.—The formal opening of the new electric lighting system will take place this month. The transfer to the new Pigeon House station was made a week ago, and the whole 180 arc lamps were connected without a hitch.

Kingston.—The infirmary sub-committee who were appointed to go into the subject of electric lighting have been asked to submit their report as quickly as possible, and £1,000 or £1,100 will probably be wanted for extending electric lighting.

Gravesend.—The resident electrical engineer in his last report estimates further sums required in connection with electricity and dust destroying, which, with amounts contemplated by the Electric Committee, and contingencies, amount to £5,100.

Whitehead.—The National Electric Wiring Company have completed their preliminary arrangements for lighting the town, and a prospectus is to be issued almost immediately. It is expected that the whole of the work will be completed within three months.

Wireless Telegraphy.—So numerous have been the instances in coastwise navigation in America during the past year of the breaking away of barges from their tugs, that one of the large towing companies has decided to equip the tugs with a wireless telegraph system.

Stock Exchange.—The Stock Exchange Committee have appointed Oct. 7 special settling day for Bournemouth and Poole Electricity Supply Company's provisional certificates (fully and partly paid) for a further issue of 4,500 ordinary shares of £10 each, Nos. 22,501 to 27,000.

Littlehampton.—At Wednesday's meeting of the ratepayers' association the chairman introduced the subject of the introduction of the electric light into the town for discussion. The meeting decided that it would be to the advantage of the town if a company were introduced.

Dundee.—The Town Council some time ago decided to lay out £15,000 on new electric cables and £10,000 on engines, dynamos, and work in the station, while a considerable sum is required to cover expenditure already incurred. It is therefore considered necessary to go to Parliament to get additional borrowing powers, probably to the extent of £70,000.

Anglo-American Telegraph Co.—The directors have resolved, after placing £6,000 to the credit of the renewal fund, to declare an interim dividend for the quarter ending Sept. 30 of 15s. per cent. on the ordinary stock and £1. 10s. per cent. on the preferred stock, less income tax, payable on Nov. 2 to the stockholders registered on the books on Sept. 30.

Islington.—In order to encourage an increased day load, the Electricity Committee recommend the adoption of the following sliding scale in the case of all electricity for motor power purposes consumed between midnight and 6 p.m.: for all units up to 2,000, 2d. per unit; from 2,000 to 20,000, 1½d. per unit; and from 20,000 and over, 1½d. per unit.

Removals.—Messrs. Edward Le Bas and Co., iron, steel, and metal merchants, have removed to Dock House, Billiter-street, E.C. The telephone numbers and telegraphic address of the firm will remain as before. Messrs. Englebert and Co., lubricant manufacturers, 44 to 47, Bishopsgate-street, E.C., have removed to 119-125, Finsbury-pavement, London, E.C.

London-Paris Telephone.—It is rumoured that arrangements are being completed whereby it will shortly be possible to obtain the use of the telephone between London and Paris during the night at half the present rates—*i.e.*, at 4s. per conversation of three minutes—provided that a monthly subscription be taken for a period of not less than six minutes per night.

Bourne.—The Post Office telephone system is being installed in the town, and will soon be ready for operations. Already the necessary posts for overhead wires have been erected in that part of the town which the trunk line did not serve, and additional wires have been put on the trunk lines. There are over 20 subscribers for the service, which will be ready almost immediately.

Abercanaid.—A fire occurred early on Tuesday in the electrical engine-house of the Hills Plymouth Company at Abercanaid. The loss is estimated at about £1,000. Besides an engine for electric lighting, the building contained a pumping engine, which was not irretrievably ruined, but seven motors, one generator, some expensive belting, and various adjuncts were totally destroyed.

Maidstone.—The Electricity Committee, in the last report, recommend that a flat rate of 4½d. per unit be charged for the lighting of all public buildings, and that an average flat rate of 4½d. per unit be charged for all premises where residences and shops are combined, and that they be empowered to expend the sum of £500 for purchasing motors to let out on hire. The matter has been referred to the Finance Committee.

Macclesfield.—The Electricity Committee have been considering schemes for supplying the borough with electricity, submitted by Messrs. Enright and Co., Messrs. Crompton and Co., and the British Westinghouse Electric and Manufacturing Company. The first scheme is estimated at £26,000, the second £16,000, and the third £32,000. At their last meeting the committee decided to recommend Messrs. Crompton's scheme for acceptance.

Hamilton.—The electric light was formally inaugurated on Tuesday in the principal streets. Provost Keith switched on the new lights, 66 in number, of the Bremner pattern. Provost Keith was presented with the bronze switch with which he turned on the new light, and, along with Mr. Meechan, convener of the Electric Committee, with gold-mounted switches, suitably inscribed, as mementoes of their services in switching on the temporary supply in February last.

Wolverhampton.—The members of the Wolverhampton Trades Council last week paid a visit to the municipal electric light and power station, where they were shown round by Messrs. Howie and Vickers (assistant engineers), Smith (main superintendent), Creasey (assistant main superintendent), Jones (draughtsman), Stubbs (assistant draughtsman), and Dudley (station superintendent). Afterwards refreshments were provided by Councillor Gough Allen.

Leicester.—The electric lighting accounts for the half-year ended June 30 show a net profit, after paying interest on the capital of the undertaking, of £3,847. 6s. Out of this has been paid £2,545. 10s. 1d., the half-year's amount of sinking fund, leaving a balance of £1,301. 15s. 11d. The extension of the electric lighting station at the Aylestone-road works has been completed. Leicester's municipal water, gas, and electric departments show a joint profit of £38,000 on the working of the past half-year.

Swansea.—We are informed that the difficulty which arose some time ago in connection with the scheme for erecting an electrical organ in St. Mary's Parish Church is now practically settled, and Messrs. Norman and Beard are proceeding with the work. The surveyor has

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prepared a report on the lighting of the boundaries of the borough, showing that 106 new lamps would be required, which would cost £318 and an expenditure of £304 a year. The matter has been deferred till the next half-year's estimates are brought forward.

Greenock.—At Wednesday's meeting of the Parish Council a discussion took place on a proposal that Smithston Asylum and Poorhouse should be lighted with electricity. The sub-committee agreed to ask the Corporation to forego the guarantee of a minimum payment of £300 per annum for 10 years on the understanding that the Parish Council would not generate electricity at Smithston for lighting purposes, nor receive it from any other source during the same period. It was agreed by the Council to hold the matter over for a month.

Agencies.—Messrs. James T. Donald and Co., Limited, engineers and steel merchants, 35, McAlpine-street, Glasgow, have been appointed as the Bell Rock Belting Company's sole agents for Scotland, and will keep large stocks of the company's various kinds of belting. Thomas Parker, Limited, electrical engineers and contractors, of Wolverhampton, have appointed Mr. Haley Hodgson, M.I.Mech.E., their representative for the city of London and district. The offices are at Mansion House-chambers, 20, Bucklersbury, Queen Victoria-street, London, E.C.

Wallasey.—The electricity works capital account shows an expenditure up to March, 1902, of £54,636, increased during the year to £63,179. Of this amount, £3,613 was repaid formerly, and another £1,784 during the year, leaving a total of £57,780. The year closed with £16.074 to the credit of the capital account. The year's revenue was £14 328, and expenditure, including £500 for depreciation and renewals, £8,478, leaving a surplus of £5,849. Of this sum, £1,698 went in interest and £1,784 in loan repayments, leaving a net profit of £2,336 in favour of the district fund account.

Luton.—The electrical engineer in his last report, stated that from July 23 to Sept. 11, 1903, 13,378 units had been generated; that an equivalent to 311 8-c.p. lamps and three motors of 6 h.p. had been connected, making a total of 117 consumers with 8,087 lamps and 24 motors of 70 h.p.; that the units generated showed an increase of 71 per cent. over the corresponding period of last year; and that over 745 lamps and five motors were now being wired. The electric light is to be installed in the new tramp wards now in course of erection, and an estimate obtained for an installation throughout the infirmary.

Para Rubber.—This year's harvest of rubber, which closed June 30, is estimated at 29,890 tons. This is only 108 tons less than that of the year 1901-2, which holds the record. Of this amount 15,261 tons went to Europe and 14,566 tons to America. As compared with last year this shows a decrease of over 500 tons in the exports to Europe and a corresponding increase in those to America. From the port of Manaos 16,600,000lb. went to Europe and 18,400,000lb. to the U.S.A. The corresponding figures for Para were 13,400,000 and 1,360,000; 3,500,000lb. went to Europe from Iquitos. The stock on June 30 amounted to 129 tons, and a large increase in the exploitation of forests is expected.

Cardiff.—At the last meeting of the General Purposes Committee of the Corporation the Chairman of the Electric Lighting Committee said that the net contributions from the rates to his committee had been reduced to £1,818. The revenue balance on March 31, 1903, was £3,073, less £771 appropriated in aid of the rates and £995 instalments on loan fund account. There was consequently a net balance of £1,306. The loans repaid to the same period amounted to £11,042, and there was a reserve fund of £500. The summary of profit and loss account for the last five years was as follows: to March, 1899, loss, £1,067; 1900, loss, £1,794; 1901, profit, £9. 15s. 3d.; 1902. £1,117. 11s. 4d.; 1903, £3,648. The credit balance on the five years yas, therefore, over £1,913.

Wrexham.—The Town Council on Tuesday approved a scheme of extending the electric cables for increased public and private lighting, and instructed the electrical engineer to prepare a statement as to the approximate cost. It was proposed to place 41 arc, 6 Nernst, and 7 incandescent lamps in the principal streets of the town, and to take away 10 Bray and 117 ordinary lamps. The cable will be laid solid in wood casing, and the centre of the town will not be disturbed, as there are plenty of spare ways under the present cables which will be utilised as far as possible. The candle-power of the present lamps is 2,372, but the proposed new arc, Nernst, and incandescent lamps will have a candle-power of 83,615. The total current outlay for lighting is estimated at £932 as against £752 at present. Considerable additional consumption from private persons is expected.

Hammersmith.—Mr. G. Gilbert Bell in his last report draws attention to the fact that the provision of a complete arrangement for using the River Thames water for condensing purposes at the generating station, already referred to by us, and the extension of the supply mains to the northern portion of the borough, have been set to work. A new sub-station has been built in order to supply the King's Theatre. The number of new consumers connected is 234, being an increase of 238 in the number connected during the previous year, and making a total of 1,224 consumers connected at the end of the year. The average number of lamps per consumer is now 48 8 c.p., which shows a steady decrease, proving that most of the large consumers are now connected, and that new business is obtained from private houses. The number of units sold to consumers shows an increase of 277,586 over the previous year, and the maximum demand upon the works has increased by 144 kw. to 1,320 kw.

London Gazette.—A receiving order has been made out in the estate of Thomas Williams, electrical engineer, 54, Bridge-street, Llandaff, lately residing at 13, Despenser-street, Cardiff, Glamorgan. A general meeting of the South Shields Electrical Engineering Company, Limited, will be held at the offices of Messrs. Strachan and Co, 18, Grainger-street West, Newcastle-on-Tyne, on Oct. 30, at 4 p.m., to receive the liquidator's report, showing how the winding-up of the company has been conducted and its property disposed of, to hear any explanation that may be given by the liquidator. A general meeting of the London United Tramways, Limited (in liquidation), will be held at Clare-street House, Bristol, on Oct. 30, 1903, at 12 noon, for the purpose of having laid before the meeting the account of the liquidator, showing the manner in which the winding-up has been conducted and the property of the company disposed of, and of hearing an explanation thereof given by the liquidator.

Keighley.—Last year's accounts show that the consumers have grown from 92 to 133, and the number of units sold from 90,000 to 137,000, or an increase of 50 per cent. The cost of coal was less than the previous year, although nearly half as much more electricity has been sold. There is a steady increase in the quantity of coal consumed—viz., 1901-2, 732 tons; 1902-3, 750 tons—but the price averaged for the previous year 7s. 6d., and for the year under review only 7s. 2d.; 51 per cent. more electricity was sold, but only 2½ per cent. more coal was consumed. The loss of £461 last year has been converted, on working expenses only, into a profit of £168, so that the result of the working was £620 better than the previous year. The interest and sinking fund brought up the total cost per unit to 7·39. The average price obtained has been 3·66, so that, practically, every unit of electricity sold is sold at about half its actual cost, but with a steady increase in the sale of current this loss will be gradually converted into an actual profit.

Portsmouth.—At the conclusion of Monday's enquiry into the Town Council's application for sanction to borrow £12,000 for telephone extensions, Mr. H. Percy Boulnois asked the town clerk (Mr. A. Hellard) to furnish him with a statement of accounts regarding the working of the Corporation telephones since March 31. The accounts of the undertaking from March 31 to June 30 show a profit on the working of the municipal exchange, after charging interest and sinking fund, on the capital of £25,500, the amount originally sanctioned by the Local Government Board. It was explained to the inspector that only from April 1 have the Corporation began to give an effective exchange, and further it was stated the loss on terminals would not reach £50 at the present rate, whereas Mr. Robb stated that it would be nearer £150 than £100. The delay in the publication of the borough accounts is explained by the amount of work entailed in the auditing, printing, and revising. The accounts occupy about 220 pages, and have been in the hands of the printer for a month. Their publication is not expected for at least a fortnight. The accounts up to March 31, which, however, only included one month's actual working of the municipal telephones, and which were handed round at the enquiry, show that there was a balance to the committee's credit of £25. 14s. 10d. The capital expenditure was £19,876. 17s. 3d., and at the end of the month there was £5,623. 2s. 9d. in hand of the £25,500 loan sanctioned.

Iron and Steel Institute.—It will be remembered that at the conclusion of the general meeting at Barrow-in-Furness, Mr. Charles Kirchhoff, of New York, tendered, on behalf of the American members of the Iron and Steel Institute, an invitation to the institute to hold its next autumn meeting in New York. This invitation, which was endorsed by the American Institute of Mining Engineers, the American Society of Mechanical Engineers, the American Institute of Electrical Engineers, the Franklin Institute, and the American Foundrymen's Association, was, on the motion of the president, accepted by the general meeting with acclamation. It is proposed that the autumn meeting shall take place in New York on Oct. 24, 25, and 26, 1904. After the meeting there will be an excursion to Philadelphia, Washington, Pittsburgh, Cleveland, Niagara Falls, and Buffalo, returning to New York on Nov. 10. During the trip night travelling will be avoided, and every endeavour will be made to obviate fatigue. The two Sundays will be spent at Washington and at Niagara Falls. The approximate cost of the stay in the United States is estimated at £25. For the convenience of members desirous of visiting the St. Louis Exhibition, arrangements will be made for a limited number to leave Pittsburgh for St. Louis and Chicago, reaching New York on the evening of Nov. 10. This trip will necessitate three nights being spent in sleeping cars, and the approximate cost will be £35. In order to carry on negotiations with the principal steamship companies so as to obtain for members the advantages of reduced rates, the secretary, Mr. Bennett H. Brough, asks to be informed as soon as possible as to the probable number of members who propose attending the meeting.

Motherwell.—Mr. S. E. Britton, in his last report, states: "During the past financial year the number of consumers connected is 74, making a total of 164, being an increase of 82 per cent. The applications made during the year are equal to 12,915 8-c p. lamps, making the total connections 23,209, an increase of 125 per cent. The number of units sold is 291,247, an increase of 124,387. The consumption of light has increased 48 per cent., power 830 per cent., public lighting 13 per cent., which is an average increase of 74·5 per cent. The total cost of producing the energy sold is £1,548. 12s. 5d., or 1·28d. per unit, and is, as compared with the previous year, an increased expenditure of £543. 13s. 2d., and a decrease per unit sold of ·17d. per unit—that is, the cost per unit sold is 13 per cent. lower than the previous year. The cost of attending, repairs, and renewals to public lamps is £234. 9s., as against £343. 4s. 6d. the previous year; the decrease of £108. 15s. 6d. is due to the system of grouping incandescent street lamps. The total expenditure, therefore, is £1,783. 1s. 5d., an increase over the previous year of £434. 17s. 7d. The income from private lighting is £1,467. 15s. 4d.; power, £589. 17s. 11d.; hire of motor and sundry receipts, £276. 0s. 2d.; public lighting, £2,001. 12s.; a total income from all sources of £4,335. 5s. 5d., an increase of 41 per cent. This is highly satisfactory, considering that the prices charged for private lighting and power were 20 and 25 per cent. lower than the previous year. The income provides a gross profit of £2,552. 4s., to which is to be added £12. 14s. (bank interest on deposit), making a total of £2,564. 18s. to meet interest on loans

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and sinking fund charges. The interest on loans amounts to £1,298. 10s. 1d., and the sinking fund £1,100, together a total of £2,398. 10s. 1d.: this amount, deducted from the gross profit, leaves a net profit of £166. 7s. 11d. From these figures I hope the committee will clearly see the rapid strides the undertaking has made. It is satisfactory to note that, although the charges for private lighting and power were considerably lower than the previous year, the income is still more than enough to meet all charges against the revenue account. The financial result of this second year is such as should enable the Town Council to reduce the charges for light and power. I recommend that for private lighting the charge be reduced from 4d. to 3½d. per unit, small and intermittent users of power remain at 2d., and larger consumers of power be charged on a sliding scale—namely, 1½d. for the first 5,000 units per quarter, 1¼d. for the second 5,000 units per quarter, and 1d. per unit for any further quantity per quarter." Mr. Britton's recommendation has been adopted by the Motherwell Town Council, and the prices are now 3½d. per unit for light and 2d. to 1d. per unit for power.

TRACTION.

Ipswich.—The Town Council have decided to run a service of cars on Sundays.

Rowley.—The District Council are taking steps for obtaining a loan for tramway purposes.

Uxbridge.—The time for completing the tramway to Uxbridge has been extended to April, 1904.

Luton.—A special meeting of the Town Council is to be held to consider the tramway question.

Connah's Quay.—The Urban District Council are supporting the scheme for a light railway in this district.

Maidstone.—Tenders will be shortly invited by the Urban District Council for carrying out the whole work connected with the proposed light railway.

Birmingham.—A Birmingham correspondent informs us that Mr. Baker has arrived in the city to take up his duties as tramway manager to the Corporation.

Pwllheli.—The Town Council are going to oppose the light railway scheme at the enquiry owing to the refusal of the promoters to divert the route so as to avoid Ala-road.

Bexley.—The new electric tramway, six miles in length, from Plumstead to Bexley, was last week examined by the Board of Trade officials, and was opened to the public yesterday (Thursday).

Kirkcaldy.—The extension of the tramway system is being vigorously pushed forward. The extension will provide a circular route, with the addition of a line running west to the public park.

Sunderland.—A new car-shed and repairing shops were formally opened by the chairman of the Tramways Committee on Wednesday. The buildings have cost over £14,000, and taken two years to build.

Perth.—At a meeting of the Town Council on Monday a committee was appointed to carry out the reconstruction of the tramways for electric traction and to take steps to appoint an engineer to advise them.

Croydon.—Memorials were presented to the Town Council at their last meeting and referred to committee for consideration urging the extension of the tramways to the borough boundary at Upper Norwood.

Calcutta Tramways Co.—The directors of the Calcutta Tramways Company, Limited, have declared an interim dividend of 2s. 6d. per share (being at the rate of 5 per cent. per annum) for the half-year ended June 30 last.

Electro-Pneumatic Signalling.—The Lancashire and Yorkshire Railway Company are introducing the Westinghouse electro-pneumatic system of signalling at the new station which is now approaching completion at Bolton.

Torquay.—The Town Council, who propose to adopt the Dolter surface-contact system owing to the narrowness of the streets and their consequent unsuitability for the overhead trolley system, have appointed a committee to confer with the company's representatives.

Altrincham.—The tramway question was discussed at a ratepayers' meeting last week with reference to a proposal to obtain a provisional order for a tramway to connect Altrincham with the southern tramways line at West Timperley. A poll is to be taken on the question.

Bradford.—The question of the amalgamation of the Tramways and the Electricity Committee has been considered by a special committee appointed for the purpose. Opinion was very evenly divided, and on the committee dividing the resolution to amalgamate was lost by one vote.

Southampton.—The Board of Trade have sanctioned the new piece of tramway from Portswood depôt to the borough boundary. A sub-committee has been empowered to purchase a quantity of curve rails for the tramways, and the borough engineer is to make a report on the matter.

London Tramway Employees.—Arrangements have been made by the London Central Council of the Social Democratic Federation for a meeting of the employés of the London United Tramways with the object of "resisting the tyranny of your employers and improving your conditions of labour."

Macclesfield.—At the last meeting of the Council a letter was read from Messrs. Ashwell and Tutin, of Nottingham, with regard to their renewed tramway proposals, and the town clerk was directed in reply to ask them to first satisfy the County Council with regard to their scheme, and then approach the committee.

Heywood.—At a special meeting of the Town Council it was decided to give notice to the Bury, Rochdale, and Oldham Steam Tramway Company to sell all the tramways belonging to them in the Heywood borough to the Corporation. It is proposed to convert the system to electrical working when municipalised.

Birkenshaw.—The tramway to Birkenshaw in connection with the Bradford city system has now been completed to the Half Way House, Birkenshaw, and a trial trip was run over it this week. The line, which is 1 mile 654 yards in length, leaves the main tramway to Tong at the junction of the Drighlington and Birkenshaw roads.

Scarborough.—The work of constructing the electric tramways was to have been commenced on Wednesday, but the preparations are not yet complete, and it will probably be a fortnight before the work can be begun. Offices for the engineer (Mr. J. E. Edmundson) and his staff have been established in Scalby-road, and a start will be made at this point.

North-Eastern Railway.—In our note under this heading in our last issue we inadvertently referred to the motors with which the new corridor cars are being equipped as of the "General Electric" type. This, however, is a mistake. The motors and the equipment throughout will be of British Thomson-Houston make entirely, and not General Electric.

London County Council.—The traffic returns of the London County Council tramways for the week ending Sept. 26 show receipts at £11,054. 4s. 1d., being an increase of £2,575. 6s. 3½d. when compared with the corresponding week in 1902. For the aggregate 179 days of the present year the receipts have been £260,121. 17s. 6d. This sum shows an increase of £41,481. 4s. 11d.

Johnstone.—Plans for the new electric tramways were submitted to a special meeting of the Town Council in committee. These show that Mr. Murphy, the promoter, has fixed the terminus at Hag-road, which is the boundary of the burgh, and only a short distance from Milliken Park. Mr. Murphy is to be again communicated with, so as to explain certain matters in connection with the undertaking.

Belfast.—The City Corporation have received a report from Mr. Chas. H. Merz in regard to the proposed conversion of the city tramways to electric traction when they become the property of the Corporation. Mr. Merz recommends the adoption of the overhead trolley system, and estimates the total cost of carrying out the scheme at £664,621. Mr. Merz is now to be asked to prepare the necessary plans for presentation to Parliament.

Manchester-Liverpool Mono-Railway.—It is reported that this project is at present at a standstill. After the Bill authorising the line received the Royal assent on Aug. 17, 1901, the Monorail Construction Company was formed, and in due course a prospectus was issued to raise £2,000,000 of capital in £10 shares. The response of the public was not, however, such as to justify proceeding with the work, and the scheme, it is stated, is now in abeyance.

Aberdeen.—Colonel von Donop, R.E., on behalf of the Board of Trade, this week made an official inspection of the Ferryhill tramway track from the north end of Crown-street to Duthie Park. This part of the system has been open for some time, the traffic having been conducted according to temporary regulations suggested by the Board of Trade. Arrangements have been completed for the opening of the Torry tramway from Palmerston-road to St. Fittick's-road on Monday, Oct. 12.

Dukinfield.—At the last meeting of the Town Council a resolution was moved opposing any extension of the tramways scheme in which Hyde, Stalybridge, Mossley, and Dukinfield are interested. It was contended that the present scheme was much too large, and until the Joint Board knew whether it would be a success or otherwise, it would not be right to embark on extensions outside the Joint Board's area. After a long discussion the resolution was carried by 10 votes to 6.

German Tramway Deputation to Glasgow.—Herr A. Stavenow, general superintendent Berlin tramways, and Herr A. Münde, engineer and chairman State Railways, Berlin, were in Glasgow last week to study the city tramway system. They were particularly interested in the arrangements for the making and repairing of cars at the Coplawhill works of the tramway department, and also in the design of car in use at Glasgow. They also made very close inspection of the traffic arrangements, routes, fares, etc.

Leeds.—The Tramways Committee have further considered the obtaining of powers to borrow £125,000 for the purpose of constructing the new lines authorised by the provisional order of 1902-3. These lines include extensions in York-road, Stanley-road, Domestic-street, Belle Vue-road, and Hyde Park-road, as well as the extensions to Bramley and Rodley, and the continuation of the line from Kirkstall to the city boundary at Horsforth. Nothing definite was decided, and the committee subsequently inspected the routes in question.

Wigan.—A meeting of representatives of the Corporation and the Ince-in-Makerfield District Council has been held to consider the question of the leasing of the tramways. The meeting arrived at an agreement by which Wigan undertakes to adopt the broad gauge and to equip for electric traction the lines from Wigan to the boundary of Ince at Amberswood, whilst Ince is to grant a 21 years' lease of the tramway in its township to the Wigan Corporation. It is expected that the work of constructing the lines will be commenced very soon.

Additional Traffic Returns.—Anglo-Argentine, £2,223 increase; Barcelona Ensanche y Gracia, £56 increase; Barcelona, £1,015 decrease; Brisbane, £141 increase (month of August, £11,736, increase £294); British Columbia Electric (month of March), gross earnings £10,352, net income £2,658; Buenos Ayres and Belgrano Electric, £122 increase (month of August, £13,431, increase £533); Calcutta, £620 increase; Cape Town (month of August), receipts £15,349, expenditure £8,696; Isle of Thanet Electric, £109 decrease; Mexico Electric (month of August), receipts £48,600; expenses, £27,900; Perth Electric, £157 increase; Port Elizabeth (month of August), receipts £3,875, expenditure £2,305.

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Middlesbrough.—At a meeting of the Corporation Streets Committee on Friday a letter was read from the Imperial Tramways Company relative to the tramway extensions, and asking that a date be fixed in order that the question might be discussed. The Town Clerk said there would be a meeting of the representatives of the Middlesbrough, Ormesby, Normanby, and Eston authorities this week with reference to the establishment of an independent tramway system. It was decided that it would be advisable to hold this meeting of the authorities first.

Cheshire.—A scheme is being promoted for the supply of electricity and power gas throughout Cheshire. In conjunction with the scheme it is intended to apply for powers to construct an electric tramway connecting Macclesfield on the one side with Hazel Grove and Stockport to Manchester, and from Macclesfield to Congleton, Sandbach, Crewe, and Nantwich, with a branch line from Macclesfield, through Broken Cross, Henbury, Chelford, Knutsford, to Warrington. The scheme will comprise tramways to open out inter-communication with all the towns in Cheshire.

Norwood.—The question of the extension of the London County Council tramways to Upper Norwood continues to engage public attention, and was the subject of discussion at this week's meeting of the Lambeth Borough Council. The following motion gave rise to a long debate: "That this Council, having learned that a poll has been taken in the Upper Norwood postal district, and that a memorial has been presented on behalf of the Upper Norwood Ratepayers' Association showing that three to one were in favour of trams running to that district, respectfully urge the London County Council to run a line of trams to Westow-hill, Upper Norwood."

Lewisham.—The tradesmen of Lewisham, Lee, and Forest Hill have prepared a memorial urging the Borough Council of Lewisham to agree to the London County Council's terms, and intimating that at the November elections only those candidates prepared to make the question of tramways the first consideration will receive their support. At the last meeting of the Borough Council the memorial was presented, and a recommendation from a special committee to the effect that the Council should offer a sixth contribution to four schemes proposed by the London County Council was agreed to. The tradesmen attended in large numbers, and in their petition urged that "trade follows the trams."

North Wales.—The promoters of the Flintshire electric tramways scheme have issued a map showing the proposed line of route Starting from Queen's Ferry, the line will run parallel to the Chester and Holyhead to Bagillt, and thence inland up to the town of Holywell; from there through Halkyn and Northop on to the town of Mold, thence to the colliery centre of Buckley, and down again to Queen's Ferry, a circle in all of some 26 miles. There will also be a branch line from Flint and Northop. The overhead trolley system will be adopted, and both passengers and goods will be carried. The route traversed—with the exception of the eight miles from Queen's Ferry to Bagillt—is at present devoid of railway facilities.

Heckmondwike.—There have lately been numerous complaints about the unsatisfactory running of the tramcars through Heckmondwike. At the last meeting of the District Council it was explained that when the agreement was entered into the estimates were based upon a 76-kw. plant being sufficient, the company having reduced the limit to that figure from 150. Now, however, it was found that a 250-kw. plant was required. The agreement provided for such a contingency arising, but instead of the company paying the extra price stipulated, they had made an offer which the Council regarded as preposterous. The latter body, it was added, were prepared to meet the company without insisting on the full advantage to which the agreement entitled them.

Erith.—The following tramways are to be constructed at the earliest possible date, and Messrs. Hawtayne and Zeden will be employed as consulting engineers: (1) part of tramway No. 1, commencing in Bexley-road at the boundary of the parish of Crayford, at Northumberland Heath, by a junction with the Bexley tramways along Bexley-road to the junction of Queen's-road and Pier-road; (2) tramway No. 2, along Pier-road; (3) part of tramway No. 3, from the corner of Pier-road proceeding in a southerly direction along High-street, Crayford-road, and South-road to the boundary of the parish of Crayford; (4) further part of tramway No. 3, commencing in High-street at the junction of the new road through the Walnut Tree House estate, along West-street and Lower-road, to the intersection of Church-manorway; (5) tramway No. 8, along the new road through the Walnut Tree House estate.

Crewe.—Another effort is being made to get the Town Council to undertake the provision of a tramway scheme for the borough. On the last occasion a public meeting decided against the Corporation having anything to do with it, and a poll of the ratepayers was taken with the same result. The London and North-Western Railway also opposed any municipal scheme. The promoters, however, now believe that the railway opposition would be withdrawn if a less ambitious scheme than that originally proposed was prepared, and a requisition has been presented to the Mayor, signed by several hundred ratepayers, asking that another public meeting should be called to consider the question. The Mayor has intimated that he will accede to the desire of the memorialists, and it is expected that in the meantime the views of the directors of the railway company will be made known, which will largely influence any future proceedings.

Tramway Lifeguards.—At an inquest held in Sheffield in respect of the death of a girl run over and killed by an electric car on Saturday last, the jury expressed the desire to hear something of the lifeguards in use in the city. Mr. A. L. C. Fell, the tramways manager, was called, and stated that their original lifeguards were of wire, but they were not satisfactory. He was sent to Germany to enquire into Continental methods, and he found that the wooden type of guard was almost universally adopted in Germany. During the past four months six or seven accidents had happened to cars fitted with the wooden lifeguards, and in every instance the person knocked down had been pushed on one side, the most serious casualty being a broken arm. This was the first fatal accident with lifeguards of this pattern that had happened in Sheffield. The wooden guard was almost as satisfactory as any guard in use in Sheffield, and recently further experiments had been made with the "drop gate guard." The committee took means to secure the most effectual guard, and were constantly making trials.

Wallasey.—An abstract of accounts of the Urban District Council for the year ended with March last has just been published. A summary of the revenue accounts shows that whereas the year commenced with a balance in favour of the district fund of £5,824, and £308 in favour of the tramways account, the period under review ended with £17,793 in favour of the district fund and £2,806 in favour of the tramways fund. The electric tramways capital account shows that the expenditure up to March, 1902, was £97,902, which was increased during the past year to £120.503, showing at the end of last March a debit balance of £7,134. The revenue account states that the receipts from all sources during the year were £31,474, and working expenses, including £4,500 charged to depreciation and renewal fund, were £23 694, giving a surplus of £7,780, which, added to £308 in hand at the commencement of the year, made a surplus of £8,088. Of this sum, £3.772 went for interest on loans, £1,408 to the sinking fund (making that fund amount to £1,640), and £100 on loan charges, leaving a net profit of £2,806.

Cardiff.—The engineers have been requested to report on the proposed extensions of the Crwys-road and Cowbridge-road tramway routes, and present estimates of the cost at the next meeting of the committee. Mr. Arthur Ellis states that the receipts from the electric tramcars during the last 5½ months—viz., from April 1—showed an increase of £15,500 over the same period last year. It is announced that there will be a decrease in the service of 20 cars for the winter months, beginning Oct. 1. Mr. Ellis has presented a long report dealing with the revision of the fares over the whole system, and a special meeting will be held to consider the report. A novelty will be introduced in Cardiff next week in the shape of an electrically-illuminated tramcar The car will be adorned with about 2,000 lamps, and the Tramways Committee decided that the fare should be 6d. between the terminus on each of the different routes. The innovation partakes of the nature of an experiment, and the car will not be run upon more than one route on the same evening. The committee have been instructed to ascertain the probable income from advertisements on the cars.

A "Tube" Casualty.—On Monday were published details of a fatality which occurred on the Central London Railway late on Thursday night last week. It appears that as a westward-bound train entered Notting Hill Gate Station at midnight a man of the artisan class was seen to fall across the rails from the platform. The train was promptly pulled up, and the officials on making a search found the man lying in the "invert," or narrow channel, which runs between the lines. A hasty examination showed that he was dead, though he had not been injured by the train. A doctor who was summoned pronounced death to be due to a broken neck. The secretary of the Central London Railway informed a Press representative that it was practically impossible for a person to be "electrocuted" on the rails of the "Tube," at any rate, near the platform. The walls opposite the platform were covered with wood, and only an electrical expert would know how to place himself on the lines so as to suffer from shock. Even then it would be necessary for the person to have his boots or clothing wet. In 999 out of 1,000 cases an accidental fall on to the line would result in no harm from shock.

Brighton.—With reference to an enquiry which had been made as to the amount of capital which will have to be gradually written off on the completion of the Southwick power station, Mr. Arthur Wright has reported to the Lighting Committee of the Brighton Town Council that the original cost of the three tramway generating sets was £7,530, of which £205 has already been provided for by the sinking fund. In his opinion these sets would realise between £4,000 and £5,000 if sold any time during the next five years. The evaporative condenser referred to in his previous report had been in use for seven years, and cost roughly £1,500. Of this, about £200 had been provided for by the sinking fund, and the balance should, in his opinion, be written off during the next three years. The 270 meters which Mr. Christie had reported as being obsolete, were of the Chamberlain and Hookham and Thompson types, and had been in use for about 10 years. The amount at which they stood in the ledgers was about £1,400, and this amount would, in his opinion, be at once written off, as they failed in selling any one of them after publicly advertising same. The consideration of the report has been deferred by the committee, The same committee have had before them a report from Mr. John Christie, resident engineer, stating that he found in actual practice that greater efficiency could be obtained out of the storage battery used in conjunction with the tramway supply if they added 12 more cells, which would enable them to take a much greater output from it, and maintain the full pressure to the tramways throughout the whole discharge. He had obtained prices from the Electrical Power Storage Company, who had at present men carrying out some alterations to the existing battery, and they stated that if they place the order with them while their men are here they would erect them complete, and let them fall under the terms of the existing contract, for the sum of £14. 11s. 6d. per cell. He recommended acceptance of this offer, and suggested that the capital to pay for this should be borrowed on the same terms as the existing loan, when the next enquiry was being held. The committee have resolved that the report be approved and acted upon.

Control of Highways.—There was issued this week the report of the committee appointed by the Local Government Board to enquire

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into the general condition and sufficiency of the roads in England and Wales, and to report whether any, and, if so, what amendment of the law relating to these matters or its administration is desirable in view of the various purposes for which the roads now are, or shortly may be, utilised, and particularly whether any change of the authorities who have control over the roads or of their powers is required. The committee suggest that the maintenance and improvement of all the principal roads in a county should be placed under the direct control of County Highway Boards representative of all the authorities having at present rights and powers with regard to main roads. Some roads, the committee remark, are of more than county importance, and their maintenance in the highest efficiency should be regarded as a matter of national concern under the immediate supervision of a department of the Local Government Board. That part of the report relating to tramways and light railways is, from our point of view, the most important. It reads as follows: "From the evidence which we have received, and from photographs placed before us, we have arrived at the conclusion that the presence of tramcars and light railway cars upon roads of inadequate width is the principal obstruction to the free passage of other vehicles upon such roads, and the main cause of any insufficiency of road accommodation which at present exists. This condition of things is, in our opinion, largely due to the fact that the interests of through traffic have not in the past been sufficiently represented before some of the central authorities from whom permission to lay rails upon the public roads has to be obtained. Except under very special circumstances, such permission should, in our opinion, only be obtainable when the road is, or is to be made, of sufficient width to enable loaded wagons to pass freely on either side of the tramlines. Tramways and light railways are, or are intended to be, remunerative undertakings, and it does not appear to us unreasonable to require that the promoters of such undertakings should either leave to, or provide for, other users of the public roads sufficient road accommodation. Our recommendation is that it should be provided by Parliament that, except under very special circumstances, proved to the satisfaction of the sanctioning authorities, no tramway or light railway should be, in future, laid down upon any road which has not, or will not have when the works are completed, a minimum width of carriageway. The minimum width which we suggest is 33ft. if it is proposed to lay a double line of rails of ordinary gauge, and 27ft. in the case of a single line. It appears to us that even these minimum widths would be wholly inadequate in some places where the traffic is great. We suggest that such cases should be met by giving to every highway authority a full right to appear and be heard before any tribunal which is dealing with a proposal to lay rails upon any road under the control of such authority. We further recommend that, inasmuch as the promoters of light railways have power to purchase lands compulsorily, they should, in districts where the roads are narrow and cannot be widened except at great expense, or are already congested with traffic, be required to exercise their powers and lay the railways on lands acquired for the purpose instead of upon the roads."

Wellington (N.Z.).—Elsewhere in this issue will be found a list of the tenders accepted by the Wellington (N.Z.) Corporation in connection with the tramway scheme for that city. Mr. W. R. Wright, the electrical engineer, who has charge of the scheme, has presented to the City Council a long report on his recent visit to London, and in this he comments on the tenders which were sent in in response to the Council's invitation. In the course of his report, which is condensed in the *New Zealand Times*, Mr. Wright explains that tenders were called for in globo and in section. Tenders in globo included all the supplies and constructional work excepting the raw material for the permanent way. The following were the divisions of the sectional tenders: the supply of plant for the power station, the erection of the plant for the power station, the supply of certain tramcars, the supply of rails, etc., for the permanent way, the laying of the rails, etc., for the permanent way, the supply of cables and overhead equipment, the erection of the cables and overhead equipment. The tender of Messrs. Macartney, M'Elroy, and Co. for sections was considerably higher than the in globo, the difference being £8,671. 4s. 8d. In both cases they were high in the power-house section. Seeing this, he wrote asking if they would accept their in globo tender less the power-house. To this they agreed, and, further, they gave the Corporation the opportunity of 1 per cent. off the scheduled rates if the order was placed before February, thus making a saving of £2,236. 4s. 8d., plus 1 per cent. on £113,883. 19s. 7d., which is £1,138. 16s. 9d. An alteration was made in the number of points and crossings, which again reduced the tender by £411. 1s. 9d., making a total saving of £3,786. 3s. 2d. As to the tenders for the equipment of the power-house, nine were received for the supply and erection and 12 for the supply only. After careful consideration on the part of the Advisory Board, they found they could not do better than recommend the committee to accept the tender of the Electric Construction Company, at a total amount of £26,956. 17s., being £24,611. 17s. 10d. for supplies and £2,345 for erection. Several alterations were made, which reduced the original tender to £23,255, showing a saving of £752. 12s. 4d. In reference to Macartney-M'Elroy's tender, says Mr. Wright, only one sub-contractor was mentioned—namely, the General Electric Company of America. As, however, the power-house equipment was taken from their tender, this firm was to a very large extent cut out. Messrs. Macartney-M'Elroy are not manufacturers, and after the order was placed with them they had to arrange with all the sub-contractors, and found difficulty in getting a firm to take the cars at the price quoted. Before recommending the acceptance of their tender, however, the engineer made a point of obtaining the names of several firms proposed as sub-contractors to Messrs. Macartney-M'Elroy for portions of the supplies. The works or manufactures from them were carefully inspected. In the case of the cars, the works were visited. This was done to satisfy himself, not only as to the workmanship, but as to the quantity and quality of timber kept in stock. The order for this section was finally placed with the British Electric Company, of Manchester. They are a new firm, and do not carry so large a stock of timber as some other manufacturers, but turn out a really good car. Before leaving England arrangements were made for an inspector to visit the works twice a week to see that no green wood was used in the building of the cars. "In the case of points and crossings," Mr. Wright proceeds, "Macartney-M'Elroy submitted two firms, Messrs. Hadfields, of Sheffield, and the Lorain Steel Company, of London and (works) America. These two firms ran very close, and our contractors seemed to be doing their best to bring them down. I allowed them some time and then told them to close one way or the other, and if the two were equal to give the British firm preference. This was not intended to be antagonistic to the American firm, for they have a very good reputation for this class of work, but was done with the feeling that our inspectors, who were in England, would be thus enabled to deal with this matter. Macartney-M'Elroy informed me that they had placed the order with the Sheffield firm, who were a little below the American, and so had the advantage." The section of the rails, the engineer states, was altered a little, as a Standards Committee of the Board of Trade has been sitting to fix standard sections of rails for railway and tramway construction. These are just out, and Wellington is the first municipality to avail itself of this standard section. It will be of great advantage when ordering renewals, and a further supply of points and crossings, as the manufacturers can now stock the standard sections. This advantage also applies to wheel tyres. The inspectors appointed by the Advisory Committee are Mr. J. H. Woodward and Mr. Howard Smith. Mr. Woodward has had a very large experience of manufacture of all kinds of electrical apparatus, and is now engaged as a junior in the firm of Messrs. Preece and Cardew, the consulting engineers, and is looked upon by that firm as a very able man. Of Mr. Howard Smith, who passes the permanent way, nothing need be said except that he is an an authority in permanent-way material, and was elected chairman of the committee set up to standardise the rail sections for tramway and railway purposes. In concluding his report, Mr. Wright says that by dividing the contracts as scheduled instead of accepting them in globo a saving of four or five thousand pounds has been affected. Both firms expect to fulfil their contracts to time—that is to say, the route between Newtown Park and the Government railway station will be ready for running in April next.

PROVISIONAL PATENTS, 1903.

SEPT. 21.

20245. Improvements in or relating to electric rheostats, motor starters, regulators, and analogous electrical apparatus. Robert Frederick Hall, 24, Temple-row, Birmingham.

20249. Electric sparking device for exploding gas-engines, oil-engines, and vaporising engines of every description. William Macaulay, 7, St. John's-place, Larne, Ireland.

20274. Improvements in and relating to electrical casing or conduits. Sir Hiram Maxim Electrical and Engineering Company, Limited, Alfred William Hill, and James Harrington, Gillingham-street, Victoria, London.

20285. An improved machine for the separation of ores and other materials by means of electromagnets. William Blackmore, 5, Bishopsgate-street Within, London.

20291. Improvements in electric fittings, such as switches or the like, having combined insulating and conducting portions. Charles Francis Ritchel, 55, Chancery-lane, London. (Date applied for under Patents Act, 1901, Oct. 13, 1902, being date of application in United States.) (Complete specification.)

20301. Improvements in commutator brushes. The Morgan Crucible Company, Limited, and Charles William Speirs, 4, South-street, Finsbury, London.

20302. Improvements in commutator brushes. The Morgan Crucible Company, Limited, and Charles William Speirs, 4, South-street, Finsbury, London.

20303. Improvements in commutator brushes. The Morgan Crucible Company, Limited, and Charles William Speirs, 4, South-street, Finsbury, London.

SEPT. 22.

20337. Magnetic minder for iron ships. George G. Jackson, 122, Upper Milton-road, Gillingham, Kent.

20366. Improvements in coverings for insulating electrical wires and the like. Leopold Frank, 77, Colmore-row, Birmingham.

20401. Improvements in electric switches. Charles Ernest Hunter and William Hodges Warren, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

20405. Improvements in the method of producing rapid electrical oscillations and system of devices therefor. Frank Schrottke and Gesellschaft für drahtlose Telegraphie m. b. H., 6, Lord-street, Liverpool. (Complete specification.)

20423. Improvements in the ventilation of dynamo-electric machines. Henry Metcalf Hobart, Oswaldestre House, Norfolk-street, Strand, London.

20424. Improvements relating to sparkless running of commutating dynamo-electric machines. Franklin Punga, Oswaldestre House, Norfolk-street, Strand, London.

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SEPT. 23.

20435. Improvements in or relating to electric ignition apparatus for internal-combustion motors and the like. John Budge and Charles Edward Forman, 18, Hertford-street, Coventry.

20443. Improved electrical lamp. Emanuel Hermann, 5, Corporation-street, Birmingham.

20450. Improvements in electric arc lamps. Frederik William Edward Schuer, 37, Claremont-square, London.

20497. Electric plant for the synthetical production of nitric products by means of discharges of electricity in gaseous mixtures. Joseph von Kowalski and Ignacy Moscicki, 40, Chancery-lane, London. (Complete specification.)

SEPT. 24.

20517. Improvements in and connected with the fixing of pulleys, electric wires, and such like to ceilings. Colin McCullum and James McGruther, 154, St. Vincent-street, Glasgow.

20523. Improvements in electric switches. August Eckstein and Albert Julius David Krause, Peel Works, Adelphi, Salford.

20547. Improved arm-supporter for telephones and the like. Heinrich Ehret II., 112, Potsdamerstrasse, Berlin. (Complete specification.)

20566. Improvements connected with electric meters for indicating the maximum demand of current. Frederick John Beaumont, 173, Fleet-street, London.

20569. Improvements in or relating to pocket electric lighting devices. Lawrence Gunn Sloan, 6, Lord-street, Liverpool. (The Elektricitäts-Gesellschaft Hydrawerk, Germany.)

20572. An improved electric induction device for medical and like purposes. Victor Reichenberger and Eugen Weiersmüller, 6, Lord-street, Liverpool. (Complete specification.)

20577. Improvements in or relating to magneto-electric machines or motors. Heinrich Hansen Knutzen, 111, Hatton-garden, London.

SEPT. 25.

20606. Improvements in multipolar dynamo-electric machines. John Henry Holmes, Portland-road Works, Newcastle-on-Tyne.

20611. Improvements in dynamo-electric generators. Miles Walker, 7, Skerton-road, Old Trafford, Manchester.

20633. Improvements in attaching electrical insulators to insulator brackets. Edward John Chambers, 7, Staple-inn, London.

20634. Improvements in attaching insulators to the tubular arms of telegraph and like poles. Edward John Chambers, 7, Staple-inn, London.

20635. Improvements in magnetic separators. Arthur Allan and Samuel Benton, 7, Staple-inn, London.

20641. Improvements in telephone selective systems and apparatus therefor. Noble Samuel McKinsey and Anton R. Nelson, 36, Chancery-lane, London.

20645. Improvements in arc lamps. William Tichborne Upton, John Edward Elliott, and Hubert Bevan Pratt, 11, Southampton-buildings, Chancery-lane, London.

20655. Process for the electrolytic production of metals of the earthy alkalies, and more especially of metallic calcium. William Edward Evans, 27, Chancery-lane, London. (Elektrochemische Werke G. m. b. H., Germany.) (Complete specification.)

20658. Improvements in or connected with overhead trolley lines for electric traction. Alexander George Ionides and Alexios Constantine Manuel, 4, South-street, Finsbury, London.

20662. Improved means for guiding the trolley wheels of tramway vehicles at the junctions in overhead conductors. Arthur Henry Holmes and Henry Walter Holmes, 111, Hatton-garden, London.

SEPT. 26.

20685. Improvements in electrical resistance furnaces. William Simm and Thomas James Denny, 29, Great George-street, Westminster, London.

20691. Improvements in or relating to the cells of primary batteries. Albert Joseph George, 33, Hatton-wall, Hatton-garden, London.

20700. Improvements in trolley electric tramways. George Hall, 4, Corporation-street, Manchester.

COMPLETE SPECIFICATIONS ACCEPTED.

To be published Oct. 15, 1903.

1902.

14112. Miners' electric lamps. Prested.

20355. Morse telegraphs. Ducretet.

20571. Alternate-current motors. Fynn.

20572. Alternate-current motors. Fynn.

23021. Apparatus for electrically igniting miners' safety lamps. Best and Ackroyd and Best, Limited.

23037. Signalling apparatus for electric railways. Sheehy.

23022. Apparatus for electrically igniting miners' safety lamps. Best and Ackroyd and Best, Limited.

23255. Apparatus for use in electric telegraphy or the like. Jacobs and Nicholson.

23387. Main and branch electric switches. Ewart.

24212. Brush-holders for dynamo-electric machines. Carolan. (General Electric Company.)

24634. Driving mechanism for use in connection with electric train-lighting systems and for other purposes. Bousfield. (Gerdes.)

24865. Insulating substances for cables, wires, and other electrical devices. Pilkington and Ormandy.

25794. Electric controllers. Middleton and Smith.

25904. Systems of electrical distribution. Carolan. (General Electric Company.)

25949 Gas or electric light brackets applicable for bakers' ovens. Gillard.

27895 Casing for supporting the effective iron rings of electrical machines. Laschet.

1903.

12484. Means for transforming electric waves applicable to wireless telegraphy and the like. Braun.

15532. Dynamo suspension gear for use in connection with electric lighting systems for railway carriages and the like. Electric and Ordnance Accessories Company, Limited, and Hall.

17666. Means for determining the action of Rontgen rays. Holzknecht.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.	Last price
Commercial and Industrial.—	£	£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1 ..	½-¾
Aron Electricity Meter, 5 p.c. Cum. Pref. Shares, 1-125,000	1 ..	½-¾
British Insulated and Helsby Cables, Ord., 1-100,000	5 ..	6¼-7
—— 5 per cent. Cum. Pref., 1-100,000	5 ..	5¼-5⅜
—— 4½ per cent. Mortgage Debentures	100 ..	103-106
British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red.	100 ..	104-106
British Westinghouse Elec. and Manuf., 6 per cent. Pref., 275,001-375,000	5 ..	5¼-5⅜
—— 4 per cent. Mortgage Debenture Stock	100 ..	100-102
Brush Electrical Engineering, Ordinary, Nos. 1-105,731	2 ..	¾-1¼
—— Non. Cum., 6 per cent. Pref.	2 ..	1-1¼
—— 4½ per cent. 1st Debenture Stock	100 ..	97-100
—— 4½ per cent. 2nd Debenture Stock	100 ..	85-90
Callender's Cable, Debentures	100 ..	106-110
—— Ordinary	5 ..	11¼-12¼
—— 5 per cent. Pref.	5 ..	5¼-5⅜
Crompton and Co.	5 ..	2-2¼
—— 5 per cent. Debentures	100 ..	100-104
Edison and Swan United, "A" Shares, 1-99,261	3 ..	¼
—— "A" Shares, 01-017,139	5 ..	1¼-1⅜
—— 5 per cent. Debentures	100 ..	77-82
—— 4 per cent. Deb. Stock, Red.	100 ..	72-77
Electric Construction, Limited, Nos. 1 to 112,100	2 ..	1⅜-1⅞
—— 7 per cent. Cumulative Pref.	2 ..	2¼-3
—— 4 per cent. Perp. 1st Mort. Deb.	100 ..	98-101
Ferranti Limited, 5 per cent. 1st Mort. Deb. Stock, Red.	100 ..	90-95
General Electric Company (1900), 5 per cent. Cum. Pref.	10 ..	9¼-10
—— 4 per cent. 1st Mort. Deb. Stock	100 ..	97-100
W. T. Henley's Telegraph Works, Ordinary	5 ..	14-15
—— 4½ per cent. Preference	5 ..	5-5¼
—— 4½ per cent. Debentures	100 ..	108-112
India Rubber, Gutta Percha, and Telegraph Works	10 ..	18¼-18¾
—— 4 per cent. Debentures	100 ..	100-103
Parker, Thos., Limited, Ordinary	10 ..	14¼-15¼
Telegraph Construction and Maintenance	12 ..	34-37
—— 5 per cent. Bonds	100 ..	100-103
Electric Lighting and Supply.—		
Blackheath & Greenwich District Ordinary 1,301-101,300	1 ..	⅝-¾
—— 4½ per cent. Deb. Stk. Certs., Red. and Conv.	100 ..	118-121
Bournemouth and Poole, Ordinary	10 ..	12¼-13¼
—— 4½ per cent. Cum. Pref., 7,501-15,000	10 ..	10-11
—— 6 per cent. Cum. Second Pref., 15,001-22,500	10 ..	10¼-11¼
—— 4½ per cent. Debenture Stock, Red.	100 ..	103-106
Bromley (Kent) Electric Light and Power Co., 4½ per cent. 1st Debenture Stock, Red.	100 ..	102-105
Brompton and Kensington, Ordinary	5 ..	10⅜-11¼
—— 7 per cent. Preference	5 ..	10¼-10⅜
Calcutta Electric Supply Corp., Ordinary, Nos. 1-40,000	5 ..	7-7¼
—— Nos. 20,001-30,000	5 ..	7-8
Cambridge Electric Supply Company, Ltd., £10 Ord.	8 ..	14½
—— £10 Ord.	6 ..	10⅜
Central Electric Supply, Ltd., 4 per cent. Guar Deb. Stock	100 ..	107-110
Charing Cross and Strand, Nos. 1-70,000	5 ..	9-9½
—— 4½ per cent. Cum. Pref.	5 ..	5¼-5
—— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000	5 ..	4¾-5
—— 4 per cent. Debenture Stock, Red. (Prov. Certs.)	100 ..	104-106
Chelsea Electricity Supply	5 ..	5¾-6¼
—— 4½ per cent. Debentures	100 ..	108-111
City of London, Ordinary	10 ..	10¼-11
—— 6 per cent. Cumulative Pref.	10 ..	13-14
—— 5 per cent. Debenture Stock	100 ..	122-127
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100 ..	102-105
County of London and Brush Provincial, Ordinary	10 ..	7¼-8¼
—— 6 per cent. Cum. Pref.	10 ..	11¼-12¼
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	100 ..	109-112
Edmundsons' Electricity Corporation, Ordinary, 1-50,000	5 ..	6¼-7
—— 6 per cent. Cum. Pref.	5 ..	6¼-6⅞
—— 4½ per cent. First Mort. Deb.	100 ..	107-110
Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-30,000	5 ..	3¼-4¼
—— 5 per cent. Debenture Stock, Red.	100 ..	96-98
Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000	5 ..	6-6¼
—— 4½ per cent. First Deb. Stock, Red.	100 ..	100-103
Hove Electric Lighting, Limited, Ord., 1-13,000	5 ..	7¼-8¼
Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000	5 ..	10¼-11¼
—— 4 per cent. Debenture Stock Red.	100 ..	103-106

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Name.	Amount paid.	Last price.
	£	£
Kensington and Knightsbridge and Notting Hill	100	103-106
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	9½-10½
London Electric, Ordinary	5	1½-2½
—— 6 per cent. Pref.	5	5½-6½
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	100-102
Metropolitan, Ordinary	10	17½-18½
—— 1½ per cent. First Mortgage Debenture Stock	100	110-114
—— 3½ per cent. Mortgage Debenture, Red.	100	97-100
Newcastle-upon-Tyne Electric Supply, Ordinary	5	98-101
—— Preference	4	100-103
Notting Hill Electric Lighting	10	13-14
—— 4 per cent. First Mort. Debs., Nos. 1-500 (Reg.)	100	99-102
Oxford Electric, Ordinary, 1-96 and 407-14,510	5	5-5½
—— 4 per cent. Debenture Stock	100	98-101
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100	100-102
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5	3-3½
—— 4 per cent. Debenture Stock	100	85-90
South London, Ordinary	5	3½-4½
St. James's and Pall Mall, Ordinary, 101-30,080	5	15-16
—— 7 per cent. Pref.	5	8-9
—— 3½ per cent. Deb.	100	98-101
Urban Electric Supply Co., Ordinary, 8-30,007	5	5-5½
—— 5 per cent. Cumulative Preference, 50,001-80,000	5	5-5½
Westminster, Ordinary	5	13-14
—— 5 per cent. Cum. Pref., 110,101-138,251	5	6-6½

Electric Railways.—

Central London, Ordinary	100	94-97
—— 4 per cent. Pref.	100	99-102
—— " deferred	100	99-102
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100	115-118
City and South London, Consolidated Ordinary	100	58-60
—— 4 per cent. Debenture Stock	100	116-119
—— 5 per cent. Pref. Stock '91	100	127-130
—— " " " '96	100	126-129
—— " " " '01	100	125-128
Liverpool Overhead, 5 per cent. Pref.	—	13-13½
—— Ordinary, 1-50,000	—	7½-8
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	—	102-104
Waterloo and City, Ordinary	100	94-97

Electric Tramways.—

Anglo-Argentine, 1-260,007	5	4¼-4½
—— Permanent 6 per cent. Debenture Stock, 1888	100	126-130
Blackpool and Fleetwood Tramroad	10	13½-14½
Brisbane Tramway Invest., Lim., Ord., 1-75,000	5	2-3
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5	4-4½
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100	100-103
British Columbia Electric Railway Co., Ord., Nos. 1-20,000	100	81-84
—— Non-Cum. 5 per cent. Pref., Nos. 25,001-38,500	100	82-85
—— 4½ per cent. 1st Mt. Debs., Nos. 1-6,250, of £40 each	40	104-106 p.c.

Name.	Amount paid.	Last price
	£	£
British Electric Traction, Ord. 1-300,000 & 60,001-90,000	10	12¼-13
—— 6 per cent. Cm. Pf., 30,001-60,000	10	11½-12
—— 5 per cent. Perpetual Debenture Stock	100	122-125
Buenos Ayres and Belgrano Tram., Ord., 1-100,000	5	2¾-2¾
—— "A" 6 per cent. Cm. Pf., 1-40,000	5	5-5½
—— "B" 6 per cent. Cm. Pf., 1-27,500	5	4¾-5¼
—— 5 per cent. Deb. Stock, Red.	100	107-110
—— Prov. Cert., all paid	100	99-102
Cape Electric Tramways, Nos. 1-480,000	1	2¼-2¾
City of Birmingham Tramways, 5 per cent. Cum. Pref.	10	5-5¼
—— 4 per cent. 1st Mortgage Deb., 1-3,000 (1917)	100	99-102
Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red.	100	102 105
Cork Electric Tramways and Lighting Co., Ordinary	10	13-14
—— 5 per cent. Cum. Pref.	10	11-12
—— Debentures	100	96-99
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10	12¼-13½
—— 6 per cent. Pref., Nos. within 1-60,000	10	15-16
—— 3½ per cent. Mort. Debs., 1-3,000, Red.	100	94-97
Imperial Tramways Ordinary	all	22-22½
—— 6 per cent. Cum. Pref.	all	14½-15½
—— 4½ per cent. Deb Stock	100	112-114
Isle of Thanet Electric Tramways and Lighting, 5 per cent. Cum. Pref., Nos. 30,001-60,000	5	3¾-4¼
—— 4 per cent. Debenture Stock	100	92-95
Kidderminster and District Lighting and Traction, Pref.	5	3¼-4¼
London United Trys. (1901), 5 per cent. Cum. Pref.	10	11½-12½
—— 4 per cent. 1st Mt. Db. Stock, Red.	100	104-106
Metropolitan Electric Trams., Deferred, 1,000 001-1,514,016	1	3/16-5/16
—— 5 per cent. Cum. Pref., 500,001-814,016	1	¾-1¼
New General Traction, Ordinary	5	1½
—— 6 per cent. Cum. Pref.	5	2-3
—— 5 per cent. Mortgage Debentures, 1-1,713 (Regd.)	100	88-93
Oldham, Aston, and Hyde Tramway, Ordinary	10	10½-10¾
—— 5 per cent. Cum. Pref.	10	11½-12½
Perth Elec. Tramways (W.A.) 5 per cent. 1 Mort. Deb. Stk.	100	99-102
Potteries Electric Traction, Ordinary, 20,001-40,000	10	9-10
—— 5 per cent. Cum. Pref., 1-20,000	10	8¼-9¼
—— 4½ per cent. Debenture Stock	100	103-106
South Lancashire Electric Traction and Power Company—		
—— £250,000 Ordinary	1	1
—— £101,132 6 per cent. Preference	1	1
—— £528,093 4½ per cent. Debenture Stock	100 p.c.	100 p.c.

Telephones.—

National Telephone, Preferred	100	99-101
—— Deferred Stock	100	75-77
—— 6 per cent. Cum. First Pref.	10	13-14
—— 6 per cent. Cum. Second Pref.	10	13-14
—— 5 per cent. Non-Cum. Third Pref.	5	5-5¼
—— 3½ per cent. Deb. Stock, Red.	100	93 95
—— 4 per cent. Deb. Stock, Red.	100	101-103
Oriental Telephone and Electric Company	1	13/16-15/16

TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line	Traffic Returns for week			Increase or decrease.		Miles of single track open.		Accounts for past year.				Receipts per			Cost per car mile.
	Ending	1903.	1902.	Week.	Current year.	1903.	1902.	Ending	Total receipts	Passengers carried.	Car miles run.	Pas-s'nger	Car mile.	Mile of track.	
		£	£	£	£				£			d.	d.	£	d.
Aberdeen Corporation	Sep. 26	1,247	995	+ 252	+ 2,964	19½	17½	May 31	37,931	9,099,715	794,641	0·98	13·02	1,970	6·14
Ayr Corporation	,, 28	283	267	+ 16	—	8	6	Sept. 25	12,503	2,979,276	290,099	1·00	10·34	1,560	4·7
Birmingham Tramways	,, 26	5,629	5,472	+ 227	+ 8,665	6½	6½	—	—	—	—	—	—	—	—
Blackburn Corporation	,, 25	844	831	+ 13	+ 657	24	24	March 25*a*	40,964	7,234,106	826,558	1·36	11·87	1,705	7·44
Blackpool Corporation	,, 21	1,500	1,616	− 116	− 255	17½	16½	,, 31	211,168	6,169,121	784,443	1·52	10·8	—	—
Blackpool-Fleetwood Tramways	,, 26	904	1,013	− 109	− 218	16½	16½	Dec. 31	30,923	2,049,677	584,989	3·62	12·68	1,932	6·99
Bolton Corporation	,, 27	1,845	1,707	+ 138	+ 6,433	38	25	March 31	85,704	17,761,605	1,896,247	1·15	10·75	3,430	5·87
Bournemouth Corporation	,, 23	1,193	—	—	—	10½	—	—	—	—	—	—	—	—	—
Bradford Corporation	,, 27	3,999	3,586	+ 413	+11,871	41	—	—	—	—	—	—	—	—	—
Brighton Corporation	,, 27	990	1,033	− 43	+ 5,844	6½	—	,, 31	—	10,432,508	1,031,928	1·00	10·10	—	—
Bristol Tramways Company	,, 25	5,151	4,934	+ 217	—	51½	51½	Dec. 31	223,480	41,192,899	5,724,114	1·30	9·38	4,348	—
Burnley Corporation	,, 26	948	711	+ 237	—	—	—	—	—	—	—	—	—	—	—
Burton Corporation	,, 27	433	—	—	—	—	—	—	—	—	—	—	—	—	—
Cardiff Corporation	,, 26	2,004	1,610	+ 391	—	—	—	—	—	—	—	—	—	—	—
Carlisle Tramways Company	,, 25	209	202	+ 7	+ 511	—	—	,, 31	—	2,216,583	320,129*h*	—	—	—	—
Central London Railway	,, 26	6,088	6,599	− 511	− 3,483*h*	6	—	,, 31	367,225	45,305,110	1,276,971*a*	1·87	66·6*a*	59,076	35·6*a*
City and South London Railway	,, 27	2,642	3,028	− 386	− 4,213	6⅜	—	,, 31	165,003*a*	19,069,319*a*	—	—	—	—	—
Cork E. T. and L. Company	,, 24	553	801	− 248	− 2,281	—	—	—	—	—	—	—	—	—	—
Darwen Corporation	,, 25	233	240	− 7	− 184	7·23	—	March 31*g*	12,341	2,360,735	254,279	1·25	11·65	1,707	9·36
Dover Corporation	,, 29	253	252	+ 1	+ 58	3	—	—	—	—	—	—	—	—	—
Dublin & Lucan Electric Railway	,, 27	138	112	+ 25	+ 109*h*	—	—	Dec. 31	5,796	364,796	102,087	3·81	13·62	859	7·68
Dublin U. T., electric cars	,, 25	4,105	3,972	+ 133	} —	46	46	March 31	126,121	24,553,133	3,429,356	1·23	8·82	2,741	5·06*h*
Dublin S. District, Electric	,, 25	978	932	+ 46											
Dundee City Tramways	,, 23	837	803	+ 34	—	22	22	May 15	35,874	9,084,522	752,814	0·93	11·276	1,630	—
East Ham Corporation	,, 26	728	588	+ 140	+ 5,527	10·75	7·52	March 31	25,341	9,971,337	650,224	0·61	9·35	2,357	—
Farnworth U.D.C.	,, 9	142	142	—	+ 500	—	—	—	—	—	—	—	—	—	—
Glasgow Corporation	,, 26	14,633	13,081	+1,552	+25,105	124	101	May 31*g*	656,572	177,179,549	14,008,750	0·88	11·25	5,489 *b*	7·40*d*
Halifax Corporation	,, 26	1,451	1,253	+ 203	—	30½	27¾	—	—	—	—	—	—	—	—
Huddersfield Corporation	—	—	—	—	—	34	35	March 31	56,631*h*	9,738,213	1,218,539	1·4	11·14	1,618	6·38
Hull Corporation, E. S.	,, 26	1,911	1,718	+ 192	+ 2,347	19	19	,, 31	87,707*h*	21,065,999	2,218,696	1·00	9·49	5,004	5·07
Ilkeston Corporation	,, 25	183	—	—	—	—	—	—	—	—	—	—	—	—	—
Kirkcaldy Corporation	,, 23	179	—	—	—	—	—	—	—	—	—	—	—	—	—
Leeds Corporation	,, 26	5,740	5,267	+ 473	—	77	—	March 25	262,656	57,239,779	5,773,651	1·11	10·91	3,283	—
Liverpool Corporation	,, 19	10,440	10,260	+ 180	+11,943	101	95	Dec. 31	504,304	108,906,472	11,705,425	1·11	10·34	5,000	6·88
Liverpool Overhead Railway	,, 27	1,709	1,472	+ 237	+ 1,501	15½	15½	June 30	79,252	10,466,726	986,185*a*	1·82	19·30*a*	5,110	— *a*
Lowestoft Corporation	,, 26	260	—	—	—	—	—	—	—	—	—	—	—	—	—
Nelson Corporation	,, 26	106	—	—	—	3	—	—	—	—	—	—	—	—	—
Newcastle-on-Tyne Corporation	,, 26	3,593	3,013	+ 580	—	38½	36	March 25*g*	150,334	33,474,122	3,379,119	1·08	10·93	4,175	6·17
Portsmouth Corporation	,, 26	1,951	1,845	+ 106	—	29	29	Sept. 30	47,651	9,168,157	868,157	1·24	13·17	1,643	—
Rochdale Corporation	,, 21	138	133	+ 5	—	4½	..	March 31	5,416	925,281	127,456	1·38	10·27	—	7·66
Rotherham Corporation	,, 24	521	—	—	—	—	—	—	—	—	—	—	—	—	—
Salford Corporation	,, 28	4,390	3,105	+1,285	+30,798	—	—	—	—	—	—	—	—	—	—
Sheffield Corporation	,, 28	4,755	—	—	—	53½	46½	Mar. 25*g*	216,309	56,812,049†	4,926,083	0·904	10·428	7,510	7·0
Southampton Corporation	,, 17	1,060	1,109	− 48	—	11	11	,, 31	35,874	9,084,522	752,814	0·946	11·436	3,760	—
Sunderland Corporation	,, 27	1,226	1,188	+ 38	+ 1,664	18·48	17·18	,, 31	59,930	13,987,121	1,270,957	1·03	11·3	3,243	6·45
Wallasey U.D.C.	,, 26	756	666	+ 90	+ 2,441	10·5	10·5	,, 31*g*	31,307	5,690,378	654,550	1·32	11·47	2,981	6·97

* Includes maintenance of permanent way and proportion of profits paid to the tramway companies for term of unexpired lease. *a* Train mile
b Per mile of single track. *c* Include rail and tram. *d* including depreciation. *f* Including one section of horse traction. *g* 1903. *h* Half-year's figures.

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NOTES.

Institution of Mechanical Engineers.—The first monthly meeting of the winter session of this institution takes place on the 16th inst., when a paper will be presented by Mr. Henry Davey on "The Newcomen Engine." Mr. J. Hartley Wicksteed, the president, will be in the chair.

Electro-Harmonic Society.—Mr. Martin F. Roberts, assistant engineer-in-chief at the General Post Office, will preside at to-night's concert of the above society. It marks the opening of the society's winter season, and an excellent programme has been arranged. The concert will commence at 8 o'clock precisely in the Crown Room of the Holborn Restaurant.

Mechanical Engineers' Graduates' Association. The Graduates' Association in connection with the Institution of Mechanical Engineers holds its first meeting of the new session on Monday evening, when Prof. A. B. W. Kennedy, F.R.S., will occupy the chair. The paper to be read is on "The Design of a Town's Tramway Scheme," by Mr. Wm. McDonald.

Junior Institution of Engineers.—A large number of members of this institution paid a visit to the International Fire Exhibition at Earl's Court on Oct. 2. Many of the interesting exhibits were closely inspected, where possible the apparatus being shown in operation. The next visit of the institution takes place on Saturday afternoon, Oct. 17, when the new Vauxhall Bridge works are to be seen.

New Books.—Messrs. Chas. Griffin and Co. have just issued the fourth edition of vol. i. and third edition of vol. ii. of Prof. Andrew Jamieson's text-book of "Applied Mechanics and Mechanical Engineering." The first of these volumes contains some 540 pages of text, 300 illustrations, and 540 questions, including many from Institution of Civil Engineers' examinations. It has been thoroughly revised and enlarged for the fourth edition. Vol. ii. has also been revised and enlarged, and now runs into 608 pages and 371 illustrations. The price of each volume is 8s. 6d.

Glasgow Local Section.—This section of the Institution has now completed its arrangements for the coming session. In order to bring the members and their friends together and to inaugurate the session, the committee have arranged to hold the second annual dinner on Wednesday, Nov. 4, and on the Tuesday following, the 10th, the first business meeting will be held, at which the chairman, Mr. Wm. A. Chamen, will deliver his address. Other meetings during the session will be held on the following Tuesday evenings: Nov. 10, Dec. 8, Jan. 12, Feb. 9, March 8, April 12, and May 10. The annual smoking concert is fixed for Feb. 6.

Engineering Feat in Paris.—In the construction of the extension lines of the Metropolitan Railway in Paris a curious engineering problem has presented itself. At the Place de l'Opera three lines of the railway will cross one over the other at three different levels. The presence of water in the subsoil near the surface renders the construction of the tunnels somewhat difficult at this point, and the engineers are solving the problem in a rather paradoxical way. Large cavities about 70ft. deep are being dug in the earth and these filled with great blocks of cement, forming a solid watertight mass. Then the engineers will commence boring their tunnels through the artificial rock sunk by themselves.

Michigan College of Mines.—The governors of the above institution have sent us their year-book containing the announcement of courses for 1903-04. We are interested to learn that the subject of electrical engineering in its application to mining is given due prominence to in the course of training. The rapid development of electrical methods as applied to a wide field of mining practice in lighting, power transmission, and metallurgical manipulation, makes a broad knowledge of the principles of electricity necessary to the well-equipped mining engineer. A study of electrical engineering, such as is provided at the Michigan College, both fixes these principles and gives some familiarity with current engineering practice.

The Victoria Falls.—It is stated that, in view of the approach of the Cape-to-Cairo Railway to the Victoria Falls, on the Zambesi, Sir Charles Metcalfe, consulting railway engineer to the British South Africa Company, and Mr. J. F. Jones, C.M.G., joint manager and secretary of the Chartered Company, have left England on a special mission to the United States, the principal object of which is to visit Niagara Falls and enquire into the possibilities of the transmission of power, more particularly in connection with the utilisation of the immense energy of the Victoria Falls. They will also pay visits to Chicago, St. Louis, and other great railway centres for the purpose of studying American railway methods. The mission will occupy about six weeks.

Wireless Telegraphy with France.—While so much attention has been given to the attempts to establish a commercial wireless telegraph service across the Atlantic, the narrow strip of water lying between France and this country has been left severely alone, so far at least as wireless telegraphy is concerned. We believe that Mr. Marconi's earliest experiments were made between England and France, across the Straits of Dover, but a regular service of wireless telegraphy has never been suggested, or, at any rate, been put into action. This has been left to the enterprise of the Western of France and the London, Brighton, and South Coast Railway Companies. These companies, it is reported, are shortly to establish a wireless telegraph service between Great Britain and France, and the necessary stations are now being equipped at Newhaven and Dieppe.

Steam-Turbines for Steamships.—The greatest interest is being shown in the crusade in favour of turbine engines for Atlantic and other liners, the one great object in view, of course, being to attain faster speeds. This activity leaves little room for doubt that the practicability of the rotary type of engine for steamships is fully recognised, but a development more rapid than has hitherto been seen may be expected. Orders are now on hand to equip seven vessels with turbine engines—two of which are warships—and further, several of the great Atlantic lines are investigating the claims of the turbine, including the Cunard and the White Star lines. The Allan line, however, is leading the way and has ordered a turbine-fitted steamer for the Atlantic service The results obtained with this vessel will probably decide the other lines in their future course of action one way or the other.

New Rubber-Yielding Plant.—The botanical authorities of Kew Gardens some time ago investigated a plant which was found growing in the sandy plains of the French Congo, and these investigations showed that rubber exists in the roots in sufficiently large quantities to warrant development. The name of the plant, which was discovered by a French botanist in the course of some explorations on the Congo, is Landolphia Thrallonii, and it is to be found in many places on the West Coast of Africa. The plant also thrives in Northern Nigeria, and it is these forests which are to be exploited. One firm which is already

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engaged in the manufacture of this rubber is placing it on the market at 3s. a pound, and it is said to be in every respect equal to the ordinary rubber. In view of the present comparative scarcity of rubber and its high price, the new discovery is likely to prove of very considerable commercial value.

German Electrical Industry.—The Association for the Protection of the Economic Interests of German Electrical Engineering was held recently at Mannheim, when the question of the prospects of German electrical machinery in foreign markets came in for discussion. A resolution was eventually adopted unanimously by the assembly emphasising that the German electrical industry does not require special protection in the home market, but that the greater value is attached to foreign markets being kept open, and not closed by high import duties. The association regards the new tariffs projected by Russia, Austria-Hungary, and Switzerland as prohibitive for German electrical productions, but it does not seem from the brief official report of the proceedings that the conference discussed the question of the suggested British Zollverein. It is improbable that this was done in view of the present indefinite position of the scheme.

Leeds Local Section.—Following are the arrangements which have been provisionally fixed for the ensuing session of the above section of the Institution of Electrical Engineers. So far as is possible at present we give the dates arranged for the business meetings, together with the titles of the papers which will be read at these meetings: Oct. 22—"Some Notes on Steam Turbo-Electric Generating Plants," by Mr. G. Wilkinson; Nov. 19—"Combined Electricity and Destructor Stations," by Mr. S. D. Schofield; Dec. 17—"Methods of Charging for Electrical Energy," by Mr. E. H. Crapper; Jan. 21—"Alternators in Parallel," by Mr. H. Bohle; Feb. 18—"Some Experiments with Large Gas-Engines," by Mr. W. Emmott; March 10—"Description of the Electrical Equipment of an Engine Works," by Mr. H. O. Wraith; March 24—Mr. T. S. Anderson (title not fixed); April—"Oil Extraction from Exhaust Steam and Boiler Feed Water," by Mr. A. L. C. Fell.

Speech by Telephone.—With the co-operation of the National Telephone Company and the Post Office, the Electrophone Company were enabled to carry out an interesting experiment on the occasion of Mr. Balfour's speech at Sheffield last week. The company's offices in Gerrard-street, London, were put in direct telephonic communication with Sheffield, *viâ* the London-Glasgow line, and some two dozen gentlemen in London—220 miles away—had the novel experience of listening to the delivery of Mr. Balfour's speech. Not only was the Premier's every word distinctly heard by the listeners at the company's rooms, but the occasional thumps on the table with which the speaker sometimes emphasised his argument were faithfully reproduced. The same thing has been done in America before now, and it is coming to be recognised that the reproduction of a speech by telephone so that it may be heard in a room a couple of hundred miles away or so is quite within the limits of practicability.

Salford Technical Institute.—A bulky volume has reached us from Mr. Wm. Wilson, principal of the technical institute of the borough of Salford, setting forth the arrangements of the institute for the session 1903-04. The provision for instruction in electrical subjects is, we are glad to observe, in keeping with the advancement of the science. The department is provided with a special laboratory for heat, light, and mechanics; an elementary electrical laboratory, in which all direct-reading experiments are performed; an advanced electrical laboratory, specially fitted up with a variety of reflecting galvanometers and other instruments—so that students lack nothing in their thirst for practical instruction. The experimental dynamo-room is equipped with a large high-speed vertical steam-engine, two large alternators, and three large direct-current machines, and the test-room is equally up-to-date in its equipment. In fitting up the electrical engineering department special attention has been given to alternating currents, and the needs of those engaged in electrical and kindred trades are specially looked after.

County Council Tramways Manager.—In the report which the Highways Committee presented to the London County Council at their first meeting after the summer vacation on Tuesday, interesting reference was made to the Council's late tramways manager, Mr. Alfred Baker. Mr. Baker, it seems, commenced service with the Birmingham Corporation on the 1st of the present month, but with the permission of the Corporation he will continue to assist the County Council in the conduct of their tramway affairs during the period which must elapse before the appointment of his successor. In acknowledging the readiness with which Mr. Baker has met the convenience of the Council in this matter, the committee take the opportunity of expressing their very high appreciation "of the great ability with which he has always carried out his responsible duties, and of the valuable services he has rendered to the Council during the time he has filled the office of manager." The committee also record their sense of gratitude to the Birmingham Corporation for their consideration in agreeing to the above arrangement.

The St. Marylebone Imbroglio.—As we anticipated in these columns a week or two ago, the Local Government Board have declined to intervene in the St. Marylebone imbroglio, and the decision of the London County Council not to sanction, without further statutory authority, the borrowing by the Borough Council of over 1¼ millions sterling for the purchase of the St. Marylebone property of the Metropolitan Electric Supply Company remains operative. The matter will now have to stand over till the next parliamentary session, when the Borough Council will ask the Legislature to grant them the necessary borrowing powers to raise the required loan, which, together with the accrued interest and other charges, will by that time be considerably above the amount stated above. The present case, we believe, constitutes a precedent, and it will be interesting to see whether in the future the difficulty which has confronted St. Marylebone in raising a loan will be experienced by other local authorities, not holding special statutory powers, who may desire to purchase such undertakings under the provisions of the Electric Lighting Acts. We understand that, in consequence of the present obligations of the Council, there is little or no competition in the forthcoming election of new councillors.

Covent Garden.—The arrangements for the eighth season of fancy dress balls, which will be inaugurated to-night at Covent Garden Theatre, have been conceived on the usual magnificent scale. The general idea is that of Venice at carnival time, and characteristic pieces of Venetian scenery have been chosen for pictorial representation, brilliancy being added by the liberal use of electric lamps disposed for effect by Mr. W. J. Crawshaw, the resident electrical engineer. To take the place of a second orchestra, which it has been the practice during the season of fancy dress balls to station on the grand staircase, a powerful orchestrion has been erected in the foyer of the opera house. It is the largest mechanical orchestra ever made, and gains interest, from our point of view, in that it is driven by electric motors. The effect produced is that

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of a band of about 70 instrumentalists, and would satisfy the most exacting ear. Special solo stops, introduced for the first time, include the violin, the ophicleide, and the cornet, and these being built in swell boxes, admirable crescendos and diminuendos are possible. A glockenspiel is another notable addition, and a full-sized upright grand piano, with the pedal under mechanical control, is contained within the orchestrion. Messrs. Imhoff and Mukle, 110, New Oxford-street, W.C., supplied the instrument. It is well known that these balls are under the management of Messrs. Frank Rendle and Neil Forsyth.

Cabinet Changes.—The long-awaited announcement of the reconstruction of the Cabinet consequent on the resignation of some of its principal members owing to the fiscal controversy, was made from Downing-street on Monday night. There are but two names in the list of new appointments with which we are concerned. They are those of the Hon. Alfred Lyttelton, K.C., M.P., and Lord Stanley, M P. The former, who has had no previous Ministerial experience, becomes Secretary of State for the Colonies in succession to the Right Hon. Joseph Chamberlain. Mr. Lyttelton will be chiefly remembered among electrical men for the masterly fashion in which he acted as umpire in the arbitration proceedings between the Metropolitan and the Metropolitan District Railway Companies, and for the decision which he gave as a result of those proceedings in favour of the adoption of the direct-current system of electric traction on the Inner Circle. Besides this, Mr. Lyttelton is a distinguished member of the English Bar and a King's Counsel. Lord Stanley, who succeeds Mr. Austen Chamberlain as head of the Post Office, dates his Ministerial career back to 1895, since which time he has successively filled the positions of Junior Lord of the Treasury, Press censor in South Africa, private secretary to Lord Roberts, and financial secretary to the War Office. He is the eldest son of the Earl of Derby, and is 39 years of age.

Arc Furnace for Extracting Zinc.—A patent has been granted to Dr. C. F. T. de Laval in the States on the distillation of zinc from its ores, and especially from zinc lead ores, by means of an electric furnace of the well-known type in which the radiant heat is used from an arc placed over the material to be melted. From a description in the *Electrical World*, it seems that the pulverised ore is introduced at one end of the longitudinal furnace chamber, so as to form a pile or stack sloping towards the other end of the furnace, where the arc is provided by means of two opposite carbons passing through the walls. By the action of the radiant heat upon the sloping surface of the pile, the non-volatile ingredients of the ore melt and flow down the slope into a basin just below the arc, from which they are removed through an outlet. As this melting and running down takes place, new surfaces of the stack are constantly exposed to the heat radiation. Simultaneously with this operation, the metal vapours mixed with the generated gases escape from the sloping surface and pass out of the chamber through an outlet above the arc. These vapours are then condensed by any suitable means. If the pulverised zinc ore has not been previously roasted, it is preferably mixed with iron ore while the ingredients are dry, the whole being afterwards moistened if required. The object is to eliminate the sulphur in the non-roasted zinc ore in which the zinc occurs as zinc sulphide.

Mining for Radium.—If there be any truth in the report of the discovery in the United States of large deposits of radium-yielding ore, the present enormous price of that rare metal will conceivably be considerably lowered. The deposits in question are stated to be in the region of Grand County, Utah, and the report further vouches for the fact that a company has been organised to open up the new industry. Specimens of the ore are said to have been analysed by Prof. and Madame Curie, who found it almost entirely free from gold, but carrying uranium to such an extent as to justify the working of the deposits for radium. The short history of the discovery is not without interest. Some few years ago a Mr. Stephen Lockwood met two prospectors, who in searching for gold and silver had met peculiar ore deposits in Grand County. An analysis of the ore revealed the presence of much uranium, and Mr. Lockwood, knowing its commercial value, urged the importance of the discovery upon the prospectors, and claims were staked out upon the whole deposit. The Utah bed was carnotite, a combination of uranium, vanadium, iron, copper, and barium, and, as latter researches show, radium and polonium. After establishing title to the claim, Mr. Lockwood returned home, and subsequently became interested in Prof. and Madame Curie's discovery. This suggested to Mr. Lockwood that the uranium of the Utah would yield radium, and a company has accordingly been formed to try the experiment.

Experiments on Air Friction.—Mr. Wm. Odell, before Section G of the British Association Southport meeting, described some experiments which he has made with the object of finding a convenient method of determining the power wasted by the windage of flywheels and dynamo armatures. The experiments were made with paper discs, which were mounted on the shaft of an electric motor. The excitation was kept constant, so that the torque was proportional to the current. Thus the extra current required to maintain a given speed after the disc had been fixed to the shaft gave the torque absorbed by the disc. There was found to be an angular speed for each disc above which the torque was accurately proportional to about the 2·5th power of the speed. This critical speed appeared to vary inversely as the square of the diameter. Below it the law followed was of a lower degree; but owing to the multiplication of errors of measurement no definite conclusion as to its exact nature was arrived at. As the three discs originally tried gave uncertain results as to the effects of size, a much larger one, nearly 4ft. in diameter, was also tried; and as a result of all the experiments it was concluded that the torque varies as about the 5·5th power of the diameter. To give an idea of the amount of power thus absorbed, it may be stated that a disc of 47in. required $\frac{1}{10}$ h.p. to keep up a constant speed of 500 revolutions per minute, and that if the above law holds, a 9ft. disc would absorb 10 h.p. at the same speed.

The Pacific Cable.—There has been published as a parliamentary paper an account showing the money issued from the Consolidated Fund under the provisions of the Pacific Cable Act, 1901, and the money received, expended, and borrowed, and securities created, under the Act to March 31, 1903. The return shows that, out of an authorised issue of £2,000,000, the sum of £1,060,935 was issued in 1901-2, and the balance of £939,065 in 1902-3. The expenditure up to March 31, 1902, was £1,044,701, and in the period ended March 31, 1903, a further sum of £916,080 was expended, making a total of £1,960,781, and leaving a balance of £39,218. During the year 1902-3 the money borrowed amounted to £1,215,400, and this with the sum of £784,600 borrowed in the previous year, makes up the sum of £2,000,000, the security created being an annuity of £77,544. 18s. The first payment of this annuity is to be made in December of this year, and the last on Dec. 1, 1952. Particulars of the capital expenditure of £1,960,781 are given, the chief item being £1,795,422 in respect of the contract for the cable. The balance is made up of £67,472 for the cable ship, £51,190

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for buildings, £25,006 for instruments, £20,135 for engineers' fees and expenses, and other smaller items. The receipts during the year, including a balance of £4,107 brought forward, amounted to £142,768. Of this amount £119,080 represented the parliamentary grant-in-aid, and £19,579 the traffic receipts. During the year £114,205 was expended, leaving a balance of £28,562 on March 31, 1903.

Goldsmiths' Institute. — We have received the annual syllabus of regulations for the 1903-4 session of the physics department of the above institute at New Cross. Mr. Edwin Edser is the head of the department, and has organised a regular series of experimental work for each of the various sections in which instruction is given. Judging from the syllabus, the physics department of this institution is admirably adapted for giving a thoroughly good groundwork both in ordinary physics and in electrical engineering. The aim seems to be to induce the students to learn their theory from the results of experiments carried out in the laboratory, and we know of no better way to impress scientific facts on the mind. The laboratory work is, of course, accompanied by theoretical lectures. As a rule, each subject is divided over two years, and this is an absolute necessity in view of the limited number of hours in the winter students are able to devote to evening work. The experiments which they have to carry out on the subject of electricity and magnetism, seem to us to be well arranged to give an intelligent knowledge of the essential facts of the science. The laboratories are open for 2½ hours at the time on both Wednesdays and Fridays. The other subject, that of ordinary physics, includes sound, light, and heat. We note from the syllabus that students have to keep laboratory note-books, and until they have carefully written up the results of one experiment and drawn their conclusions from the same, they are not allowed to proceed to the next. This regulation is a good one, and should be strictly enforced. We wish the department all success.

Use of Controlling Mechanism.—We recommend to the attention of managers of electric tramway systems in this country the following notes on "The Use and Abuse of Controlling Mechanism," which are taken from a paper presented by Mr. Z. F. Carver at the annual convention of the American Street Railway Association: The secret of successful mechanical management is watchfulness, care, systematic inspection. Several times every day the controller cases should be opened and the whole interior mechanism given a hasty cleaning, and a little lubrication of the contact fingers with a good quality of refined lubricant, vaseline being one of the best, though somewhat expensive. There is a tendency on some well-managed roads to have only two points on the controller—viz., on and off—the various graduations of resistances being largely a matter of form. This method gets the cars over the road, and pleases passengers who like a jolt now and then, but it is exceedingly hard on the motor equipment, and runs its cost of maintenance into large proportions. There are some methods provided to limit the rate of turn of the controller handle in going toward the loop, and in the larger equipments the rate of application is automatic, and not under the control of the motorman. In city traffic, where cars and vehicles have to go over the same ground, and where the vehicle has by common consent the right of way, it is not good practice to limit very much the rate of travel of the controller handle, because the men will find they cannot make ordinary slow-downs for the vehicle traffic with a controller slow of application and cover the ground on schedule time, so they resort to the much worse evil of only operating the controller in case of a last resort, and using the brake to hold down the speed, making the motors work against the load on cars as well as the brake. This is especially easy to do with power brakes—except the electric—and is a violation of rules which is very hard to detect.

Gas-Engine Explosions. — Following is a short abstract of a paper on this subject read by Mr. H. E. Wimperis before Section G at the recent Southport meeting of the British Association. In the autumn of 1901 the Institution of Mechanical Engineers published the second report of the Gas-Engine Research Committee drawn up by Prof. F. W. Burstall, and in this manner there was presented to the scientific and engineering world a very large mass of experimental results containing most valuable information regarding the internal economy of gas-engines. Prof. Burstall comes to several conclusions, prominent among which is his contention that the results of his experiments cannot be reconciled without the use of a variable specific heat. The writer has already published in the engineering Press an account of certain consequences which follow from this hypothesis, but before the matter could be considered upon a satisfactory basis it was necessary that the classical experiments of Mr. D. Clerk and Mr. Grover should be brought into line. In a paper contributed to the British Association last year the writer analysed Mr. D. Clark's results, and showed that they were in complete harmony with the variable specific heat hypothesis. In the present paper the writer deals with the experiments of Mr. Grover, and shows that not only is there no inconsistency between this hypothesis and Mr. Grover's results, but that by its adoption the explanation of certain difficulties in these results is the more easily given. Thus in the present paper, and in the one submitted last year, the writer claims to have achieved the object with which he set out—namely, to ascertain whether there was anything in past records of experimental work with gas-engines which would prove to be incompatible with the adoption of a variable specific heat in all future gas-engine calculations. The conclusion is that there is nothing in the classical investigations of Mr. D. Clerk or Mr. Grover which should afford any ground for hesitation in the matter.

Electric Speed Trials.—The most hopeful anticipations of the organisers of the Berlin-Zossen Electric Railway speed trials have been more than realised. On Tuesday it was announced in Berlin that a speed of 125 miles an hour had been obtained, which means an increase of over 10 miles an hour in the past fortnight. The Siemens-Halske Company, who built the car which gave this speed, may well be satisfied with the result, but the Allgemeine Elektricitäts-Gesellschaft will immediately attempt to emulate the triumph of their rivals with a car built by themselves. Of course, it must not be forgotten that this high speed of 125 miles an hour was obtained under the most favourable possible conditions on a track which had been specially constructed for high speeds, and is a straightaway stretch of 14 miles, with moderate curves at either extremity. Discoursing on these things, and the fact that the track rests upon rock-embedded sleepers, the correspondent of the *Daily Telegraph* in Berlin is led to speak of the "tremendous 96lb. rail"; but we may remind our non-technical contemporary that this is by no means an outside weight, and that some electric tramrails laid in the ordinary roads weigh several pounds in excess of that figure. However, the chief point to note about the trials is that the road bed has in no way been disturbed by the great speeds, and the track has remained practically unscathed. As our readers are aware, the three-phase alternating-current system is used, current being delivered to the cars from the overhead conductors

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at 13,000 volts, which is transformed on the cars to 350 volts for the motors. The experimental car on Tuesday was driven by Dr. Reichel, its constructor. It is assumed that in practice an average speed of, say, 93 miles would be obtained, and a definite project to that end—an express line between Berlin and Hamburg—has been afoot awaiting the development of these trials. The trials, so happily conducted without accidents, will probably induce the promoters of this scheme to push on to completion without delay.

Cathode Rays.—Following is an abstract of a paper condensed in the Chemical Society's *Journal* for the current month, describing the action of cathode rays on inorganic and organic substances. The author, E. Goldstein, says that if Elster and Geitel's assumption is true, that the colour of metallic chlorides which have been exposed to the cathode rays is due to a subchloride formed by the liberation of halogen, ammonium salts should remain colourless when subjected to the rays; but it is found that, at the temperature of liquid air, ammonium chloride becomes greenish-yellow, ammonium bromide yellowish-brown, the iodide olive-brown, and the fluoride deep blue. The colour disappears when the temperature is raised and the product exposed to daylight. Tetra-alkylammonium halogen salts behave similarly, giving various shades of colour, and yellow to green shades are also obtained with substances such as chloroacetic, trichloroacetic, and bromoacetic acids, bromoform, and chloral, which contain a halogen. On the other hand, acetic acid and aldehyde remain colourless, so that the colour of the ammonium salts and of the substituted compounds is apparently produced by the halogen. That the metal in metallic salts also helps in the production of colour is, however, shown by Giesel's results. It should be noted that the halogen in these cases must have its power of absorbing light enormously increased by the cathode rays, as it is known that the halogens, including iodine (in very dilute solution), are colourless at the temperature of liquid air. Sulphur, which at low temperature is perfectly white, becomes bright chamois-coloured in the cathode rays; the colour becomes very faint in daylight, even in liquid air, and rapidly disappears when the temperature is raised. The change here produced by the rays must be that of one allotropic form to another. The following colourless compounds also become coloured in the cathode rays when cooled in liquid air: sulphuric monohydrate (saffron-yellow), concentrated hydrochloric acid (green), phosphoric acid (hyacinth-red), hydrobromic acid of sp. gr. 1·49 (intense green), chloric acid (chamois), phosphorus pentachloride (bright yellow).

Electrolytic Copper Refining.—Perhaps the most important and valuable paper read before the recent Niagara Falls meeting of the American Electro-Chemical Society was that contributed by Dr. Wilder D. Bancroft on "Electrolytic Copper Refining," in which he gave an account of a series of tests made in Cornell University to find the most economical conditions. An abstract appears in the *Electrical World*, which states that the principal factors varied in these experiments were the temperature and the current density. Two sets of curves were plotted, one showing the relation between the cost to precipitate a ton of copper and the temperature of operation; the second set showing the relation between the cost to precipitate a ton of copper and the operating current density. From these curves it appears that a temperature of 70deg. is most satisfactory. Although the cost runs very high at this temperature for a current density of one ampere per square decimetre, it begins to drop off very rapidly as the current density increases, until it assumes a practically constant value at the higher current densities. Between 3·5 and 3·75 amperes per square decimetre would be the best current density for obtaining economical results, for at this density no extra power would be required to heat the solution. Operating at this current density, and with covered tanks, in order to prevent the heavy radiation losses, the current alone would be sufficient to heat the electrolyte to over 80deg. In order to secure a good circulation, essential for a good deposit with high current densities, the present method of pumping could be retained. If the gutters leading to and from the pump were properly insulated, the solution would not drop below 70deg. before returning to the tanks. Moreover, running at this high current density there would be a considerable saving in the first cost of the plant, inasmuch as fewer tanks are needed for the precipitation of a given amount of copper in a given time. The lower the cost of heating, the greater the advantage of a high temperature. The author sums up the results of the investigation by recommending, first, covered tanks; second, a current density of 3·5 amperes per square decimetre; third, a temperature of 70deg. C.

Pendulum Apparatus for Testing Steel.—The above apparatus for carrying out brittleness tests of steel was described before the Engineering Section of the British Association at the Southport meeting by Mr. E. G. Izod, who in the course of his paper also outlined the more general systems in use for carrying out such tests. He complained that at the present time, probably owing to the state of perfection to which the testing machine has been brought, there is too much inclination to neglect other properties of material which the usual tests do not detect, but which are quite as important as the usual standard physical tests; and that this is so is shown by M. Fremont's paper, published by the Société d'Encouragement pour l'Industrie Nationale, September, 1901, in which he throws an extraordinary light on the brittleness question, and gives several instances where serious fractures in structural and other steel were not accounted for by any of the ordinary testing methods, but were readily explained when tested for brittleness by an impact machine. At Messrs. Willans and Robinson's, Rugby, it has long been felt that a method of testing such as used by M. Fremont and others was wanted to detect the reason for certain fractures which were inexplicable by the ordinary methods used; and an experimental pendulum impact machine was made, and the tests carried out with it gave promise of such good results that a standard machine was made and is in use at the present time, giving results which gain in importance with every series of experiments carried out on it. Many types of impact machines are used, but the pendulum form of apparatus seems to give most satisfactory results. It can be calibrated to give direct readings for energy absorbed, and lends itself to very quick working even by an inexperienced operator. The idea of the arrangement is as follows: A weight is suspended pendulum-wise on a stiff rod, which swings from a centre designed to be as frictionless as possible. This weight or tup is then moved out of the vertical, and allowed to fall on to the free end of a test piece gripped by the other end in a vice, the specimen being notched to locate the break, the height of fall being always made sufficient to cause fracture with one blow. A suitable measuring arrangement is used to record the energy remaining in the weight after fracture of test-piece has occurred, and this subtracted from the calculated energy in the tup before fracture gives the energy required to break the specimen. Measurements are taken of the test-piece, and results are transferred to equivalent energy absorbed on specimen 1in. square.

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Fig. 1.—Map of the Portsmouth Municipal Telephone Area.

PORTSMOUTH CORPORATION TELEPHONES.

Considerable interest has recently been shown in the Corporation telephone undertaking at Portsmouth, from the fact that an enquiry has been held on an application to the Local Government Board for a further loan of £12,000 for extensions. We accordingly took an opportunity of visiting the exchange, which, owing to the

ALDERMAN W. T. DITTMAN, J.P., CHAIRMAN OF THE TELEPHONE COMMITTEE.

courtesy of the consulting engineer (Mr. A. R. Bennett) and the telephone manager (Mr. C. M. Gardner), was open to our inspection. Before proceeding to give a description of the equipment, which in itself is highly interesting, a few words may be said on the commercial policy of the telephone undertaking, for which the Telephone Committee, under the chairmanship of Mr. W. T. Dittman, J.P., is responsible. It will be remembered that the Tunbridge Wells Corporation telephone undertaking, while a complete success from a technical point of view as

MR. C. M. GARDNER, MANAGER OF THE PORTSMOUTH CORPORATION TELEPHONE EXCHANGE.

a telephone exchange, failed owing to its commercial organisation being defective. Our opinion is that if the Telephone Committee of that Corporation had shown the same careful supervision over the commercial affairs of the undertaking as was taken by the consulting and resident engineers respectively over the technical details, the Tunbridge Wells undertaking would not have been purchased by the National Telephone Company. As it was, neither the committee or the Corporation knew what they were spending, nor would they allow the engineers to know, with the usual result that estimates were exceeded and contracts undertaken which were bound to cause unremunerative expenditure. To compare the two undertakings would be, perhaps, invidious, but the chief difference between them lies in the fact that at Tunbridge Wells a very extensive network was organised to connect up a few widely scattered consumers throughout the large area controlled by the Corporation. The cost of this network was excessive, and yet the charges made to these outlying consumers, who were not rate-

MR. A. R. BENNETT, M.I.E.E., CONSULTING TELEPHONE ENGINEER TO THE PORTSMOUTH CORPORATION.

payers of Tunbridge Wells, was exactly the same as if they had been situated within a short distance of the exchange. At Portsmouth, on the other hand, while equal rates are charged to consumers in all parts of the area, the Corporation do not lay down trunk wires to outlying villages unless they are guaranteed a sufficient number of subscribers to make the outlay remunerative. In the same way, the committee have kept a close hand on the expenditure by obtaining from their resident engineer monthly accounts, which clearly show how the undertaking is pro-

MR. T. HOLME, ASSISTANT MANAGER.

gressing and how the cost of maintaining their system compares with the actual revenue. The result of this is that while there was much captious criticism at the recent enquiry, the committee were able to show that their consulting engineer's estimate of capital cost for a given number of lines had not been exceeded. All the time this businesslike policy is followed the committee at Portsmouth will retain the confidence of the Corporation, and the undertaking will not get into financial difficulties owing to the accumulation of an unknown deficit, as was the case at Tunbridge Wells.

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The history of the Portsmouth telephone undertaking is only a comparatively short one. The license granted by the Postmaster-General was for an area of about 100 square miles. In Fig. 1 we give a reproduction from an Ordnance map, upon which this area is included within a shaded line. The heavy black lines on this map denote the routes of the junction wires connecting up the various villages. It will be seen that the junction lines to the west terminate in the town of Gosport. Thus telephone communication between Portsmouth and Gosport is carried out by means of long junction wires, although the two towns are comparatively a short distance apart, being only separated by the harbour. At the time we inspected the exchange we tried speech with various outlying districts, and found that when conversing with an operator at Gosport the clearness of the conversation left nothing to be desired. The outlying places now connected have the number of subscribers given in the following list: Cosham, 13; Fareham, 35; Gosport, 77; Havant, 10; Emsworth, 5.

The Portsmouth undertaking was commenced in April, 1902, when the then Mayor (Major W. T. Duprée) laid the first pips for telephone wires to be drawn into, and speech was first possible between different subscribers in November, 1902. The exchange was opened in March this year, when there were 701 subscribers connected and 15 junction wires. The charge for the telephone was also commenced that month, and it is worthy of note that the first month's return showed that the undertaking had a revenue greater than the working expenses. The opposition between the Corporation exchange and that of the National Telephone Company is, of course, very great. The result of the competition is yet to be ascertained, but up to the present the Corporation are holding their own exceedingly well. Thus at the end of July this year the Corporation had connected 1,014 subscribers, as against 824 on the National Telephone Company. Of these, 376 subscribed to both undertakings. The system of charging leaves a number of options to the subscribers, and, we should think, makes it somewhat difficult for an inexperienced trader to judge both as to which undertaking he will support and under what rate. Thus, on the Corporation system, he has the

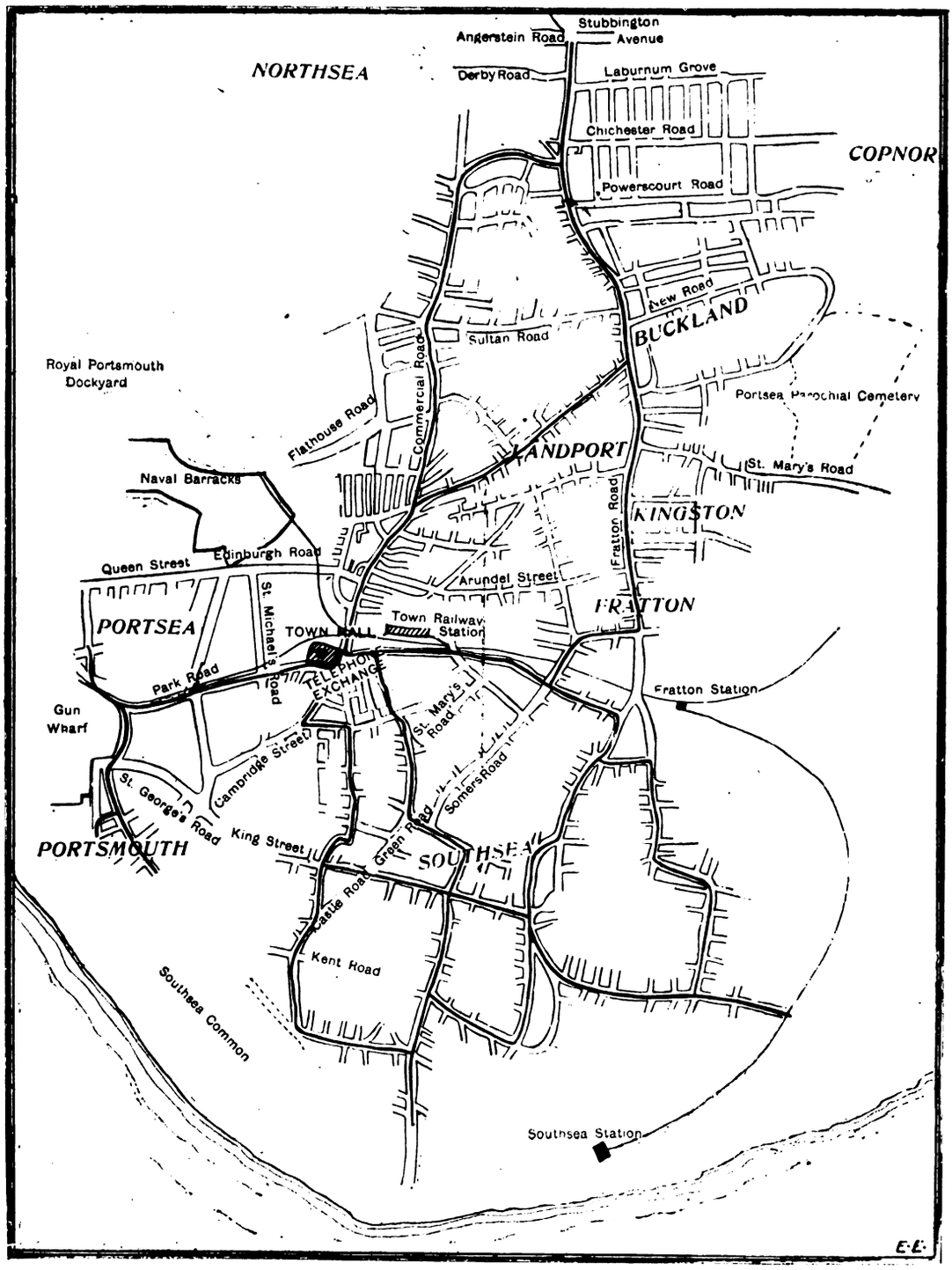

FIG. 2.—Map of the Underground Telephone Cable System at Portsmouth.

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following options: (*a*) unlimited service at £5. 17s. 6d. per annum; (*b*) unlimited service, two-party line, at £3. 10s. per annum; (*c*) toll service at £5 per annum (1,800 outward calls free), ½d. per call afterwards; (*d*) toll service at

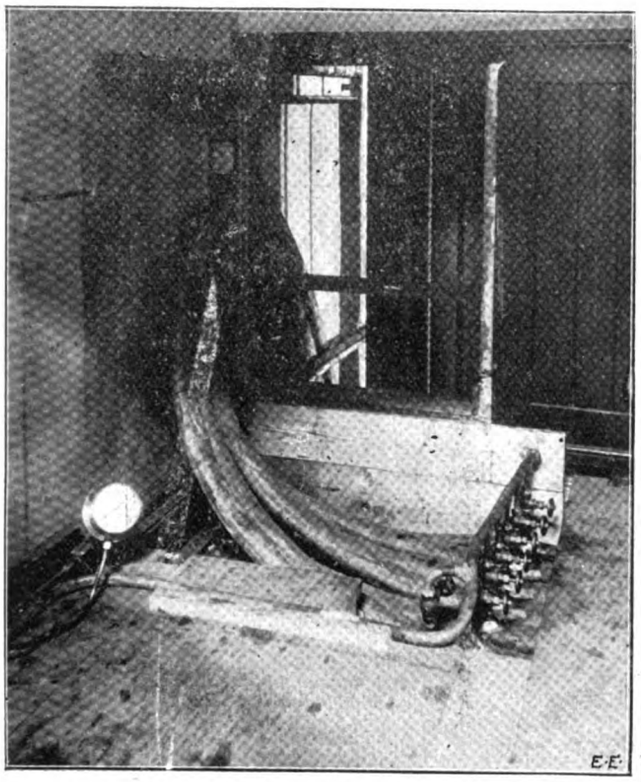

FIG. 3.—View of the Lead Cables coming into the Exchange, showing Air Cocks.

£3. 10s. per annum and ½d. per call; (*e*) toll service at £2. 10s. per annum and 1d. per call. Of the subscribers now connected more than one half pay the full rate of £5. 17s. 6d. for the unlimited service with a private wire.

The National Telephone Company were somewhat hampered in bringing their prices to conformity with the above from the fact that, under their license, they cannot reduce prices for telephone service in Portsmouth without giving an equivalent reduction to the other large towns in England of about the same size. The following figures, however, will show that by introducing alternative tariffs they have evaded the spirit of the terms of the license. On the company's Portsmouth exchange one can now obtain connection with the following annual rentals, with additional charges as given for outward calls: (*a*) unlimited service for £10 per annum; (*b*) £5. 10s. per annum, with 2,500 calls free and ½d. for calls over this number; (*c*) £5 per annum, with 1,800 calls free and ½d. for calls over this number; (*d*) £3. 10s., plus ½d. for every outward call; (*e*) £3 per annum for unlimited service with a two-party line; (*f*) £1. 5s. per annum for connection to an omnibus wire, with 600 free calls; (*g*) a still further alternative is a connection to a 10-party line, paying 1d. for every outward call, with a minimum of one call per day. From the above it will be seen that the company by introducing a call charge for telephone service have rates equal to those of the Corporation. It remains to be seen how far the company can be made to give an equal number of alternatives in the other large towns throughout England.

The system of distribution employed in Portsmouth is a combination of underground cables with overhead distribution from the ends of these cables. Fig. 2 shows the underground mains already laid or under construction for extending the system to 2,000 stations. The cables—air and paper insulated—are laid in 9in. cast-iron pipes 3in. internal diameter, and are jointed and distributed from junction boxes of Staffordshire blue brick with ventilated covers. The main cables are led into the testing-room and connected to the main distributing board for testing purposes; they are also fitted with taps for pumping dry air into the lead covering, as shown in Fig. 3. The lines are then cross-connected on to the lightning arresters and high-tension guards supplied by the International Electric Company, from where they are led to the switchboard. The switching system adapted is the central battery signal with local batteries in the subscribers' instruments. The subscribers' instruments were manufactured by the Ericsson-Bell Telephone Company, and the whole of the underground work, including the supply and laying of pipes and cables, was carried out by the British Insulated and Helsby Cables.

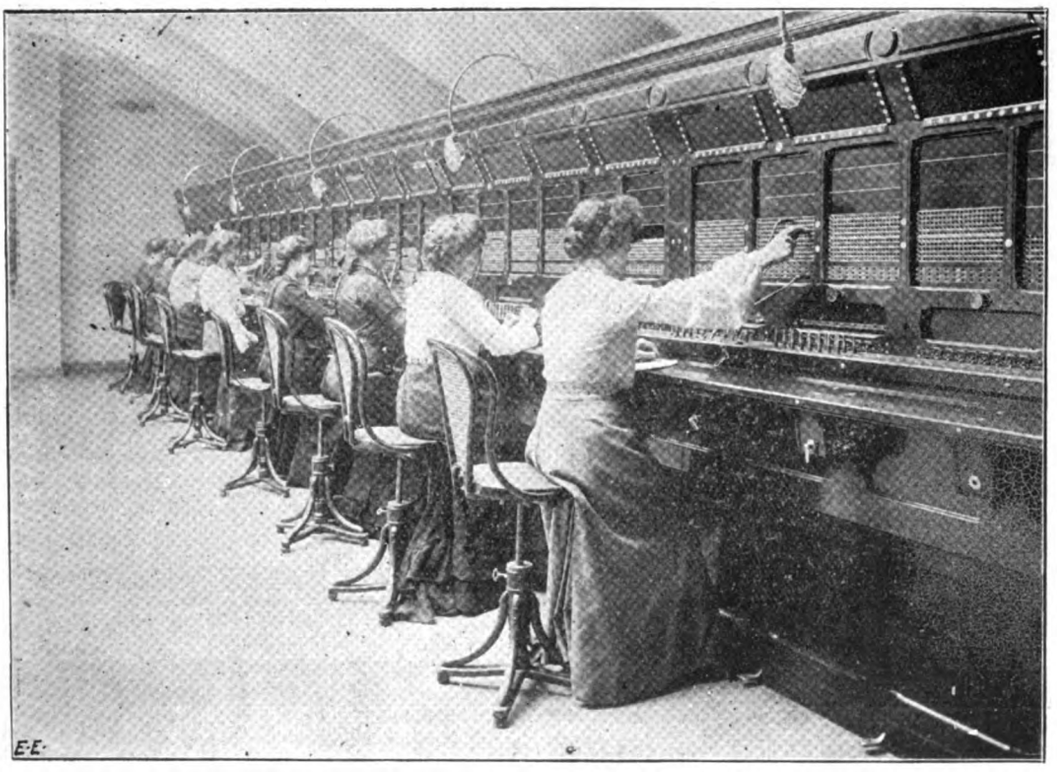

FIG. 4.—The Portsmouth Corporation Telephone Switchboard.

The switchboard is situated on the third floor of the town hall in an ideal room for telephone exchange purposes, as will readily be seen from Figs. 4 and 5. This room is excellently lighted, and a false floor gives ample space

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under it for the connecting wires. The switchboard was manufactured and supplied by the Telegraph Manufacturing Company, now the British Insulated and Helsby Cables, Limited. Each operator's position is fitted for 50 lines with "star" informer, which indicates when any of the 50 are calling. Each subscriber's metallic circuit is fitted with an indicator, which operates whenever a subscriber calls by simply pressing a red button on his instrument. When the answering plug is inserted in the local jack the indicator is automatically cut out of circuit, and the metallic loop is in direct communication with the operator. On learning the number required she tests with the thimble, and if the line is disengaged rings the subscriber by means of a pedal worked by the foot, and then completes the circuit. The completion of the circuit cuts off the operator's telephone and throws in a "ring-off" indicator. A general idea as to the construction of a section of the switchboard is shown in Fig. 6. The power for supplying the current necessary for the signalling of the subscribers to the exchange, the "ring-off" indicators, the test circuit, operator's telephones, and "star" informer circuit, is derived from the accumulators, which are charged from the electric light mains through a motor-generator, as shown in Fig. 7.

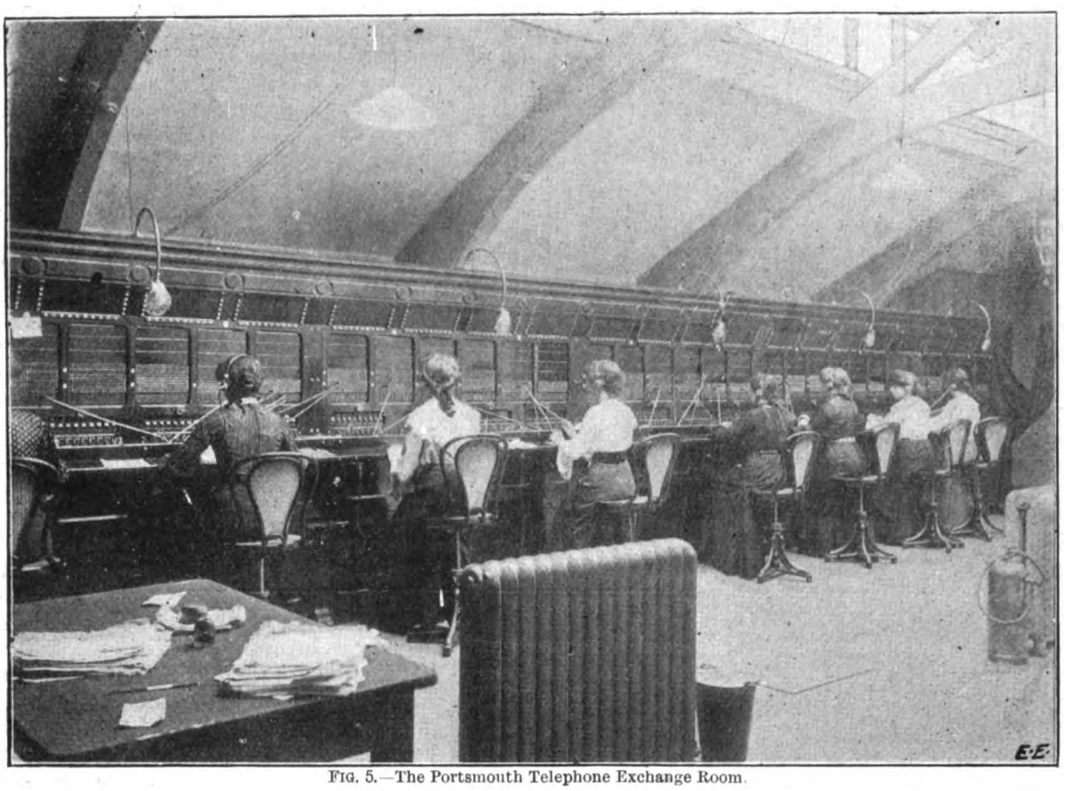

FIG. 5.—The Portsmouth Telephone Exchange Room.

The following more detailed description of the central battery multiple switchboard will be of interest to all telephone engineers: To signal the exchange a subscriber depresses the red button on his instrument, which earths one side of his line, and actuates the grid indicator. The circuit can be traced on reference to Fig. 8, a current flowing from the central battery through the indicator, the inner springs of the home jack, the inner springs of the

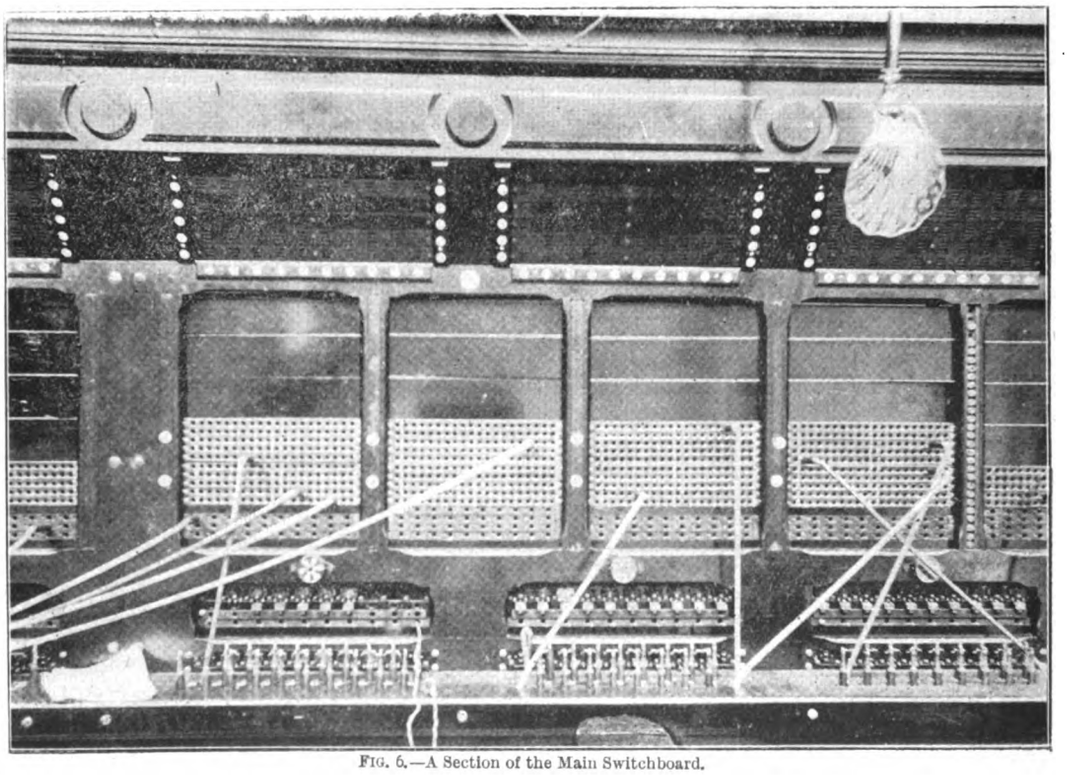

FIG. 6.—A Section of the Main Switchboard.

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multiple jacks to the first multiple, where the inner spring is connected to the earthed side of the line, whence there is a return to the earthed side of the battery. The indicators close the usual night-bell circuit through the star informer. In answer to a call the operator lifts the answering plug and inserts it in the local jack. This breaks the contact of the inner springs, thereby cutting the battery circuit and restoring the indicator, and at the same time connects the operator's telephone on to the plug. On ascertaining the number required the operator touches the bush of the wanted subscriber's jack, and if engaged hears a click in her receiver. The circuit which causes this is from the bush of the jack touched by the test thimble to the bush of the jack on the multiple where the line is already engaged, thence to the barrel of the plugs which are connected to one side of the battery, through this battery, the other side of which is joined to a double contact relay, through the coil of the relay to the test thimble. This energises the relay, thereby closing another circuit through the operator's receiver, as shown on the diagram, causing the click or engaged signal. If the line is not engaged she lifts the calling plug, which automatically disconnects the cord key from the operator's telephone and connects it to a ring-off indicator. This indicator is wound so that a current passing through both coils in series will not work it, but if a current enters between the coils the shutter falls. From a point between the two coils a connection is made to the negative side of a clearing battery, the positive side of the battery being connected direct to earth. On the completion of a conversation the subscribers replace their telephones and momentarily depress the red button, thereby causing the ring-off indicator to fall, a current flowing from the clearing battery to the centre point between the two coils, through one of the coils, one side of the line which is earthed, and thence to the earthed side of the battery. A subscriber can ring through to another without being cut off, and consequently need not listen at the telephone while information is sought at the other end. The current for ringing the subscribers' bells is derived from an alternating generator, giving 75 volts at 1,000 revolutions, driven by a Robinson hot-air engine.

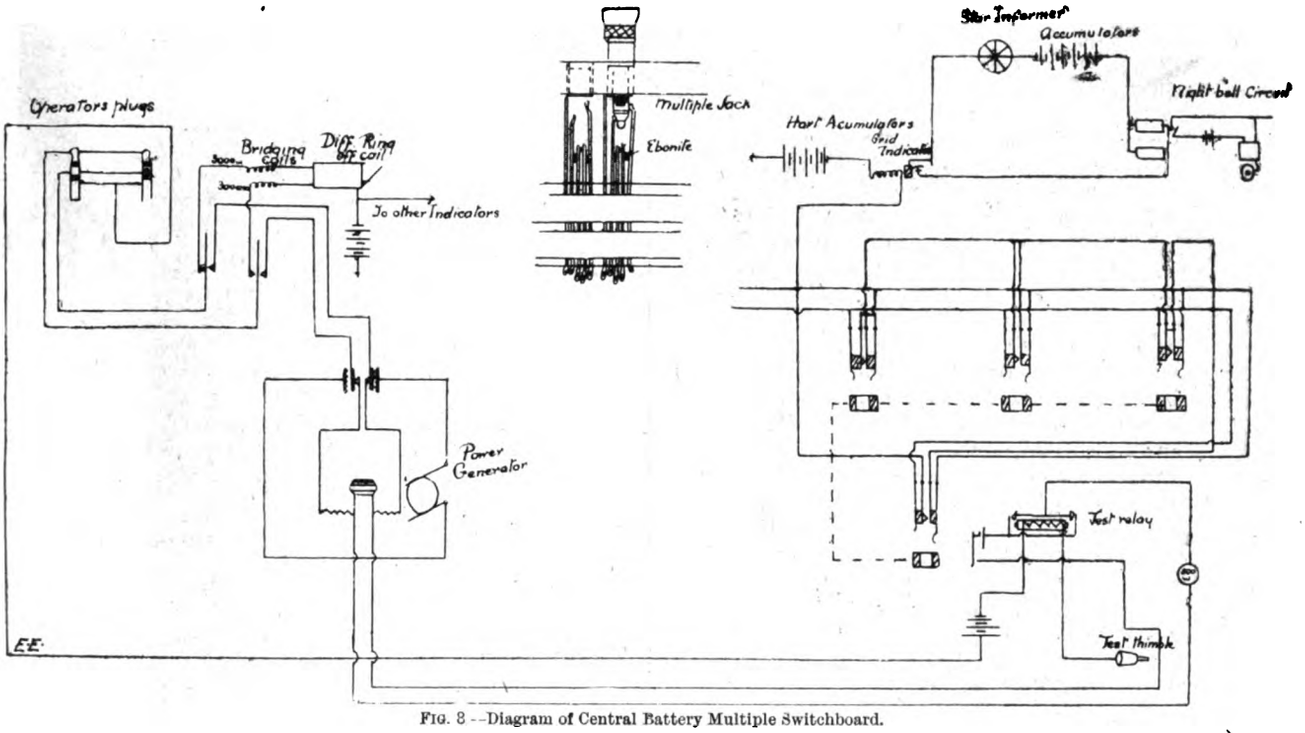

FIG. 8.—Diagram of Central Battery Multiple Switchboard.

The procedure of connecting up for Post Office trunk messages is as follows: The Post Office trunk operator selects the junction and passes the demand on the call wi e. The municipal operator then turns the lever of the speaking and ringing key (as shown in Fig. 9) associated with the circuit named into the speaking position, lifts the plug and tests by momentarily touching the socket at the wanted subscriber's jack. Unless the subscriber be engaged upon another trunk circuit, the plug is then inserted into the jack, and if the subscriber be disengaged the municipal

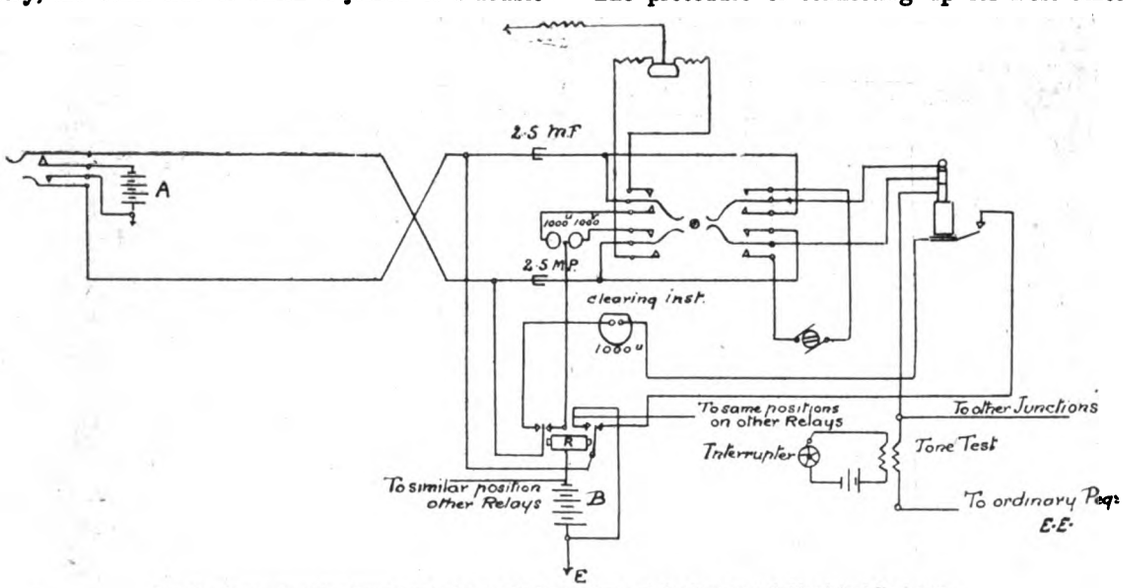

FIG. 9.—Connections for Junctions between the Post Office and the Portsmouth Municipal Exchange.

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operator rings until attention is gained. If the subscriber be already engaged upon a local conversation the trunk call is offered, and if it be accepted the local connection is severed. When the conversation terminates the subscriber rings off in the usual manner by depressing the red button on his instrument, thereby momentarily earthing the circuit. Relay R is in consequence actuated and closes a circuit which includes R itself, the junction

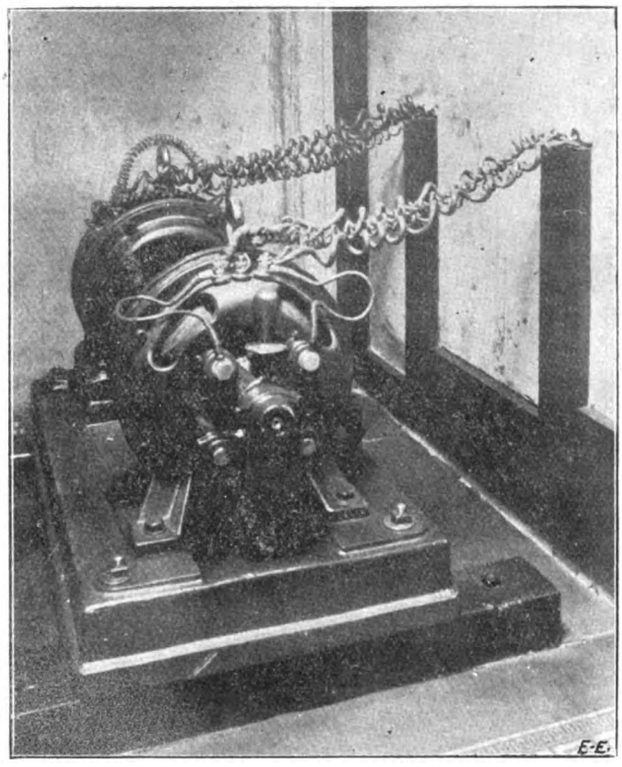

FIG. 7.—The Motor-Generator.

circuit, the indicators at the Post Office, and the battery B. A current then flows from the latter, which retains relay, R, and at the same time causes the indicator at the Post Office to display a clearing signal. The trunk operator then clears, throwing battery A into opposition to B, and consequently relay, R, ceases to be energised and again connects up the clearing indicator, which now gets a current from the battery A. The local operator then clears, the restoration of the plug breaking the clearing indicator circuit. If, owing to the expiration of the time allowed, the Post Office operator disconnects before the subscriber clears, the clearing signal is sent to the municipal exchange even if the subscriber omits to earth the circuit.

The power plant at Portsmouth for converting the alternating currents from the town mains into direct current for telephony consists of three panels of polished slate, as shown in diagram Fig. 10, the left-hand panel being the motor panel, the right-hand the dynamo, and the centre the

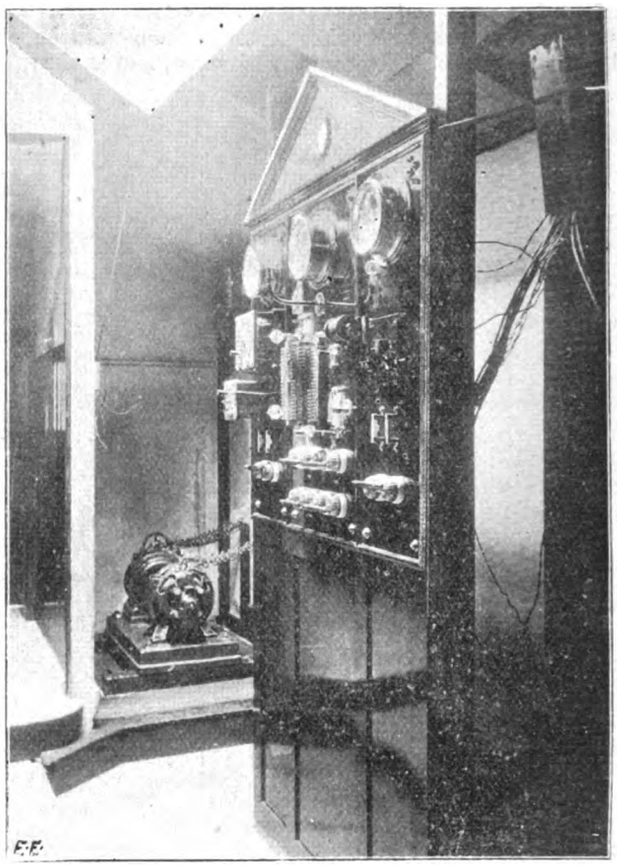

FIG. 11.—View of the Power Switchboard and Motor-Generator.

feeder. On throwing over the switch on the motor panel, the 100-volt alternating town supply is connected to the starting box, and on moving the starting-box switch to the centre stud the motor starts up from rest. When run up to speed the switch is moved to the next stud, which cuts out the resistance coils and allows the motor to attain full speed. The dynamo field is then joined in series with

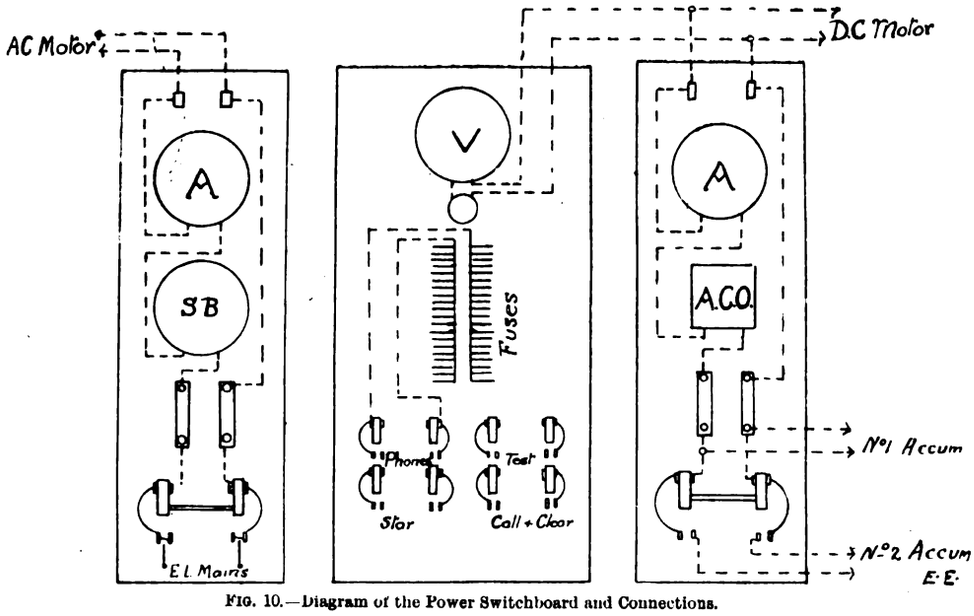

FIG. 10.—Diagram of the Power Switchboard and Connections.

resistances, the machine being shunt wound, and the dynamo volts taken before the accumulators are thrown into circuit. The double-pole accumulator switch on the right-hand panel is then thrown over, and the automatic cut-out set into the circuit. On a reversal of the current the cut-out automatically falls down, thereby disconnecting the dynamo. The feeder panel is mounted with copper bus bars, the

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various circuits for the calling, ring off, test, and operators' telephones being bridged across same by means of double-pole throw-over switches. In all the circuits are pilot lamps, which indicate any undue leakage of current. There are ampere-meters in the alternating-current circuit and the charging circuit, and a voltmeter to indicate the volts in the charging circuit and each of the feeder circuits. The dynamo is fitted with choking coils, so that in the case of the breakdown of the accumulators, which are connected in shunt, all the circuits can be worked direct on the machine. In the case of the breakdown of the dynamo there is a duplicate set of accumulators, which can be thrown into circuit until the fault is rectified. We were surprised to find that when working direct from the dynamos there was no dominant note from the commutators superimposed on the telephone speech. This, we learn, is avoided by special construction in the dynamos which involves the use of choking coils in the circuit. All the wiring of the circuits for starting the motor-generator and charging the accumulators, as well as feeding the switchboard circuits mentioned above, are brought on to the power board. This board was specially designed for the work, being the only one of its kind fitted in this country. A general idea as to this view of its construction and of the motor-generator may be gathered from Fig. 11.

The outside construction and the instrument fitting were carried out by the Corporation's own staff in preference to letting same out to contract. In extension work even more will be done by direct labour. The chairman of the Telephone Committee, Alderman W. T. Dittman, J.P., along with the committee, has guided the scheme to its present success in face of great opposition.* In conclusion, we have to thank the consulting engineer for the scheme, Mr. A. R. Bennett, of Glasgow, for permission to prepare the above description. Our thanks are also due to Mr. C. M. Gardner, manager, and to Mr. T. Holme, assistant manager, for kindly showing us all the details of the undertaking.

THE VENTILATION OF DEEP-LEVEL UNDERGROUND RAILWAYS: A SUGGESTION.

BY B. PONTIFEX.

The controversy lately carried on by various energetic daily papers about the state of the air in the "Twopenny Tube," apparently settled down to a dispute concerning the comparative deadliness of the carbonic acid from the coal in use on the Metropolitan Railway and that given off by the thousands of more or less washed humanity who patronise the tubes. Various schemes have been proposed, and some are under trial, with a view to giving fresher air at the deep levels, but they all fall under one of the following headings: (*a*) practicable, but barred by financial considerations; (*b*) utterly useless, even when not expensive; (*c*) a compromise between *a* and *b*—not too expensive, but only half doing the work.

The chief point about any system of ventilation is that, to be effective, it must be both continuous and automatic. Further, it is quite hopeless to expect the trains to accomplish anything but a somewhat useless churning of the air already in the tubes, because the Board of Trade would probably condemn any system of automatic shutters which would enable the trains to force air in and out of the stations by way of the lift-wells and staircases.

A solution of the difficulty lies in drawing off the foul air by pipes which have their suction inlet in the tunnels midway between stations, and discharging it by an upcast shaft at the level of the housetops. Fresh air would then enter the line at every station, instead of a nauseating draught of foul air slowly struggling out on the footpath, as at present. The suction inlet of the pipes is necessarily midway between stations, because it must be at the greatest possible distance from the fresh-air inlets in order to make sure that every particle of foul air is withdrawn.

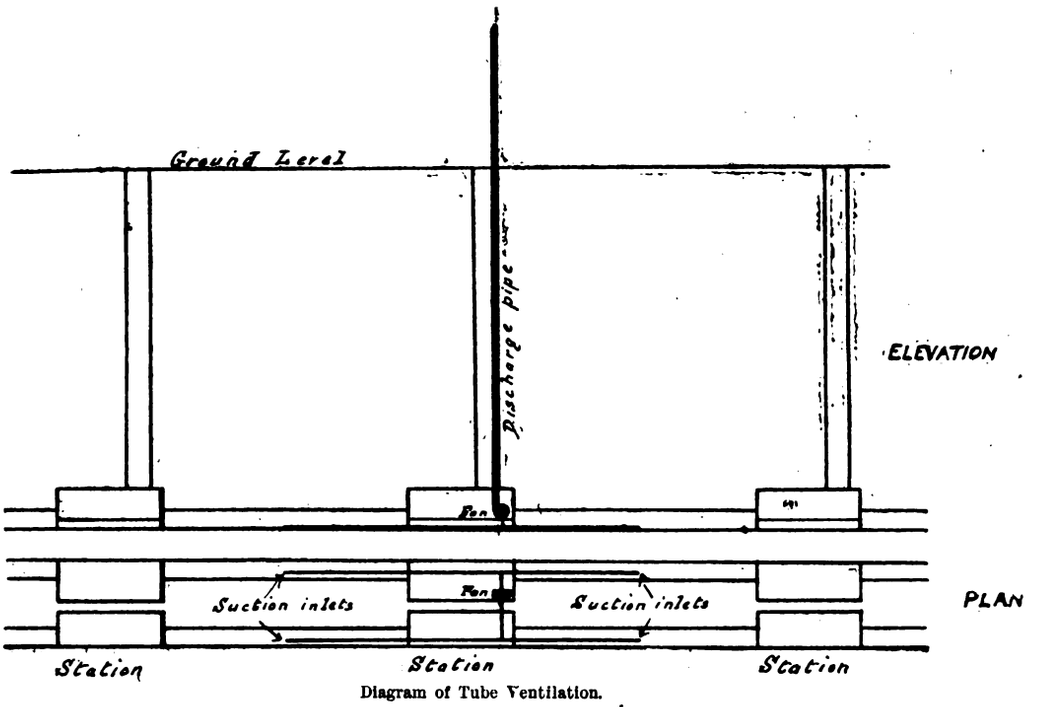

Diagram of Tube Ventilation.

The suction pipes can either be run in the tunnel invert under the rails (if these are laid on longitudinal sleepers), or can be fastened to the side in a similar manner to the cables, while the delivery shaft can be carried up the centre of the stair-well. Their cross-section would have to be arranged to get the greatest area without allowing undue flattening at corners, which would increase friction in an unnecessary manner.

The average distance between "tube" stations works out at about 700 yards, which, with a fan at alternate stations, give a total of 2,200,000 cubic feet of air to be dealt with by each fan. For this calculation the lift shafts have been taken as 30ft. diameter by 60ft. deep, station tubes 35ft. diameter by 250ft. long, and running tunnels 12ft. diameter. Some of these dimensions are excessive in order to allow for passages, etc. To entirely renew this quantity of air three times during the 20 hours when a tube line is at work, means that the fan must deliver 5,500 cubic feet of foul air per minute at a pressure (at the fan) of about 4½in. water-gauge. A reference to a fanmaker's catalogue will show that a 36in. by 4½in. fan will deliver 5,900 cubic feet per minute at 4½in. water-gauge pressure when driven by a 10-h.p. motor at 950 revolutions per minute.

* The first loan obtained was one of £25,500, and with the £12,000 now applied for the department will have capital funds to last some two years at the present rate of progress.

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To sum up, to obtain a thorough change of air three times a day in any average tube railway by continuous ventilation it is necessary to fit a 10-h.p. motor and fan at alternate stations, fitted with suction pipes running in both directions in each tunnel, and a delivery shaft carried up the centre of the stair-well. To make sure that the motors were at work whenever traffic was running, they could be supplied with current from the track through automatic starters. The whole scheme is practically automatic, and does not require any special closing of air-tight doors when traffic ceases, neither does it entail the use of a huge fan that is idle 20 hours of the day, and whose efforts are nullified five hours after traffic starts in the morning. Moreover, it can be fitted to any existing tube railway.

A SIMPLE OSCILLOGRAPH.*

For the purpose of studying the occurrences in an alternating circuit, especially if the results are to be exhibited to an audience, by far the best instrument is an oscillograph. Unfortunately, these instruments, as perfected by Messrs. H. Blondel and W. Duddell, are too expensive to come into general use. The writer has, however, constructed a simple oscillograph which has proved quite successful in the case of comparatively slow periodic changes, such as alternating currents at ordinary frequencies. The principle of this instrument is the same as that employed by Mr. Duddell. A loop, D, of hard-drawn silver wire is tightly stretched between the poles, N_3, of an electromagnet (Fig. 1). The two sides of the loop are parallel, and lie 2mm. to 3mm. apart, and a small mirror of thin glass is stuck to them. When a current is sent through the wire with the magnets excited, the moving system is deflected to an extent approximately proportional to the current strength, just as in a D'Arsonval

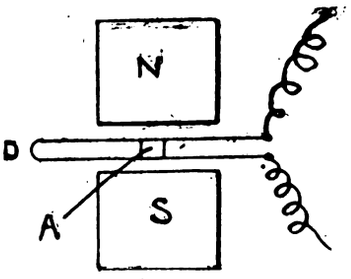

Fig. 1.

galvanometer. If the current varies periodically, the instantaneous deflections will still be proportional to the instantaneous current values provided that the natural period of the moving system is very short compared with the period of the current, and also that the damping of the system is very great. By employing a powerful magnet and a tightly-stretched wire both these conditions may be fulfilled.

Fig. 2 is a photograph of the apparatus as constructed by the writer. Two identical oscillographs are supported in an easily adjustable manner. Each consists of an electromagnet with bevelled poles very close together. The wire is mounted on ebonite, with a tightening arrangement. Each oscillograph is mounted complete with its terminals on a baseboard, A. The double apparatus shown is useful for taking two curves simultaneously. The arrangements for exhibiting curves are shown diagrammatically in Fig 3. The writer employs a small $3\frac{1}{2}$-ampere arc lamp as a source of light, L, and the beam from this passes through the lens, A, which makes it parallel, and falls on to the small oscillograph mirrors. From these the light is reflected to the revolving mirror, Sp, and thence on to the screen, S, the images of the two mirrors being made to fall on the same spot. When the mirror, Sp, is rotated the curves become visible on the screen. The amplitude of the curves can be varied at will by altering the tension of the wire or the distance of the screen from the mirror, Sp. If the screen is placed 2m. away, an amplitude of 100cm. can easily be obtained with about half an ampere in the wire loop.

For the purpose of demonstrating phase displacement between two circuits of which one is inductively loaded, the arrangement shown in Fig. 4 may be used.

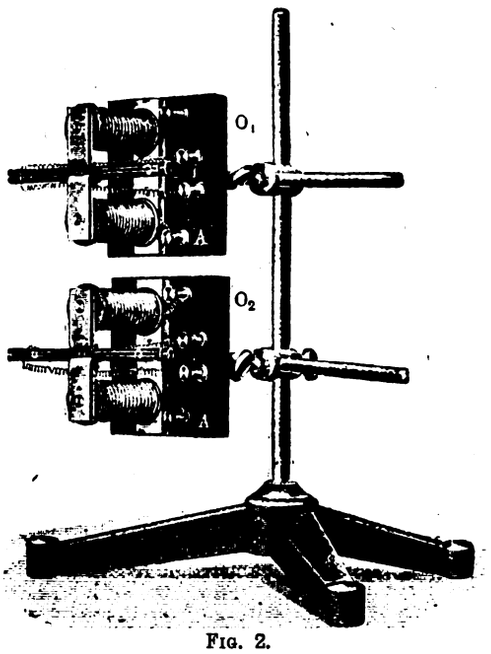

Fig. 2.

Two circuits are connected to the alternator or rotary converter, U, one containing a large non-inductive resistance, W_1 and one oscillograph, O_1, and the other containing a change-over switch, C, and a small adjustable resistance, W, to which the second oscillograph, O_2, is connected. By

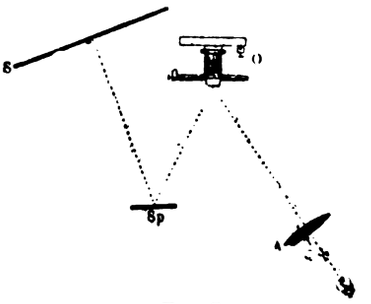

Fig 3.

means of the change-over switch either the non-inductive resistance, W_2, or the inductive coil, L, can be inserted into this second circuit. W_2 is chosen so that the current strength may be the same with either inductive or non-inductive resistance. In this way oscillograph O_1 shows the E.M.F. curve and oscillograph O_2 the current curve.

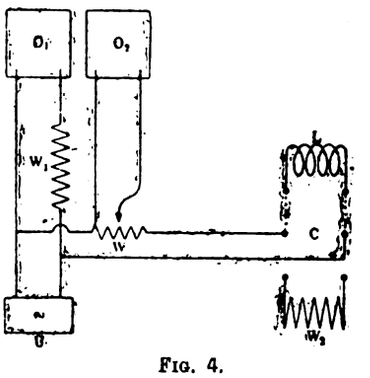

Fig. 4.

When W_2 is in circuit there is no phase displacement and the one curve lies over the other, the amplitudes being preferably made different by adjusting W or W_1. If, however, L is inserted the two curves will be seen to separate on the screen. By gradually inserting an iron core into the coil L the simultaneous effect of self-induction on the phase displacement and on the current value can be

* Translation in abstract of a paper read by A. Wehnelt before the German Physical Society.

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shown on the curves. By means of condensers the reversed phase displacement due to capacity can be demonstrated. The oscillograph is also very successful in showing the voltage and current variations occurring in the alternate-current arc. The curve of current on breaking circuit either with a metallic switch or a liquid one can also be easily shown. Many other applications will suggest themselves, the only limiting factor being the speed of variation. Thus, if the periodic time of the changes to be considered is under ·01 second, the natural swing of the system will interfere with the results, as with such an instrument the natural time of swing is about ·003 second, whilst in the Duddell oscillograph it is only about ·0001 second.

BRIGHTON MUNICIPAL TELEPHONES.

What is described as the "informal opening" of the Brighton municipal telephone system was performed by the Mayor (Mr. J. C. Backwell) on Monday in the presence of the members of the Telephone Committee and representatives of the Press. This is the second town on the South Coast to inaugurate a municipal exchange within the space of a week, the other case being that of Portsmouth. The Mayor opened the exchange by send a message to Councillor Beryl, of the Theatre Royal, who had the privilege of being the first subscriber to be rung up on the Corporation system. Subsequently several other subscribers were rung up and conversed with by the Mayor and other gentlemen present. Heartiest good wishes were expressed at both ends of the wire for the success of the undertaking, and everything passed off without anything in the nature of a hitch. The section of the system inaugurated on Monday is that covering the central portion of the town. The laying of the underground ducts was commenced on March 9 last, and up to date 25 miles of duct have been laid within the borough of Brighton. The work of laying ducts within the borough of Hove was commenced at the end of last month, and will be completed within two months. This portion of the work, both in Brighton and Hove, is being carried out by Messrs. W. T. Henley's Telegraph Works Company, Limited, of London. The cable which has been drawn into the ducts commences at the exchange with 626 wires and extends to the borough boundary on all sides, gradually diminishing, as connections are made to subscriber's premises, to 12 wires at the extremities. The number of wires at the exchange is over 3,000 at the present time. The British Insulated and Helsby Cables, Limited, of Prescot, Lancashire, are responsible for this part of the work.

The switchboard is being supplied and erected by the Ericsson-Bell Telephone Company, of Glasgow, and is unique of its kind. To call the attention of the operator the subscriber lifts the phone from its rest, and when conversation is finished replaces it, and thus gives the clearing signal automatically. A special feature is that in the event of a called subscriber not responding at once, the caller may himself ring without affecting the exchange. This will materially accelerate the operating. The switchboard is at present fitted for 1,000 subscribers, with an ultimate capacity of 5,000. The number of applications for telephone service having already considerably exceeded 1,000, the work of extending the board is to be proceeded with at once.

The instruments, which are of elegant design, bearing the borough arms, are a combination of the latest devices for giving an excellent service with a minimum of trouble to the subscribers, and are also supplied by the Ericsson-Bell Company. The fitting of these, together with the wire leading from the underground points, is being carried out by the department, instead of by contractors as originally intended. The area covered by the license extends to Burgess Hill on the north, Shoreham and Steyning on the west, and Rottingdean on the east, and embraces a number of smaller places and villages near Brighton. The extensions to these places are at present under construction. The subscription of £5. 10s. per annum for unlimited service covers the whole area without extra charge, and subscribers may also speak to any other town in the United Kingdom over the Post Office trunk wires on payment of the usual fees. The formal opening of the system for the public use will take place in the course of a few weeks when the construction is further advanced.

COMBINED REFUSE DESTRUCTORS AND ELECTRIC LIGHTING WORKS.

In view of the great deal that has been written and urged in favour of the combined dust destructor and electrical generating station, and the economical results which are said to result from such combination, the following report will, we think, be read with particular interest by electrical engineers at the present time. It has been prepared jointly by Mr. H. Mair (the borough surveyor) and Mr. G G. Bell (the resident electrical engineer of Hammersmith), who were instructed by the Cartage and Electricity (Joint) Committee of the Hammersmith Council to report upon the question of a refuse destructor for the borough. The report, which we reproduce in full, reads as follows:

"In accordance with your instructions, we herewith beg to report upon the question of a refuse destructor for the borough of Hammersmith. It is perhaps unnecessary to explain, in the first instance, that the primary object of refuse destruction is the disposal, in a sanitary manner, and rendering innocuous, all waste materials collected from the private house dustbins and trade refuse. If at the same time not only can this object be realised, but some useful product obtained by so doing, without any corresponding disadvantages or drawbacks, the cost can be materially reduced and the financial aspect of the question becomes more favourable. It is our duty to lay before you the *pros* and *cons.* of this question from these points of view.

"In the first place, there is no doubt whatever that a proper system of refuse destruction is the most sanitary method of dealing with the house refuse collected from large communities, as it can be dealt with close at hand, thus avoiding the risks and cost of transit to the dust shoots, which must of necessity be some distance from the large centres of population. The question of cost, however, is to a very large extent the ruling factor, and as the available shoots near at hand are gradually filled up, this simple method of dealing with the matter becomes more and more expensive, although from a sanitary point of view it does not materially affect the persons whose refuse is carted away. Dust destructors, therefore, really affect the community at large, and if the cost of dealing with our refuse by means of a dust destructor is heavier than by sending it away, we are paying this extra money simply for a more ideal state of affairs.

"At the present time the disposal of refuse is receiving the very serious consideration of the authorities throughout the whole of the kingdom, and up to the present time about 160 towns in Great Britain and Ireland have adopted some form of destructor. A large number of these, however (nearly one-third), have been erected quite recently, so the actual cost of dealing with refuse in this manner cannot be accurately ascertained with a modern form of destructor. It must also be borne in mind that many of these towns have no other possible method of dealing with their refuse. As, however, some municipalities have been carrying out experiments in this direction for a number of years, it will not be difficult to arrive at a figure which will give the approximate costs and be suitable for basing our estimates upon.

"The perfect dust destructor has not yet been designed, and should be a combination of the following points, but there are some very good approaches to it on the market: (1) perfect cremation of the refuse, so that there can be no offensive nuisance from partly burned gases; (2) must be capable of dealing with the refuse immediately it is delivered, so that it is not necessary to store same, as it quickly becomes offensive under these conditions; (3) no nuisance to the surrounding neighbourhood through fine dust or grit being distributed from the chimney stack; (4) the furnace temperature should be so great that the residue

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is melted and forms hard clinker, which then becomes a useful by-product. None of these points should be sacrificed in order that the refuse should be used instead of coal for any useful purpose, and if these points can be fully met and any surplus heat used for generating steam, then this steam may and should be used for driving the necessary machinery required in the destruction of the refuse, and we believe that there would be very little, if any, heat available for any other useful purpose.

"It would perhaps be as well to examine the conditions which prevail at Hammersmith, and ascertain the cost of erecting and working a destructor, and also see if any useful purpose could be served by the apparatus after its true functions have been carried out. The actual amount of dustbin and trade refuse dealt with last year was approximately 28,000 tons, but as the population of the borough is continually increasing, any destructor erected should be capable of dealing with 30,000 to 35,000 tons per annum, which, taking 300 working days in the year, will give an average of about 100 tons daily. The cost of the necessary dust destructor, as well as tipping floors, boilers, dust-catcher, buildings, and chimney, would be about £18,000, to which must be added the cost of the land. The area required would be approximately one acre, as provision must be made for a necessary inclined approach road, stores, and other buildings. This may be estimated at £2,500. The London County Council would lend this sum to be repaid within 50 years, on which we should have to pay interest at the rate of 3½ per cent. per annum, so the capital charges for interest and sinking fund on the land would amount to £93. 10s per annum. The amount, £18,000, to be borrowed for the buildings and machinery, we may take it, would have to be repaid within 30 years, and interest at the rate of 3½ per cent. per annum, so these capital charges for interest and sinking fund would amount to £915 per annum.

"In provincial towns where destructors are at work it is found that 1s. per ton is the average cost for labour only at dust destructors combined with electricity works, but this is increased to 1s. 8d. per ton if the London installations are included, so we must infer that the cost for labour here will be at least 1s. 8d. per ton, which must be added to the above figures. A further amount must also be included for depreciation, which we believe will ultimately prove to be a very heavy item, and it is not safe to estimate this at less than another 5 per cent. on the whole cost of the plant, in addition to the sinking fund previously mentioned, which will amount to another £900. When the refuse has been tipped into the destructor cell this is not the end, as there is a very heavy residue to be dealt with, which varies from 25 to nearly 50 per cent. of the total quantity placed in the cell. This must be disposed of in some manner or other as rapidly as it is made, and where building operations are in active progress or a large number of new streets and roads are being made up in the district it might be disposed of, but in our case, where sand is abundant and the number of new roads to be made is extremely small, we believe there would be difficulty in disposing of approximately 10,000 tons of clinker without barging away.

"These items may be briefly summarised thus: Cost of land—£2,500 for 50 years at 3½ per cent., £93. 10s; buildings—£18,000 for 30 years (£600 sinking fund, £315 interest) at 3½ per cent., £915; 30,000 tons of refuse at 1s. 8d., £2,500; add 5 per cent. for depreciation, £900; 10,000 tons of clinker at 2s. 7d., £1,291—total £5,699. 10s. The cost of barging away dust at the present time is 2s. 7d. per ton, which at 30,000 tons per annum equals £3,875, showing an increase of £1,824 per annum. Of course, it is possible to use the hard clinker for manufacturing artificial stones for paving, but the plant necessary to do this—*i.e.*, mills, crushers, hydraulic press, etc.—would cost a further £2,000 before we could deal with this clinker satisfactorily and economically.

"Taking it for granted that we should be able to get rid of the whole of the clink, the question arises as to whether any surplus steam which the destructor would generate could be utilised for any useful purpose. This entirely depends upon the amount of steam and the steadiness at which the supply can be maintained, as, of course, an intermittent supply would not be of any use from a commercial point of view. Mr. Goodrich, in a paper on 'Refuse Destructors,' recently stated that out of 160 towns in Great Britain and Ireland whose authorities have adopted dust destructors, 45 are combined with electricity works, 26 are combined with sewage works, whilst the remaining 89 towns use their destructors for destruction only, and do not attempt to make anything else out of same. This question is one turning upon the calorific value of the refuse, and the position which Hammersmith occupies does not justify one in looking for a very high calorific value for the following reason: it is not the centre of any very large industrial activity, so that the amount of trade refuse is absolutely a negligible quantity; it is not the centre of a rich residential district, so that the amount of combustible material in the house dustbins is reduced by the residents to the lowest possible denomination. An examination of the refuse tipped will bear this out, and, in fact, we are afraid that in order to obtain a sufficiently high temperature to ensure perfect cremation of the gases it would perhaps be necessary to add a little coal to the refuse to obtain this result. If we are fortunate enough to burn the refuse without the aid of coal, then the surplus heat, after driving the necessary plant for producing the forced draught, lighting the building, driving any artificial stone machinery, etc., will be such a negligible quantity that it is not safe to allow any credit for this in making out the estimates. Taking the average cost per ton as shown above, we arrive at a total cost of 3s 9¼d., which, we think, is a fair estimate, and may be taken as the average cost.

"The actual ascertained cost at Fulham is 3s. 7d. per ton, before, however, allowing a sufficient sum for depreciation, and working a more expensive plant suitable for assisting the electric light works. Upon examination of the annual returns of six London municipal electric light stations, three of these having the assistance of destructors, and three with coal only, the following comparison shows the value of a dust destructor: Capital expenditure per kilowatt of non-destructor stations, £80; capital expenditure per kilowatt of destructor stations, £118. The working costs of non-destructor stations is 0·2d. per unit higher than the destructor stations, which upon 5,774,644 units (their total output) represents £4,895. The extra cost of the capital involved to effect that saving is, apparently, at 5 per cent., £7,395, showing a net loss of £2,500 per annum as the cost of combining dust destructors and electric light stations. Turning again to the Fulham result: the resident engineer reports that the value of the fuel saved by using dust was £2,260 per annum, which, however, we find would be turned into a loss of about £200 if a proper amount were set aside for the depreciation of the special plant.

"We have arrived at the following conclusions: (1) That barging away is more economical at the present time. (2) That the refuse has not sufficient calorific value to justify the combination of a dust destructor with the electricity works. (3) That there is every probability that the cost of cremation of refuse will greatly decrease, whereas the cost of barging is more likely to increase. A time will come when the destructor will be necessary, and it would be good policy to obtain the necessary ground at once, having easy facilities for transport, thereby reducing the cartage."

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

AWARDS AND AWARDS—VALUABLE OR OTHERWISE.

[The following is the copy of a letter we understand was sent to the secretary of the International Fire Exhibition.—Ed. *E. E.*]

"*Re* Awards.

"Dear Sir,—We are obliged by your favour of the 16th inst., accompanied by a list of the awards made by the jury.

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"We are surprised to note that we have been awarded a bronze medal under Group 3—'Fire alarms, telephones, and telegraphs'—and it is very remarkable that we should have been awarded a bronze medal for something which we did not exhibit.

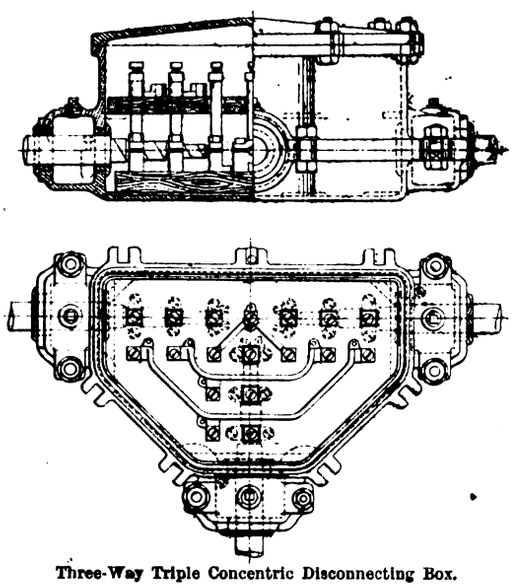
"If you will refer to our inventory sent you at your request for use of the jury, you will see that on the two pages of foolscap there is no reference whatever to any exhibit of this kind, and while the jury were at our stand we did not show them anything pertaining to telegraphs, fire alarms, or telephones.

"Perhaps the fact that our exhibit was examined immediately after lunch may account for the extraordinary classification.—Yours, faithfully, ———

TRADE NOTICES AND NOVELTIES.

Junction Boxes, etc.

Catalogue J. B., just issued from Messrs. Johnson and Phillips's Electric Cable Works, Old Charlton, Kent, deals with the various kinds of junction boxes and cable accessories manufactured by this firm. Included among the apparatus illustrated is a special form of mains disconnecting box, with fittings mounted on a marble slab on the 'bus-bar principle, so that any cable may be disconnected by means of its link without disturbing the rest. Another speciality shown is a mains fuse box, the position of which on a network system is generally on a set of distributor cables, which connect two feeding points, and its function is to blow its fuses when a fault occurs on either feeding area, and thus isolate the fault. The two outer conductors of the three-wire system have fuses and handles with clip contacts, and the neutral wire is connected by a solid link. One of the essentials of such a box is, of course, accessibility of the fittings, and we note that attention has been given to this point, also that ample clearance is allowed between fittings of opposite polarity and the sides of the box.



Three-Way Triple Concentric Disconnecting Box.

The accompanying illustration shows the arrangement of a three-way triple-concentric disconnecting box arranged on the principle that either of the cables may be disconnected electrically without affecting the connections of the two others. All the links for this purpose are above the compound level, and it can be at once seen to which cable they belong.

Thomson Polyphase Recording Wattmeter.

Pamphlet No. 151, recently issued by the British Thomson-Houston Company, Limited, Rugby, deals with the Thomson polyphase recording wattmeter, an instrument which is supplied for use on either two-phase or three-phase circuits, with balanced or unbalanced loads. It is claimed that this meter gives a perfectly accurate record when used on a circuit having a mixed load of lamps, motors, and other devices, no matter how unbalanced the load may be. Two different patterns are made—viz., round and rectangular.

Primary Cells.

From Le Carbone (late Lacombe et Cie.), 17, Water-lane, Great Tower-street, E.C., we have received a number of leaflets describing several new primary cells, etc., which they are introducing. One of these leaflets deal with the firm's patent carbon headed plate, in which direct contact between the carbon plate and terminal is obtained by means of an arrangement of transverse and longitudinal slots. Increased efficiency, durability, and economy are claimed for this plate. Another of the leaflets describes a form of their "Carbi" cell, which is recommended for open circuit work, and especially for bell, telegraph, and telephone installations. "Carbi" ignition cells; Sack cells for testing sets, alarms, etc., porous carbon cells, and Star agglomerate blocks are dealt with respectively in the remaining leaflets.

David Bridge and Co.'s Manufactures.

We have received from Messrs. David Bridge and Co., Castle Ironworks, Castleton, Manchester, a complete set of their trade catalogues, each of which is profusely illustrated. This firm's manufactures are very numerous, and include a variety of apparatus having a bearing on electricity supply undertakings and electrical manufactures, such, for example, as indiarubber and guttapercha machinery; oil separators for treating the exhaust steam of condensing or non-condensing engines, and for purifying live steam; oil pumps; milling and boring machines; friction clutches, etc. With regard to the oil separators, these are of the "Baker" type, and have been supplied to many of the principal electricity supply stations in this country, we understand.

Sundries.

The latest list of electric sundries (Section S) issued by Mr. G. Braulik, 217-218, Upper Thames-street, London, E.C., contains illustrations and particulars of a large variety of electrical apparatus, including accumulators, accessories for use with accumulators, novelties of various kinds, small motors and dynamos, medical coil sets, induction coils, etc. A patent coupling for arc lamps is dealt with among other apparatus in another list. Our attention is called to a considerable reduction in the price of this coupling.

Brush Lamps and Fittings.

Bulletin No. 4, just issued by the Brush Electrical Engineering Company, Limited, 106-112, Belvedere-road, London, S.E., contains particulars and illustrations of the firm's specialities in the way of incandescent lamps and fittings, together with a number of examples of the practical application of the same.

Ebonestos.

Messrs. B. Weaver and Co., 22, Rosoman-street, Clerkenwell, London, E.C., have sent us some illustrated sheets and tabulated price-lists of their standard "Ebonestos" insulating switch-handles, bushes, and nipples. We note that the listed articles can be delivered from stock.

Simplex Steel Conduit.

We note that the Simplex Steel Conduit Company, Limited, Westinghouse-building, Norfolk-street, Strand, W.C., have been awarded a gold medal in Group 1, Class 3, of the exhibits at the International Fire Exhibition, Earl's Court. This is but one of a number of awards of merit which the above firm have obtained from time to time for their Simplex system of conduits for interior wiring.

Tramway Motors.

Pamphlet No. 152, issued by the British Thomson-Houston Company, Limited, Rugby, deals with tramway motors of the firm's well-known types of manufacture. This pamphlet supersedes Nos. 61, 67, 125, and 132.

Steam Appliances.

The latest addition to the trade literature issued by Messrs. Holden and Brooke, Limited, Sirius Works, West Gorton, Manchester—viz., List 58—is well calculated to convey an idea as to the range of the firm's manufactures, and thus fulfil its intended purpose. The steam users' appliances illustrated include injectors of various patterns, oil separators, steam dryers, feed-water heaters, automatic feed regulators, steam traps, water gauges, strainers, valves, etc.

FORTHCOMING EVENTS.

FRIDAY, OCT. 9.

Electro-Harmonic Society.—At 8 p.m., first smoking concert, Crown Room, Holborn Restaurant.

MONDAY, OCT. 12.

Institution of Mechanical Engineers (Graduates' Association).—At 7.30 p.m., ordinary meeting. Paper: "The Design of a Town's Tramway Scheme," by Mr. Wm. McDonald.

FRIDAY, OCT. 16.

Institution of Mechanical Engineers.—At 8 p.m., ordinary meeting. Paper: "The Newcomen Engine," by Mr. Henry Davey.

SATURDAY, OCT. 17.

Junior Institution of Engineers.—At 3 p.m., visit to the New Vauxhall Bridge Works. Assemble at the Westminster entrance.

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THE

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TO CORRESPONDENTS.

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All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed*

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FISCALITY.

"And so the murder is out." Thus spake Mr. Chamberlain at Glasgow. He has commenced his campaign of missionary work to convince the British and Irish electorate that the axiomatic statement is still true, "Other times, other manners." He has sketched briefly, but lucidly, the direction in which he thinks Great Britain should act if she is to retain her place among the nations. The suggestions he makes are extremely simple, but none the less wise because of that extreme simplicity. If Mr. Chamberlain were a mathematician, he might probably point out that our export trade was the summation of two factors—the one exports within the Empire, and the other exports outside the Empire. He has strongly emphasised the fact that the exports within the Empire have been increasing while those without the Empire have been decreasing, the increase and decrease having been somewhat proportionate, so that, broadly speaking, the total has remained substantially constant. There are indications, however, that the increase within the Empire may be successfully challenged by the competition of outsiders, and if this should be the case his most virulent opponents will be compelled to acknowledge that it would be a bad day for this country. Mr. Chamberlain's proposal is twofold in character. In the first place, he wishes to unite in closer bonds the various constituents of the Empire, and to do this he would shift the incidence of taxation. He does not propose to increase taxation, and, so far, the country as a whole would neither gain nor lose by accepting his suggestions, but he strenuously points out that by shifting the incidence of taxation in the way he suggests we should be enabled to draw closer the bonds of Empire, to render the Colonial markets more secure, and make competition more difficult. Mr. Chamberlain has gone far enough to show that his ambition is to see these small British Islands stands in the same relation to the Empire as London does to the British Isles. Here he would have the heart, there he would have the limbs—each active and important members of one giant organisation. A further point he mentioned, which ought to be considered, is that politically, socially, and commercially the Empire might be absolutely self-contained, and then need not for a moment fear the vagaries of politics or commerce which traverse the world. We trust this is a true exposition of his suggestions. They have met with great opposition, and an opposition conducted upon the worst possible lines and in the worst possible taste. Those who wish Mr. Chamberlain's policy success have to combat half truths, and here is the extreme difficulty. No suggestion for so vital a change of policy to the Empire can be without its weak points, but we hold that for the moment—although there may be differences as regards details—it is the bounden duty of every man in these islands who thinks the broad suggestion the true solution of the present difficulties of the Empire to support that suggestion by all the means in his power. *Bis dat cui cito dat* is probably more true at the present moment than it ever has been in the history of English politics. Individual assistance given now, if the result of conviction after examination, will be ten thousand times more valuable than the assistance given when it is seen which way the cat jumps, or, in other words, which way the majority is going. It would be nonsensical for us to attempt to place Mr. Chamberlain's issues more clearly before the public than they have been placed by himself. He will possibly elaborate in greater detail in future speeches; but meanwhile good can be done by considering advantages and exposing fallacies. Tariffs are not necessarily methods of protection. They

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may be methods of free trade—absolutely free trade. Let us explain. Every nation may be looked upon as a market. That market has been erected, equipped, and maintained at an annual cost by the nation. Surely, it is but right that every person who trades in that market should pay rent for the use of it. If, then, tariffs were looked upon and adjusted so as to return the legitimate rent for the market provided, we maintain that that might in reality be called free trade, because every person who did business in the market would pay his proportionate share of the cost. The ordinary idea of tariffs, however, is something different. It is a higher duty than is just, in order to prevent competition in the home markets, and this brings about another phase of the question when the home business men are in a position to more than supply their own markets. An argument largely used by so-called free traders — or, as Mr. Chamberlain calls them, free importers—is that such surplus thrown upon our market is beneficial to us, in that we get it much cheaper than we ordinarily should. Has it ever occurred to a single individual who uses these arguments to carry it to extremes, and to really go into the matter far enough to come to a right conclusion? Take a case. Assume that America can supply us with all the iron and steel we require more cheaply than we can supply it ourselves, because their own market is amply protected and the surplus can be dumped down here at a low price. Were this done it would mean that the labour at present employed in these industries would no longer be wanted. What would they do? Transfer their labour to some other direction, say the enthusiasts. It is easy to say this, but anyone acquainted with what has occurred in the past through the decaying and transferring of trade knows that that conclusion is an absolute impossibility. A gentleman recently wrote some letters to the *Times*, in which he argued that if a grate could be bought at Sheffield for one pound and at Belfast for fifteen shillings, by buying at Belfast he would be the gainer of five shillings, and he proceeded to argue that it did not matter whether he bought at Belfast for fifteen shillings or in Belgium, he was clearly the gainer of five shillings. Admitted, so far as Belfast is concerned, but transfer the manufacture of all grates from Great Britain to Belgium and purchase each one at fifteen shillings instead of one pound. He contends that this would be good business, and that the country would be a gainer. Perhaps if he looks further into the matter, he may see that a very different interpretation can be put upon the transaction. Certainly he buys a grate at Belfast for fifteen shillings instead of paying one pound at Sheffield, and is a gainer of five shillings, which is much as if he had bought a pound of sugar at a grocer's on one side of the street at threepence instead of going on the other side and buying a pound for threepence-halfpenny, and thus gains one halfpenny. Take for a moment that fourteen shillings is the value of the labour expended in the construction of the grate. Each one of these fourteen shillings pays its quota, whether the grate is made in Sheffield or Belfast, to the support of the English market; while if the money goes to Belgium, not one penny of the whole lot pays its quota, and whatever that quota may be, it has to be borne among the individuals who pay taxes in this country. It might be also, when the case is carried to extremes, that a very large quantity of labour will not be able to transfer itself, and again the remainder has to support this labour in idleness. Among Mr. Chamberlain's proposals is one to impose a duty on imported manufactures, probably limiting such duty to manufactures competing with those carried on in this country. If the electrical industry will confine its attention to this one suggestion, it will see how enormously different the conditions of business would be under such circumstances.

BALLADS OF BUSINESS.

No. 3.—Estimating.

From high on Mount Olympus
The god-like buyer comes;
Prepare your wares, ye travellers;
O! drummers, beat your drums.
If Fate be kind unto you
He'll grant the boon you crave,
Of asking rates and estimates,
Till you are in the grave.

On much beprinted paper
All gloriful bedecked:
"Your lowest price, in half a trice;
"And send us, to inspect,
"Full samples, detail drawings—"
For sixpence worth at most.
And orders may proceed your way,
Ere you give up the ghost.

O! tempora. O! mores.
When orders are so scarce
That profits fair they cannot bear,
Though shareholders may curse.
But stay! there are, most busy,
Men working night and day,
Producing rates and estimates
And—giving them away.

B. C. H. J.

QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any questions should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

625. If a ·15 three-core distributor was supplied at one end with three-phase currents from three single-phase transformers connected on the mesh system, having 220 volts on the secondary coils; if incandescent lighting constituted the whole of the load, and consumers were supplied with single-phase current from one of the three sides at the rate of one ampere per two yards of run, and arranged so as to obtain a good balance—(1) How would the carrying capacity and drop be calculated? (2) To what distance would it distribute efficiently? (3) How would the lamps on each side be affected if (*a*) one of the transformers burnt out, (*b*) one of the three low-tension main fuses blew, (*c*) one of the high-tension transformer fuses blew?—S. R.

626. Give sketch and description of a good clock switch for use in switching on and off incandescent lamps?—H. P.

ANSWERS.

Question No. 617.—In an alternating-current system generating at 2,000 volts, with the outer earthed at the works, where the area of supply is a scattered one and house transformers are used connected to the high-pressure mains, what is the best way of testing the insulation of these mains without disconnecting the transformers, so as to keep ahead and get warning of any faults which may be developing?

Best Answer to No. 617 (*awarded* 10*s.*).—Perhaps the simplest way of detecting incipient faults in a system such

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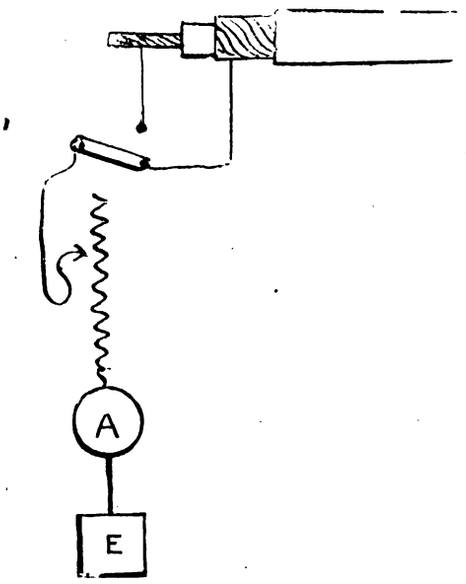
as described, is to measure the leakage current from each main to earth while the other is insulated. There must for this purpose be a switch in the earthing connection of the outer main, and a suitable arrangement of apparatus is shown in the accompanying diagram. It will be seen that either main can be earthed through an ammeter and a variable resistance. Normally the outer would be kept earthed through the ammeter, with the resistance cut out of circuit, or nearly so. Before changing over the two-way switch increase the variable resistance as a precaution, then, having switched over, the variable resistance may be



cut out altogether if the ammeter reading does not become too great. The resistance used need not be at all elaborate; a water resistance would be the cheapest, and a switch for short-circuiting it might be used for cutting out the last few ohms.

This device is extremely simple, and can be used at frequent intervals, and the leakage to earth from each main when the other is insulated carefully noted; any deterioration of insulation on the unearthed main would cause an increase in the ammeter reading. Of course, one would not expect this reading to be quite constant from day to day, as insulation resistance is affected by the weather, but any marked increase in the leakage current would be a sign of a fault, and if the fault was at all a bad one, the ammeter reading would be too great to allow the resistance to be cut out, for, of course, the voltage across the fault is 2,000, unless the fault is actually in the winding of one of the transformers, in which case the leakage current is choked down by the action of the transformer as a choking coil. The insulation resistance of either main is given, of course, by dividing 2,000 by the current to earth from the other main "dead-earthed." The ammeter should be in a conspicuous position, so that the leakage current from the inner main to earth may be always visible: it should also be provided with a fuse. Care should be taken that faults are attended to at once, and that the outer is kept earthed except for the very few seconds required for testing its insulation, or it would be a source of great danger, especially as it is supposed to be earthed.

The disadvantage of this method of insulation test is, as before stated, the fact that faults in the transformer windings themselves are not revealed in anything like their true proportion; but nothing is said in the question concerning the keeping of the system "alive"; and as in all probability the load is almost purely a lighting one, there is no reason why the system should not be switched off, say, in the middle of each day, the earthing switch opened, and the insulation resistance of the whole system tested with an ordinary testing set. Any discrepancy between the results obtained by the two methods would indicate that the fault was in one of the transformers.

The great advantage of the first method is its extreme simplicity, and the fact that the test can be applied at any time under any conditions of load.—P.

Answer to No. 617 (*awarded* 7*s.* 6*d.*).—The high-tension system of a supply station is usually tested once a week, generally Sunday morning, when plant is shut down by breaking the outer by means of plug usually provided for the purpose (Fig. 1) at the station and testing insulation to earth, using Silvertown or other testing set. As transformers, etc., are across mains we shall get the insulation of inner and outer, and as there will be a considerable amount of surface leakage the test will probably be low, but we can notice any fall in insulation from previous week, which at once should be accounted for. This leakage might, of course, be on the outer, and would not affect us to any extent, but it should be removed, as the Board of

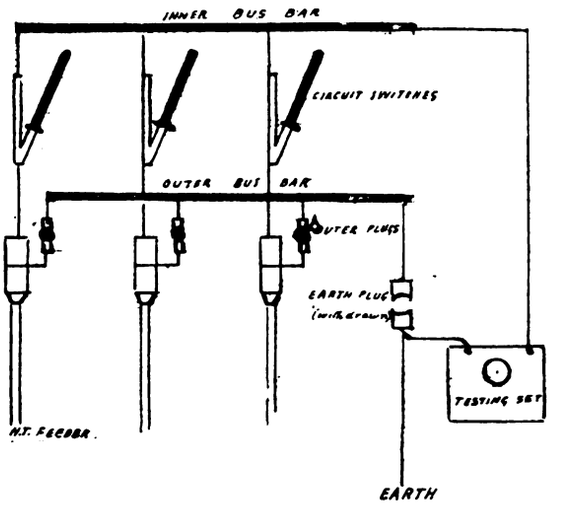


Fig. 1

Trade only allow the system to be earthed at one point, and if the leakage is on the inner, it would mean trouble if not remedied at once. Another way of testing for leakage is to break the outer, also withdraw the earthing plug and connect a low-reading ammeter between the outer bus bars and earth (Fig. 2), and run up machine on mains. Any leakage current will now return to machine through this ammeter, and if it approaches the allowable amount stipulated by the Board of Trade the circuits should be switched off until faulty one is found, and then disconnect portions

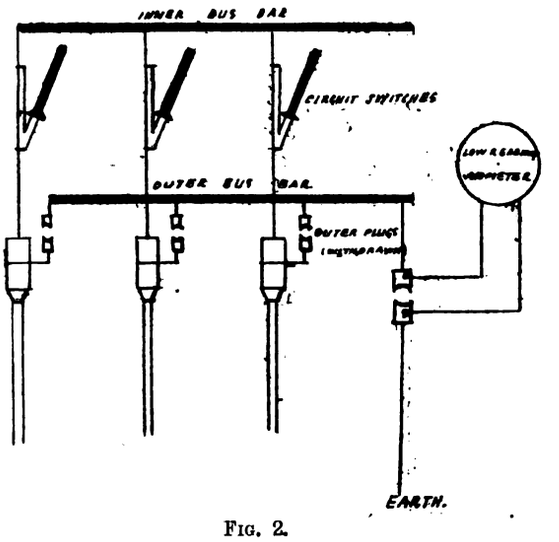


Fig. 2.

of main where possible and localise in usual way with testing set.—A. Thompson.

Answer to No. 617 (*awarded* 5*s.*).—It appears, on a consideration of the above query, that the aim of the questioner is not to produce, or that the above question shall be the means to produce, a discussion on the merits or demerits of the various systems of insulation testing which at the present time are in vogue, but that he seeks to preclude such an idea, and seems rather to desire a solution of the special difficulties which he has to contend with in this, a special and specific case. In other words, the question implies the thought of the possibility of obtaining the con-

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dition of the mains which will make it possible from time to time to take the tests which it is desirable should be taken. To that end, therefore, of solving that part of the case involved as indicated, it may be well to consider one or two important points in connection with and included in the question. (1) No disconnection of the transformers from the source of supply must be made—*i.e.*, that during the tests the consumers must not suffer that objectionable inconvenience of the extinguishing of lights in their houses. (2) No tests for insulation qualities can possibly be taken upon cables or mains when such at the time are in use supplying power to the transformers. (3) Therefore, some arrangement must be provided so as to make it possible that the requirements of No. 1 are fulfilled and that the disadvantages of No 2 are obviated.

Fig. 1 gives an approximate idea of such an arrangement. The method there represented is that, instead of transmitting the power simply by one concentric cable, as indicated in the question, to divide the cable, as it were, by using two cables of one-half the cross-sectional area of the single cable each, so as to transmit the power with the

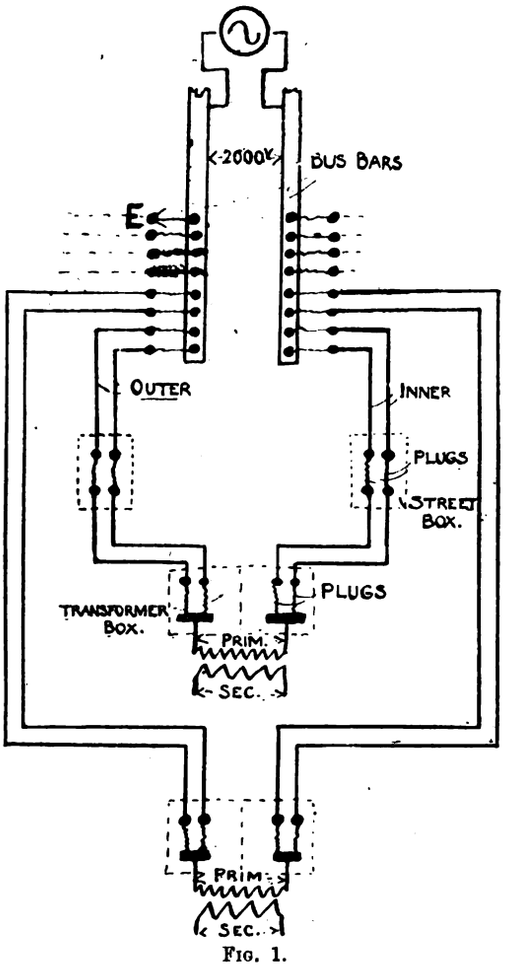

Fig. 1.

same efficiency and economy as before. The arrangement provides, also, special disconnecting boxes, so that it is possible to disconnect one cable entirely from the supply and the transformer to facilitate the testing. As the question indicates that the area of supply is a scattered one, it is quite possible that the mains from the 'bus bars at the works are connected up to street connecting boxes, and from thence, as a central point, the cables branch off to their respective districts; or else the cables might, without the intervention of street boxes, be laid from the station to the individual transformers. In either case, however, little difference exists as regards the matter that is being considered. It will be seen by a reference to Fig. 1 that two cables are employed in place of one, originally. These cables are fed separately from the station 'bus bars or auxiliary 'bus bars, so that it is possible to disconnect the cables from the aforementioned 'bus bars. The means adopted to produce such a possibility might involve the employment of either high-tension switches or plugs. In the figure plugs are represented, but these are not absolutely necessary. At the transformer end of the mains a transformer box of special type might be used (per Fig. 1). It consists of a small 'bus bar connected to the primary winding of the transformer, and plugs from terminals on the bar connect the cables to the bar, and, therefore, to the winding of the transformer. It will be seen that, provided the plugs are in their respective and proper places, both at the station and the transformer ends, the supply of power will be carried on as usual. In order to prepare the cables for the tests, each cable should be disconnected separately, and *not* at the same time. Care should be taken that both ends of the cable are disconnected by pulling the plug from *each* end out, for, if such is not attended to, an accident might possibly occur to the tester. Under the condition of one of the cables being made useless for the time being, the other cable will have to carry the whole current, which is double its ordinary current traversing its length; therefore the test should not be a prolonged one, the shorter the length of time occupied being the better compatible with accuracy of test. When the test on that cable is finished it should be reconnected into circuit again, the other cable being then disconnected and the same tests undertaken upon it.—G. W. B.

Question No. 618.—A 1-h.p. continuous-current motor, running at 1,200 revolutions per minute, drives a machine by means of gearing at the rate of 100 revolutions per minute. This machine requires to have its direction of rotation reversed every two minutes. Describe some automatic arrangement controlling the motor by means of which these reversals can be obtained.

Best Answer to No. 618 (*awarded* 10*s.*). — There are several ways of reversing a motor every two minutes.

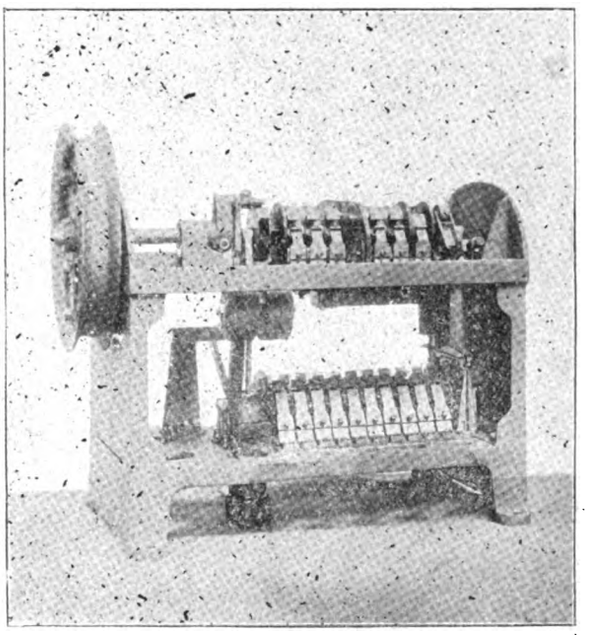

Fig. 1.

One way is to gear the switch up to the motor in such a manner that the motor operates the switch. If the motor is geared up to a shaft making 100 revolutions per minute, it follows that after the line shaft has run 200 revolutions the motor is required to be reversed. For reversing a shunt-wound motor special switching arrangements are required for the shunt, so arranged that a non-inductive resistance is placed across the field circuit before it is broken. For rapid stopping and reversing, a brake should also be fitted so that the motor is brought quickly to rest. A suitable switch for this purpose is made by Messrs. Royce, Limited, Manchester.

Fig. 1 shows the arrangement of the switch as used for hoists, etc. In this case the pulley keyed on the shaft of the switch will require removing, and in its place a disc, C, with lugs on it to engage with the weight, D; on the same shaft are keyed a crank and crank-pin, the crank-pin driving the main switch. The main switch is made up in a similar manner to a controller barrel, and it is in two parts—one negative and one positive—each part having

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the required number of contacts on it, for the mains, armature, shunt, and brake. On each side of the main barrel on the top plate are fixed a row of contact fingers. The main switch is only in contact with one set of finger contacts at a time, depending on which direction it is required to run the motor. The main switch is locked in position by means of a sprocket wheel, so that it is impossible for it to remain in an intermediate position. On moving the main switch to either of the "on" positions, the core of the ratchet coil is lifted, the coil being in series with the shunt of the motor. The core of this coil gears into a wheel fixed on the lower barrel spindle. On this

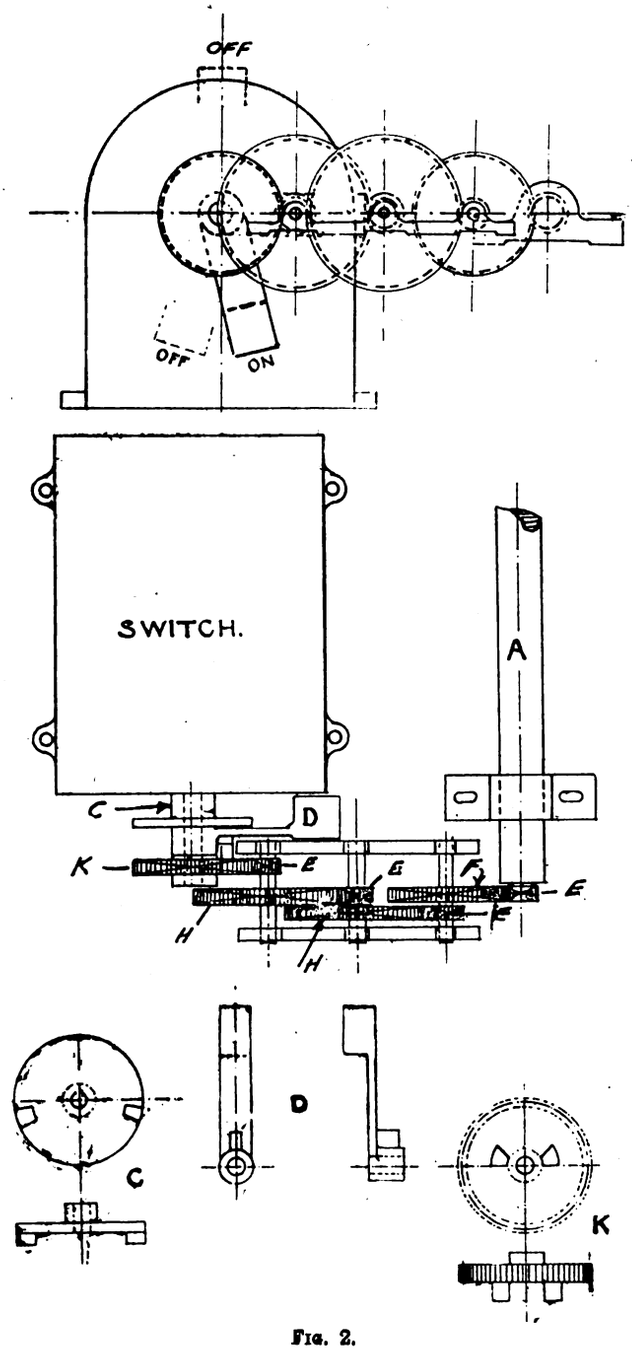

Fig. 2.

spindle is mounted a many-way switch of the tramcar controller pattern, to cut in or out the armature resistance. At the end near to the rope wheel this spindle has a small pinion fixed on it, which gears into a quadrant on which a weight is fixed, the quadrant being connected up to a dash-pot. On the main switch being put in the brake is lifted, also the core of the ratchet coil, so allowing the weight to cut the resistance out of circuit.

Fig. 2 shows the general arrangement of the required gearing and details of it for gearing the switch up to the motor so that the motor is automatically reversed. A represents line shaft; C, disc keyed on switch shaft; D, weight; E, pinions, 24 teeth, 12" diametral pitch; F, spur-wheel, 96 teeth; H, spur-wheel, 120 teeth; K, spur-wheel, 120 teeth, with clutch cast on. The line shaft, A, making 100 revolutions per minute, is geared up to the switch in such a manner that for every 200 revolutions of the shaft, A, the switch is moved from one full-on position to the other full-on position. To do this the wheel, K, has lugs cast on it. Supposing the motor is running clockwise, the weight, D, would be at one of the full-on positions. The wheel, K, would immediately start to lift the weight, D, and on D just getting over the vertical axis it would change over the switch from one full-on position to the other full-on position, leaving the wheel, K, behind. The wheel, K, will now be running in the opposite direction, and so lift the weight, D, again, and the switch changes over, the motor now being reversed again, so that by this means the motor is reversed every two minutes.—C. G.

Answer to No. 618 (*awarded* 7*s.* 6*d.*).—Although it is possible to automatically reverse the direction of rotation of a motor, the successful working of any device capable of fulfilling the requirements of the question depends upon the amount of attention it is likely to receive, which may be said of most automatic arrangements. As the question does not state the type of motor used, the writer has made

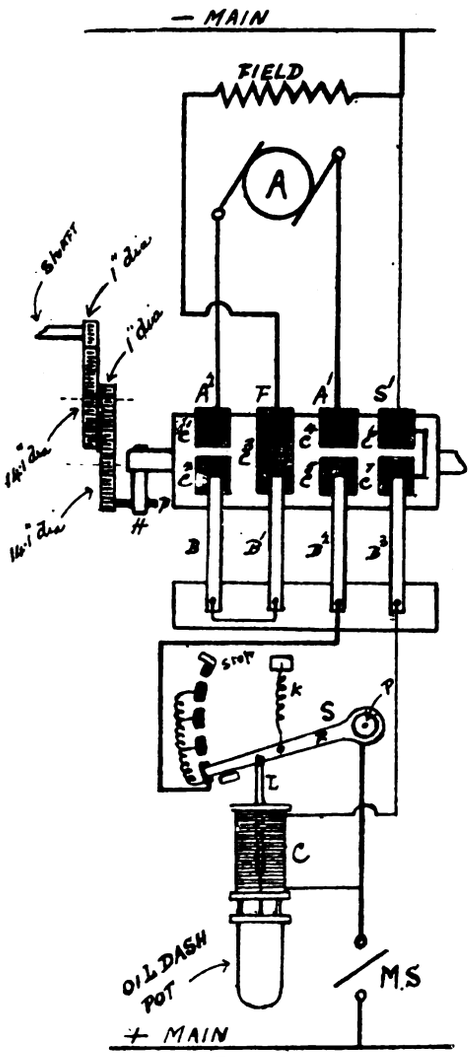

Fig. 1.

his idea of an automatic arrangement applicable to the series type of motor, as the fact that the armature and field are in series will be some protection for the motor against the vagaries of most automatic devices which will occur at times, notwithstanding every precaution. For this reason, in the writer's opinion, it would pay to replace the motor at present in use, if of the shunt type, by a series motor, as its employment would greatly increase the possibility of obtaining satisfactory working of any automatic arrangement.

As the question gives no dimensions of the driven machine, it will only be possible to give the outline and rough sketches of an arrangement which may give satisfaction. To reverse the direction of rotation of a series motor

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you reverse the armature current, the direction of current through the field coils being in each case the same, so that the controlling device must reverse the direction of the current through the armature. This may be brought about by the arrangement shown in Fig. 1, in which S is the starting switch for the motor, shown in the "full on" position. From this switch current passes through three brushes, B, B^1, and B^2 (of which B and B^1 are connected together, B^2 being insulated from them), to the commutator, C, and from it to the motor. The construction of this commutator will now be explained. It consists of seven copper contacts mounted on a wooden drum, the connections between them being shown in Fig. 2. Of these contacts, C^1 to C^5 are in the motor circuit, C^6 and C^7 being in the circuit of the coil C, which is a shunt across the mains when brush B^3 bears on either contact. Contacts C^1, C^3, C^4, and C^6 must be longer than C^2, C^5, and C^7, and reach about half way round the drum, as they have four other brushes (not shown in figure) bearing on them which conduct the current to the motor. The drum is mounted on a shaft supported at each end by a bearing, and at one end of this shaft is fixed a bar, H.

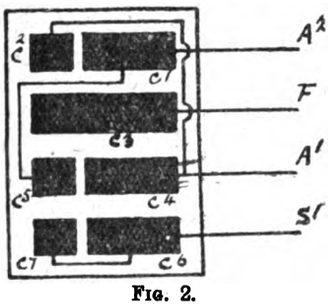

FIG. 2.

The working of the electrical part of the device is as follows. When the main switch, M S, is closed, current flows first through the coil C to brush B^3 and so on to the negative main. This causes the plunger, L, attached to the arm, R (pivoted at P), of the starting switch to be pulled down over the contacts against the resistance of the spring, K The oil dash-pot also offers a resistance to the descent of the plunger, and by so doing it prevents the starting resistance being cut out too quickly; but it does not offer any resistance to the plunger, and also the switch arm being pulled up by the spring K, when the current in coil C is interrupted.

Having explained the electrical part of the controlling device, it will be necessary to describe the method by which it is actuated by the driven machine. We have given that the speed of this machine equals 100 revolutions per minute, and also that its direction of rotation must be reversed every two minutes; therefore, it follows that the controlling device must be operated every 200 revolutions of the machine, and this may be brought about in the following manner: Fix a 1in. pinion on to the end of the machine shaft, and by means of gearing reduce the speed so that the last spur-wheel turns one revolution in two minutes. A pin, P, is fixed to the outer face of this spur-wheel, which engages with the bar, H, once in every revolution (and, therefore, once in every two minutes), pushing it over so that the brushes B, B^1, B^2, B^3 bear on contacts C^2, C^3, C^5, and C^7 respectively, thus reversing the direction of the armature current, and consequently the direction of rotation of the motor (supposing the brushes to have been on contacts C^1, C^3, C^4, and C^6 before the operation of the controlling device).

It will be seen that the current in the coil C is not reversed, but simply interrupted for an instant when the the main circuit is opened, thus allowing the switch-arm, R, to be drawn up against the stop, where it remains until brush B^3 reaches the other contact. The contacts on the commutator must be sufficiently close together to allow the brushes to bear on the second set of contacts the instant after they leave the first set. On the other hand, they must not be too close together, as this will allow the brushes to bear on both sets of contacts at the same time, When the brushes leave one set of contacts the supply of current to the motor is interrupted, but as the armature will continue revolving for a short period in virtue of its momentum, its motion will be sufficient to bring the other set of contacts on the brushes (if the space between the contacts is not too great), when the motor will start up in the opposite direction as regards its rotation. To prevent the brushes catching, the space between the two sets of contacts must be filled in with vulcanite or some other insulator having the same thickness as the contact pieces, so that the brushes will have a continuous path to travel over. Although this arrangement looks fairly satisfactory on paper, several details would have to be carefully worked out before satisfactory working would be obtained. The writer would suggest that "W. F. S." employs a reversing arrangement between the motor and the machine similar to that employed on Green economisers to reverse the direction of motion of the scrapers, as the employment of such an arrangement would ensure more satisfactory working than any device controlling the motor without submitting the latter to any strains.—J. W. R.

Answer to No. 618 (*awarded 7s. 6d.*).—"W. F. S." may attain his purpose either mechanically or electrically. As

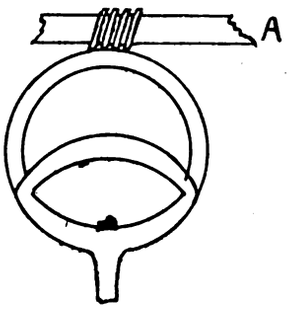

FIG. 1.

the motor is only 1 h.p., electrically would, no doubt, be more suitable, but Fig. 1 shows a mechanical method. The machine is driven by gearing through the mechanism used in planing machines for reversing the table. The striker has a heavy weight on it actuated by the cam shown. A is the dynamo shaft. No doubt a double reduction would be necessary to get the slow speed so that the cam might operate the striker once in two minutes. The electrical method shown has been used successfully by the writer for a different purpose, but applies to the case of "W. F. S." C is a powerful clockwork mechanism; D a vulcanite coupling; E an ordinary commutator; B is the starting switch with long arm; A is an electromagnet with armature and catch, G. A clock is provided with two-minute wheel instead of one-minute. A contact is fitted

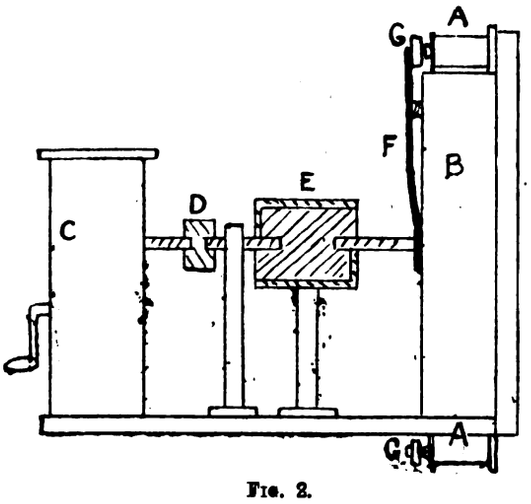

FIG. 2.

on this, with dry cell connected up to the electro-magnets, A A. The action is as follows: When the clock makes contact the arm is released. The current is immediately cut off. Next the fields of the motor are reversed. The current is again switched on, till at full speed the arm is stopped by the catch, G, at the bottom. In other two minutes the bottom catch is released, current cut off, fields reversed, and motor turned on again. H is a spring against which the arm, F, strikes each time. The

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idea is that if the winding-up of C is forgotten the motor will at last stop, as the arm, F, will not have power to go past H. The contacts shaded black are the live contacts.

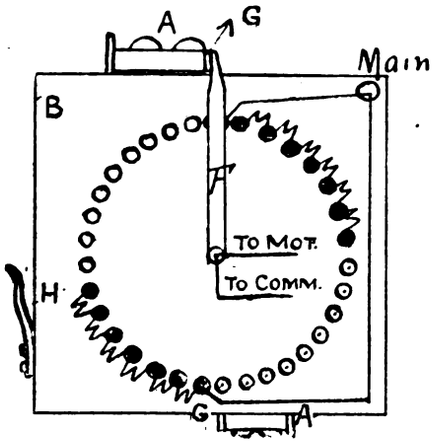

FIG. 3.—A A, Release Magnets; B, Starting Switch; C, Driving Mechanism; E, Commutator; D, Insulator; F, Switch Arm; G G, Catches.

The two sets are in parallel. The clock should be an 18-day mechanism, with switch, S. It should be noted also that the carbon take-off pieces should be on the starting switch at two points, and that the mechanism, C, should

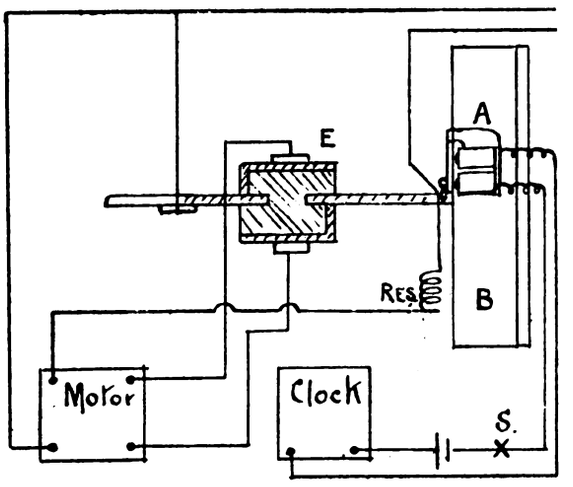

FIG. 4.

have a "fly" to regulate its speed; two lamps of 8 c.p. should be put in series across the fields to take up the "kick" at breaking of contact —POLYPHASE.

Answer to No. 618 (*awarded* 7*s.* 6*d.*).—The most satisfactory arrangement would be to always keep the motor running in one direction and have a mechanical reversing motion. A suitable reversing gear is shown in Fig. 1.

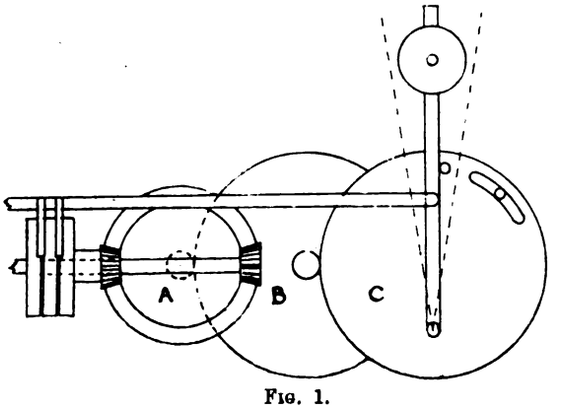

FIG. 1.

There are two fast and one loose pulley with one belt; this belt is thrown on each of the fast pulleys in turn at intervals of two minutes. The bevel pinions are connected each to its own fast pulley, one being on a "quill," through which passes the shaft of the other; the wheel A will then rotate in opposite directions, such direction depending on which pulley the belt is driving. On the axis of A is a pinion driving B, from the axis of which latter another pinion drives C. Motor runs at 1,200 revolutions per minute; if the diameter of pulleys shown in sketch are to the diameter of pulley on motor, their speed will be $1,200 \div 3 = 400$ revolutions per minute. With a ratio between bevel wheel and pinions of 4 to 1, A will run at 100 revolutions per minute; the machine may therefore be driven from its axis. With pinions for reversing gear having 20 teeth each, and each of the driven having 300, in two minutes C will turn $\frac{2 \times 100 \times 20 \times 20}{300 \times 300} = \frac{8}{9}$ of a revolution. The wheel C carries two pins which push lever to the vertical position; the balance weight then shifts the fork on to the other pulley. By having eight-ninths of a revolution in two minutes, for C two pins may be employed, one fixed and the other adjustable, giving some latitude when setting the gear. Of course, any suitable wheels could be used. For instance, by introducing another pair of drivers of 20 and driven of 120 teeth, the wheel actuating lever would in two minutes make $\frac{2 \times 100 \times 20 \times 20 \times 20}{120 \times 120 \times 120} = \frac{25}{27}$ of a revolution.

If, however, it is desired that the motor should have its direction of rotation reversed, a method is suggested in Fig. 2 The sketch almost explains itself. A clock-making contact for desired time at regular intervals causes a relay

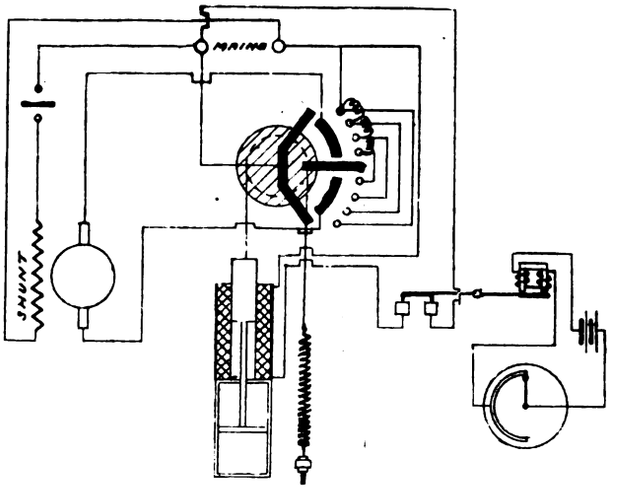

FIG. 2.

to actuate solenoid by closing the circuit through two mercury-cups. When the solenoid is energised, core is pulled down and switch turns in a counter-clockwise direction. On the circuit being broken by the withdrawal of copper connecting piece from the mercury-cups, the spring pulls switch round in clockwise direction. A dash-pot is fitted below solenoid to prevent hunting and allow of a more or less gradual movement of the starting switch. It is only necessary to have one set of resistances.—M. M.

PERSONAL.

Mr. Percy E. Rycroft, a senior engineer-on-watch, City of London Electric Lighting Company, Limited, has been appointed assistant engineer and works manager to the Islington Borough Council's electricity department. There were 101 applicants for the post. Mr. C. H. Yeaman has been appointed chief assistant and distributing engineer at the electric lighting station at his present salary of £300 per annum.

We are informed that Mr. Henry M. Sayers, M.I.E.E., has left the staff of the British Electric Traction Company, and is carrying on a consulting practice at 36, Victoria-street, Westminster.

Messrs. G. L. Badger, London, and G. L. Stonier, Lincoln, have been appointed junior engineers at the Dundee Corporation electricity works.

Mr. Liddle, Edinburgh, has been appointed electrical engineer to carry out the arrangements for the wiring of the new hospital at Bo'ness.

Mr. C. G. Eley, of Old Charlton, has been appointed charge engineer at the Plumstead electricity works.

Mr. W. E. Rogers having decided not to accept the post of second engineer-in-charge at Bermondsey to which he had been appointed, Mr. W. W. Alston, of the electricity works, Oldham, has been appointed to the position at a salary of £125 per annum, subject to his acceptance of the same.

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LARGE GAS-ENGINE GENERATING PLANT.

There are increasingly numerous signs of the coming popularity of the gas-engine, and those who pin their faith to this form of prime mover will probably have no cause for disappointment in the near future. Putting on one side for the present the question of the superiority or otherwise of gas-engines in large electric generating stations for the supply of electric light and power generally, there is no doubt that in one line of business especially the gas-engine is the coming thing. We refer to paper mills. In several parts of the country in which the papermaking machinery is controlled by electricity, the gas-engine has superseded the steam-engine, and the change has been amply justified by the results Generally speaking, it is found in practice that the greatest saving is effected in the coal bill, and it will be found on the average that the consumption is about 1lb. of coal with gas to 3½lb. with steam working, and when it is considered that the average number of hours of working in a paper mills is 144 a week, it will be seen that the economy effected in this direction alone must be very considerable. We are led to make these remarks in view of what is being done at Messrs. McMurray's Royal Paper Mills at Wandsworth. These mills, originally driven throughout by steam-engines—were recently completely gutted by fire, and the directors have placed the responsibility for their reconstruction, together with the electrical equipment, entirely in the hands of Messrs. Handcock and Dykes, consulting engineers, of Victoria street, Westminster. Most of the contracts for the work have now been let, and the scheme is to go on to completion without delay. Under the new proposals, about which we are able to give some interesting information, four or five of the old boilers will be retained for the production of steam for heating purposes and for working one of the paper machines. All the rest of the power will be supplied by a bituminous producer-gas plant. As will be seen from the list of tenders given below, four Willans engines are to be installed, and two of these will drive direct on to shafting, from which the beaters are driven, the remaining machinery, including one of the large paper machines, being driven electrically by means of continuous-current 220-volt motors. We hope to be able to give particulars of the motor equipment later on. The directors of the mills are confident that when the scheme is completed in accordance with the plans which Messrs. Handcock and Dykes have prepared, they will effect a saving in fuel and in other directions which will repay the cost of the new power plant in about three years. The complete installation, which is expected to run with a cost approaching £40,000, will be ready for working in June next, when we trust the hopeful anticipations of the millowners will be realised. In view of the great interest which is being taken in this question just now we make no apology for appending the full list of tenders for the generators, gas-engine plant, and buildings, in the hope that they may interest engineers who are about to carry out installations of a similar character. The accompanying tenders are for four 230-b.h.p. gas-engines, bituminous producer plant, and all accessories. The engineers' estimate of May 24, 1903, amounted to £11,000 with contingencies.

Contractor.	Gas generator.	Producer plant.	Engines and shafting.	Traveller and accessories.	Total.	Delivery.
		£	£	£	£	
Willans and Robinson	Mason (accepted)	2,467	5,950	350	8,757	
	Mond	3,662	5,950	350	9,962	37 weeks.
J. E. H. Andrew and Co. ...	Wilson	2,484	8,088	315	10,887	Plant and three engines within 10 months.
Premier Gas-Engine Company	Mond	3,360	7,758	280	11,398	43 weeks.
Richardsons-Westgarth	Mason, single engines	2,467	10,270	415	13,152	Producer and three engines within 26 weeks.
	,, tandem ,,	2,467	10,720	415	13,602	
	Horshay, single ,,	2,503	10,270	415	13,188	
	,, tandem ,,	2,503	10,720	415	13 638	
	Mond, single ,,	3,661	10,270	415	14,346	
	,, tandem ,,	3,661	10,720	415	14,796	
Crossley Bros.	Crossley	3,055	9,650	550	13,255	Gas plant and thre engines in 10 months.
Power Gas Corporation.....	—	3,487 (800-b.h.p. gas plant) 3,687 (10,000-b.h.p. gas plant)	—	—	—	

Following is the list of tenders for two continuous-current generators for direct coupling to the gas-engines, main switchboard, 33 motors aggregating 350 b.h.p., main cables for power and electric lighting, the engineer's estimate for which amounted to £6,700:

Bruce Peebles and Co. (accepted)	£6,216	0	0
Bruce Peebles and Co. (alternative).....	6,296	0	0
G. E. Taylor and Co.	6,394	0	0
Greenwood and Batley	6,414	9	0
Siemens Bros. (exclusive of 50-h.p. calender house motor)..	6,502	0	0
Johnson and Phillips	6,506	0	0
Dawson and Co.	6,606	0	0
J. H. Holmes and Co.....	6,885	0	0
Electromotors, Limited	6,968	10	0
Bergtheil and Young	7,028	18	0
Mather and Platt.....	7,034	0	0
Crompton and Co.	7,038	0	0
Marryatt and Place.....	7,332	0	0
Dick, Kerr, and Co.....	7,625	0	0
Drake and Gorham	9,460	0	0

For the rebuilding of the mills and foundations, etc., the engineer's estimate was £6,596, and the following three tenders were received:

W. Guthrie and Co. (accepted)	£5,135	10	7
C. Leather and Co.	5,754	17	10
J. O. Richardson	8,394	4	8

APPOINTMENTS VACANT.

Resident Electrical Engineer, Leek Urban District Council, £150 per annum. See advertisement in last issue.

Mechanical Engineer to superintend machinery, Commissioners of the Port of Calcutta, Rs.1,000 per month, Oct. 15. See advertisement.

Telephone Switchboard Inspector, Portsmouth. See advertisement.

Assistant Electrical Engineer, Shipley Urban District Council, Oct. 19. See advertisement.

Shift Engineer, Reading. Oct. 16. See advertisement.

Assistant Mechanical Engineer, Commissioners for the Port of Calcutta. Candidates must be specially qualified in electrical engineering. Salary, Rs.600, rising in annual increments of Rs.50 to Rs.750. Applications will be received up to 15th inst. by the Commissioners' London agent, Mr. J. H. Apjohn, M.A.M.I.C.E., 17, Victoria-street, Westminster, London, S.W.

Engineer, Sheffield, who will have charge of highway, sewer, and tramway work. Applications should be made by 14th inst. to Mr. Charles F. Wike, M.I.C.E., city surveyor, on forms which may can be obtained from his office, Town Hall, Sheffield.

LEGAL INTELLIGENCE.

SPEED OF ELECTRIC CARS.

Judge Emden, sitting at Lambeth County Court on the 1st inst. without a jury, had before him a case in which Joseph Beardshaw sued the London County Council to recover damages for personal injuries sustained. On the morning of Sunday, July 12, Beardshaw was crossing Camberwell New-road in a wagonette going for an excursion, when one of the London County Council electric tramcars struck the rear of the vehicle, smashing it and knocking out several of the occupants.

Mr. J. H. Rider, electrical engineer to the Council, stated the proper speed for cars on level roads was 10 miles an hour. It was possible by turning the handle 180deg. to increase the speed to 18 or 20 miles an hour. Under ordinary conditions the cars going at 10 miles an hour could be pulled up in their own length—33ft. 6in.

Judge Emden, in giving judgment, said he could not agree that because 10 miles an hour was the limit that was not too great a speed, especially along a road studded on each side with streets from which traffic was always coming. He held that in this case the speed was more than 10 miles an hour, and that the driver had not the car under proper control. He awarded plaintiff £21 damages. Four other persons injured on the same occasion were awarded damages varying from £7. 10s. to £21.

Three drivers of the London United Tramways Company were summoned at Brentford for excessive driving, the rates at which it was stated they were going being 16, 18, and 15 miles per hour. It was also said that numerous complaints had been made of accidents caused through excessive driving. The defendants denied that they were exceeding the speed limit, and applied for an adjournment in order to call witnesses.

Mr. Montague Sharpe said he failed to see any difference between them and motors, who were continually brought up, and why they should doubt what the stop-watches registered. It appeared to him that the drivers did not know at what rate they really went. An adjournment was granted on payment of costs.

The adjourned hearing of the case brought by Mr. Moffat Ford against four drivers of electric tramcars for exceeding the limit of speed laid down by the Board of Trade has been fixed by Mr. Rose to be heard at the West London Police Court to-day (Friday) afternoon.

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COMPANIES' MEETINGS AND REPORTS.

SOUTH LANCS. ELECTRIC TRACTION AND POWER.

The stockholders of this Company held a meeting at Liverpool on Wednesday to consider the scheme submitted by the Board for the reconstruction of the capital of the Company, by which the present 4½ per cent. first mortgage debenture stock is to be converted into 5½ per cent. second mortgage debenture stock, each holder receiving as a bonus an amount of fully paid ordinary shares in the Company equal to 20 per cent. of his holding in debenture stock and a new terminable first mortgage debenture stock to be issued under the borrowing powers of the Company to provide the money for continuing the work of constructing the tramways and for other purposes, the issue of each class of debenture stock to be limited to £600,000, and no borrowed capital beyond these limits to rank in priority to or *pari passu* with the proposed second mortgage debenture stock without the consent of the holders, given by extraordinary resolution passed at a general meeting of such holders.

The scheme was ultimately adopted after discussion.

CAPE TOWN CONSOLIDATED TRAMWAYS.

The ordinary general meeting of the shareholders in this Company was held on Tuesday at London-wall-buildings, E.C., Baron E. B. D'Erlanger presiding.

In moving the adoption of the report (which appeared in our last issue), the **Chairman** said the whole tramway system only came into operation in November, 1902, and the traffic was increasing at a satisfactory rate. In January, 1903, they carried 90,406 passengers, in February 102,474, and in March 103,634. From April to November, which were the winter months, there was a falling-off in the traffic; but the passengers carried showed a substantial increase over the numbers carried in the same period in 1902.

Mr. L. Breitmeyer seconded the motion, which was agreed to.

SWANSEA TRAMWAYS.

The report of the Swansea Improvements and Tramways Company for the half-year ended June 30 last states that the gross receipts of the tramways undertaking amount to £12,982, being an increase of £718, and expenses (including debenture and other interest) to £9,564, an increase of £529. The increase in expenses is caused almost entirely by increased local taxation. The profit on the half-year's working is £3,417, which, added to the balance of £204 brought forward, makes a total of £3,621 at credit of profit and loss account. The directors recommend that this sum be applied in reduction of amount due to the British Electric Traction Company, Limited, £1,000; to dividend on 984 preference shares at the rate of 6 per cent. per annum, and on 4,016 preference shares at the rate of 5 per cent. per annum, leaving to be carried forward £1,322. The working of the Mumbles Railway and pier shows a deficiency. The gross receipts amount to £8,247, as compared with £7,598 for the corresponding period of last year, and expenses to £10,791, as compared with £10,002. As in the case of the tramway undertaking, the increase of £789 in the expenses is largely owing to increased local taxation. The deficiency on the half-year's working of £2,543 is carried forward. For some time past the efforts of the Board have been directed towards realising the assets of the Improvements undertaking. Some progress is being made. The statement of accounts for the tramways shows that during the half-year a sum of £315 was expended on additions, bringing the total capital outlay on the reconstruction of the old tramways, together with the expenditure on reconstruction and electrical equipment of the lines, to £136,949. The principal items on the debtor side of the balance-sheet are as follows: to British Electric Traction Company, Limited, balance of advances for reconstruction, £23,000; to sundry creditors, £10,558; to reserve and depreciation fund, £10,611. The profit and loss account shows traffic receipts amounting to £12.645, and advertising receipts, £204. Power and running expenses came to £5,053; repairs and maintenance, £1,379; administration of general expenses, £1,783. The accounts of the improvements undertaking, which comprises the Palace Theatre of Varieties, show a deficit for the half-year of £821. The lease account of the Mumbles Railway and pier shows expenses amounting to £10,791, and receipts amounting to £8,247, leaving a deficiency of £2,543. The traffic receipts on this line came to £7,440, the pier and refreshment-room receipts to £1,493 (less £1,128 on pier, shops, and refreshment-room expenses), and the advertising receipts, rents, and sundries to £442.

WILLANS AND ROBINSON.

The report of the directors for the half-year ended June 30, 1903, states that after writing off as depreciation from plant, etc., the sum of £6,849. 3s. 11d., and paying interest upon debenture stock, the balance to the credit of profit and loss account at the end of the half-year (including £1,374. 19s. 11d. brought forward) is £24,227. 12s. 8d. Out of this the directors propose that dividends be paid at the rate of 6 per cent. per annum upon the preference shares and at 6 per cent. per annum upon the ordinary shares, amounting in all to £19,999. 16s. The amount payable to directors, in accordance with the articles of association and with the resolution of Oct. 2, 1901, is £391. 8s. 10d., leaving an available balance of £3,836. 10d. From this the directors propose to carry £1,500 to the reserve fund, and to increase the amount carried forward by £961. 7s. 11d., raising it to £2,336. 7s. 10d. Certain important orders have lately been taken on the basis of payment being made in part in shares of the companies giving the orders. The Queen's Ferry Works are still not in a position to earn profits for the Company, but satisfactory progress has been made in overcoming the difficulties which have been met with. The gas-engine business, to which allusion was made six months ago, promises to be very successful. A vertical gas-engine of 375 i.h.p., which has lately been erected by the Corporation of Redditch, is working extremely well. The Corporation of St. Helens has placed an order with the Company for a horizontal gas-engine of 750 i.h.p., and two of about 1,000 i.h.p. each have been ordered for the electric light station at Reading. Two smaller vertical engines are also on order, and four other horizontal engines of about 300 i.h.p. each. It is believed that the patents which the Company holds, combined with its reputation for good work, will ensure it a large business in gas-engines.

Dr. PROFIT AND LOSS ACCOUNT.	£	s.	d.
Rent, rates, and taxes	1,003	17	1
Interest on debenture stock	4,943	14	3
Salaries, including directors' remuneration	8,282	3	11
Contingent salaries to employés	1,474	7	5
Fire insurance	98	13	1
Legal and professional charges (including £411. 12s. 5d. costs under an arbitration award)	559	4	6
Advertising	501	1	11
Books, stationery, and printing	1,147	17	7
Postage and telegrams	334	12	11
Travelling, hotel, and general expenses	783	8	10
Auditors' fee and expenses	124	13	3
Subscription to sick club, benevolent fund, etc.	423	1	10
Depreciation of property and plant and machinery	6,849	3	11
Long-service bonus	1,137	13	6
Balance carried down	22,852	12	9
	£50,516	6	9

Cr.	£	s.	d.
Gross profit for the half year	45,745	16	7
Royalties	2,447	0	0
Interest on investments, etc.	2,292	19	2
Transfer and registration fees	30	11	0
	£50,516	6	9

ELECTROLYTIC ALKALI.

The directors in their report on the working of the year ended Aug. 31 last state that the accounts show that the net profit for the year is £483, which, with the amount of £368 brought forward, makes a total of £852. The directors recommend that this amount be carried forward. The directors regret that the result is not more satisfactory; but it is largely accounted for by the conflict between foreign and English manufacturers of bleaching powder, resulting in great depression of prices—a result over which the directors have had no control. Those who are familiar with the situation will be somewhat gratified to find, notwithstanding the low price which the Company have been obliged to accept for the product named (during eight out of the twelve months under review), that no loss of capital whatever has been incurred. All buildings, as well as plant, machinery, and tools, have been kept in a high state of efficiency during the year, and adequate allowances have been made for depreciation. The offices of the Company have been completed, and, without any outlay on furniture more than was absolutely necessary, the staff are enabled to do more and better work. During the year the parent company have acquired certain patents for improvements in the process, and, in accordance with their agreement as vendors, they have placed these additional patents at the service of this Company.

CHILIAN ELECTRIC TRAMWAY AND LIGHT.

The report of the directors for 1902 shows, after payment of interest accruing on advances for construction and other charges, a balance to debit of £3,626. From this amount is deducted the balance to the credit of profit and loss account carried forward from 1901, £3,301, leaving a net balance to debit of that account, to be carried forward, of £324. The net profits for the year 1902 on the operation of the tramways amounted to 271,058dol. During the first half of the year 1902 a net profit was made of 92,998dol., but during that time time business generally was very depressed, owing principally to the strained relations existing with the Argentine Republic, and the constant fear of war between the two States. When this condition of suspense was put an end to on the resumption of friendly intercourse between the two countries, emphasised by the visit of the Argentine Peace Commissioners to Santiago in September, 1902, business began to improve all round; and the net profit from the tramways from July 1, 1902, to Dec. 31, 1902, amounted to 178,060dol. During the 12 months ended Dec. 31, 1902, the Company carried 45,175,916 passengers, earning 2,003,487dol., as against 43,831,591 passengers, earning 1,965,660dol. for the preceding year. The reconstruction of the tramway to electric traction is now completed with the exception of two to three kilometres. During 1902 the electric lighting department showed a total profit of 113,390dol., which has been carried to the profit and loss account. An amicable arrangement has been arrived at with the Municipality of Santiago, and that Corporation is now gradually taking the Company's light over an ever-increasing area of the city. Capital outlay has exceeded the authorised issue of capital and debentures, and the directors will have to bring forward proposals at an early date for increasing the capital to the necessary requirements of the undertaking.

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NEW COMPANIES REGISTERED.

Cross Electric Engineering and Manufacturing Company, Limited (78,669).—Capital, £4,000. Objects: to acquire and carry on the business of A. H. Sparkes and W. F. Carter as manufacturing electricians, etc.

Jarrow and District Electric Traction Company, Limited.—Capital, £50,000. Objects: to carry on in the United Kingdom and elsewhere the business of carriers of passengers and goods, electrical engineers, etc. Registered office: Donington House, Norfolk-street, W.C.

CONTRACTS FOR ELECTRICAL SUPPLIES.

Luton.—The Guardians invite tenders for lighting the new tramp wards by electricity.

Macao.—The Colonial Office at Lisbon invite tenders for the electric lighting of Macao. Tenders by Oct. 21.

Nelson.—The Corporation invite tenders for a 400-kw. engine and dynamo, by Oct. 19. See advertisement.

Lisbon.—The Public Works Department require tenders for the public electric lighting of Macao. Tenders by Oct. 21.

Paris.—The Post and Telegraph Department, 103, Rue de Grenelle, require switchboards for telegraph and telephone offices by 15th inst.

Army Contracts.—A notice from the Secretary of State for War referring to tenders for annual supplies will be found in our advertisement columns.

Pietermaritzburg.—Tenders are invited by the Natal Government Railways Electrical Department for additional plant for the power station at Pietermaritzburg.

Swindon.—The Corporation invite tenders for the supply of and delivery of (a) maximum demand indicators and (b) fuse boxes for 12 months. Tenders by 14th inst.

Dudley.—The Guardians invite tenders for the supply and fixing of the various appliances for the electric installation to the laundry and boiler house. See advertisement.

Swansea.—The Corporation invite tenders for the supply, delivery, fixing, and connecting of ducts, troughs, cables, wires, street boxes, etc. Tenders by Oct. 31. See advertisement.

Transvaal Colony.—The Chairman of the Tender Board, Pretoria, requires tenders for installing and working the electric lighting of Potchefstrom for about five years. Tenders by Oct. 30.

France.—The Prefect of the Isère requires tenders for laying and working two tramway lines, about 49 miles. Tenders by 15th inst Particulars may be obtained from the Prefecture of the Department.

London, N.E.—The Bethnal Green Borough Council invite tenders for clearing the site of proposed electricity works. Specification may be obtained from the Borough Surveyor. Tenders by 4 p.m. on 13th inst.

London.—The Directors of the Metropolitan Railway Company invite tenders for the erection of a repairing shed and shops for electric rolling-stock at Neasden. Specifications, etc., after 5th inst. Tenders by 19th inst.

Kilmarnock.—The Corporation invite tenders for the supply, delivery, and erection of three Lancashire boilers, engines and dynamos, overhead hand travelling crane, storage battery, and switchboard, by Nov. 18. See advertisement.

Blackpool.—The Corporation invite tenders for the supply of arc lamp carbons for the ensuing year. Specification, etc., may be obtained on application to Mr. Charles Furness, borough electrical and tramway engineer, Electricity Works, Blackpool.

Liverpool.—The Tramways Committee invite tenders for the supply of ticket punches from Jan. 1, 1904. Specification, etc., may be obtained from the General Manager, Corporation Tramways, 6, Sir Thomas-street. Tenders by 10 a.m. on 14th inst.

Shanghai.—The French Colony propose to instal motor-propelled tramways. Tenders may be sent by Oct. 31, 1903, to Secrétariat de la Municipalité Française de Shanghai. Particulars may be obtained from l'Office National du Commerce Extérieur, Rue Feydeau, 3, Paris.

Russia.—The Russian Minister of the Interior has sanctioned a plan for the reconstruction of three lines of municipal tramways—namely, those in Newsky, Sadovaia, and Wassiliostrow districts. Each car is to provide for two classes of travellers, and will accommodate 52 persons.

Todmorden.—The Corporation invite tenders for one Lancashire boiler, two steam dynamos and balancer booster, two feed pumps and one injector, economiser, surface or jet condenser, switchboard and instruments, storage battery, cable work, and overhead hand crane. See advertisement.

West Ham.—The London County Council invite tenders for the supply and erection of (a) engine, dynamo, switchboard, etc., and (b) electrical wiring, mains, and fittings required in connection with the installation of electric light at the Abbey Mills pumping station. Tenders by Nov. 3.

Leicester.—The Tramway Committee invite tenders for erection of two district car-sheds, offices, and all other buildings and works in connection therewith. Specifications, etc., may be obtained at the office of Mr. E. George Mawbey, M.I.C.E., Town Hall, Leicester. Tenders by 23rd inst.

Salford.—The Tramways Committee invite tenders for the installation of electric light at their central car depôt in Frederick-road, Pendleton. Specifications and plans may be obtained from the General Manager, Tramway Offices, 32, Blackfriars-street. Tenders by 5 p.m. on 19th inst.

Canterbury.—The Urban Sanitary Authority invite tenders for the supply of 2,220 yards of ·4 square inch t c/c cable. Specification may be obtained from the Engineer, Electricity Works, Canterbury. Tenders by 10th inst. to the Town Clerk, Burgate-street. See advertisement in last issue.

Halifax.—The Tramways and Electricity Committee invite tenders for (a) 750-kw. continuous-current dynamo, driven direct by horizontal engine; (b) two 9ft. by 30ft. Lancashire boilers; (c) high-tension three-phase cable, etc. Tenders to Mr. Keighley Walton, town clerk, by Oct. 21.

East Barnet.—The Urban District Council will receive proposals for carrying out the provisions of their electric lighting order within the Council's district. Further particulars upon application to Mr. Henry York, the Council's surveyor, Council Offices, Station-road, New Barnet. See advertisement in last issue.

Johannesburg.—The Municipality require tenders for gas generating plant or for steam generating plant and for gas motors or steam motors, with electric generators and accessories. Particulars may be obtained from the Town Clerk, Johannesburg, or from Messrs. Mordey and Dawbarn, 82, Victoria-street. Tenders by Oct. 19.

Swansea.—The Corporation invite tenders for (1) laying of permanent way, including rail bonding; (2) rails and fishplates; (3) steel tiebars, bolts, and nuts; (4) points, crossings, cast-steel curved rails, and special work; (A) overhead electrical equipment; (B) ducts, troughs, cables, wires, section and other boxes, etc. Tenders by Oct. 31. See advertisement in previous issue.

Aberdeen.—The Town Council invite tenders for the construction of the following works: about 700 lineal yards of cable subway, 6½ft. high by 4½ft. wide; about 750 lineal yards of pipe sewers, 9in. to 30in. internal diameter; together with cable-distributing chambers, manholes, shafts, diversion of sewer, and other works in connection therewith. Tenders, etc., by 11 a.m. on 14th inst.

Salford.—The Tramways Committee invite tenders for the supply and delivery of planing, turning, boring, drilling, grinding, milling, screwing, punching, and shearing, and wood-working machinery, power hammer, shafting motors, etc., at their central car depôt, Frederick-road, Pendleton. Specifications, etc., can be obtained from the General Manager, 32, Blackfriars-street, Salford. Tenders by Oct. 19.

Harrismith (South Africa).—The Town Council invite tenders for the following electrical machinery and accessories f.o.b. and alternatively erected in Harrismith, Orange River Colony, South Africa: two water-tube boilers and one 25-kw. and two 80-kw. steam alternators, with ejector condensers, switchboards, pipework, and other accessories. Specifications, etc., may be seen and obtained at the offices of Messrs. Mordey and Dawbarn, 82, Victoria-street, Westminster, S.W. Tenders to Messrs. Webster, Steel, and Co., 5, East-India-avenue, Leadenhall-street, London, E.C., by noon on 19th inst.

Great Western Railway.—The Directors invite tenders for the supply of telegraph instruments, telegraph apparatus, copper wire, G.P. wire, etc., telegraph ironwork and tools, telegraph drysalteries, electric light carbons, incandescent electric lamps, iron rivets, bolts and nuts, etc., fishplates, and bolts and nuts for permanent way, and telegraph poles and yellow pines, etc., from Dec. 1 next to Nov. 30, 1904. Samples, etc., may be seen from 6th to 15th inst., at the office of the Stores Superintendent, Swindon. Specifications, etc., may be obtained at the office of the Stores Superintendent. Tenders by 19th inst. to Mr. G. K. Mills, secretary, Paddington Station, London. See advertisement in last issue.

RESULTS OF TENDERS.

Kingston.—The tender of Mr. T. Button has been accepted for wiring private premises at £21. 10s.

Honley.—The Council have accepted the tender for a countershaft by Messrs. Joseph Beaumont and Sons.

Edinburgh.—The tender of Messrs. Johnson and Phillips for arc lamps, at £6 per lamp, has been accepted.

Buxton.—Messrs. J. Wolstenholme and Son's tender, £42. 10s., for piping and valves has been accepted by the Urban District Council.

Aston.—The tender of the Brush Electrical Engineering Company for the overhead electrical equipment of the tramways, at £4,742, has been recommended for acceptance.

Rotherham.—The tender of the British Electric Car Company for £813 for a watering-car has been accepted. A magnetic Westinghouse brake is to be attached to the car.

Dewsbury.—The tender of Messrs. Siemens and Co., of London, for the delivery and fixing of a 300-kw. dynamo, with engine, for the electricity works has been accepted.

Worthing.—Seven tenders for reconstructing the storage battery at the generating station, the prices varying from £683 to £1,205, have been referred to the consulting engineers for report on same.

Newcastle-under-Lyme.—The Corporation have placed the contract for the storage battery with the Electrical Power Storage Company, Limited, of 4, Great Winchester-street, London, E.C.

London, W.C.—The tender of W. J. Fryer and Co., Bravington Engineering Works, Paddington, and Sloane-square, £497, has been accepted for supplying and fixing electric lift and conveyor, for Messrs. W. H. Smith and Son, 186, Strand.

Paisley.—Messrs. W. T. Glover and Co., Limited, Trafford Park, have obtained the contract from Mr. W. M. Murphy for the whole of the mains, ducts, troughing, excavation, etc., at £13,088, in connection with the extensive tramway scheme.

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Burghill (Hereford).—The tender of W. J. Fryer and Co., Bravington Engineering Works, Paddington, and Sloane-square, at £2,198, for additions to the electric light plant and supplying and laying new cables for the Asylums Committee, has been accepted.

London County Council.—The tender of Messrs. J. Westwood and Co., Limited, Millwall, amounting to £36,808. 14s. 6d., has been accepted for the supply, delivery, and erection of the steelwork for the first portion of the Greenwich electricity generating station.

Derby.—The tender of Mr. J. Dickinson, amounting to £8,066. 4s. 1d., has been accepted for the erection of car-sheds. The Tramway Committee have arranged for J. and G. White, Limited, to fix bonds of rails at 9d. each instead of the work being done by the Corporation themselves, as originally proposed.

Dundee.—The Corporation have accepted the following tenders: for the relaying of distribution mains in the central area—British Insulated and Helsby Cables, Limited, for three single cables, paper insulated, lead-covered, laid solid in three-chase troughing; taking down of wall between the two engine-rooms—J. Carnegie, 94, Commercial-street, Dundee.

Fulham.—The following tenders have been recommended for acceptance: Messrs. Windsor and Co., for the construction of sub-stations for the sum of £520 (Contract A); Mr. Thomas Pearce, £455 for constructing a transformer chamber in Townmead-road (Contract 25); British Electric Transformer Company, Limited, for supply of transformers for £292 (Contract 26).

Turbo-Dynamos.—Messrs. C. A. Parsons and Co., Eaton Works, Newcastle-on-Tyne, have received an order from the Scarborough Electric Supply Company, Limited, for the supply of two 300-kw. special traction turbo-dynamos, 450-550 volts, complete with surface condensers and air and circulating pumps; also from the Dalmellington Iron Company for one 290-kw. turbo-dynamo, 500 volts, complete with condenser.

Stoke-upon-Trent.—The following tenders have been accepted for the supply and erection of the following plant in connection with the proposed electricity and destructor works, for the Corporation: (Contract 10, Section A) pipework; (B) non-conducting covering; (C) water-softening plant—(A) Crompton and Co., piping; (B) lagging (sub-contractor, Mica Boiler Covering Company); (C) Pulsometer Engineering Company, water softener.

Hammersmith.—The following tenders have been obtained for covering sundry steam-pipes with a non-conducting composition so as to increase their efficiency:

G. Pidduck and Co. (accepted)	£26	5	0
F. Leroy and Co.	34	0	0
A. Haacke and Co.	31	3	4
Hobdell, Way, and Co.	41	10	0

Hastings.—The Town Council have accepted the tender of the Key Engineering Company, Limited, for 75 10-ampere, 37 25-ampere, and 13 50-ampere Stanley magnetic suspension meters at £613. 5s. Contracts have also been recently placed with the Key Engineering Company by the Southport Corporation for 74 Stanley meters, the County of London Electric Lighting Company for 75 meters, the Bexley Corporation for 50 meters, and by other undertakings for smaller trial orders.

Bermondsey.—The Borough Council have accepted the tender of A. White and Co., of 82, Paradise-street, at £8,363, for the erection of buildings in connection with extensions to the dust destructor house, electric light station, boiler-house, etc.; the tender of Messrs. Hughes and Stirling, Clock House, Arundel-street, Strand, for Contract No. 12, at £3,837; also the tender of Messrs. Siemens Bros., Electric Light and Power Department, Woolwich, Kent, for Contract No. 13, at £6,893 Contract 12 includes the construction, supply, and erection of two dust destructor cells, with furnace, flues, etc., and storage bins; of one watertube boiler and brickwork setting, one water-storage tank with supports for same, and the consequent necessary extensions to steam, feed, and exhaust piping systems. Contract 13 includes the construction, supply, and erection of two 300-kw. steam generators, two 20-kw. feeder boosters, one 15-kw. motor balancer, and sundry switchgear and connecting cable required in connection with the extensions in Rotherhithe. The accepted tender specifies Willans triple-expansion engines.

London County Council.—Tenders for low-tension switchboards for New Cross and Camberwell sub-station have been received as follows:

B. Thomas, Manchester (recommended for acceptance)...	£1,746	2	6
J. G. Statter and Co., Birmingham	1,935	19	6
Electrical Company, Limited, London	1,984	1	0
Kelvin and J. White, Glasgow	2,006	2	0
F. Suter and Co., Limited, London	2,021	8	0
Electrical Construction Company, Limited, Wolverhampton	2,026	0	0
W. Sanders, Wednesbury	2,027	0	0
Siemens Bros. and Co., Limited, London	2,090	0	0
Electric and Ordnance Accessories Company, Limited, Birmingham	2,098	19	0
Cowans, Limited, Manchester	2,110	5	0
Dorman and Smith, Manchester	2,202	0	0
British Westinghouse Electric and Manufacturing Company, Limited, London	2,223	0	0
Berry, Skinner, and Co., London	2,270	0	0
Ferranti Limited, Hollinwood	2,336	0	0
A. Reyrolle and Co., Limited, Hebburn-upon-Tyne	2,682	4	0
International Electrical Engineering Company, London	2,684	4	0
Torque Electrical Engineering Company, London	2,699	3	0
Elliott Bros., London	2,836	2	0
Clift Manufacturing Company, London	3,630	0	0
General Electric Company, Limited, London	3,639	0	0

Bristol.—The City Council have accepted the following tenders for electrical plant: Babcock and Wilcox, Limited, boilers, £9,324; Oliver and Co., Limited, arc lamps, £2,556; Alley, Maclellan, and Co., condensing plant, £3,285. 12s.; British Westinghouse Electric and Manufacturing Company, Limited, exciters £774. 2s., transformers £723. 18s. 6d.; C. A. Hayes, erection of arc lamp standards, £375; Newton Electrical Engineering Company, Limited, motors, £509; J. P. Hall and Sons, pumps, £408; Ferranti Limited, switchgear, £395. 10s.; Doulton and Co., Limited, water-softening plant, £352. 8s.

BUSINESS NOTES.

TRACTION.

Southend.—Since Jan. 1 2,700,000 passengers have been carried by the electric cars.

Batley.—The electric cars are expected to be running in the town in a week or two.

Colchester.—The Town Council have decided to apply for a loan of £61,164 for tramway purposes.

Blackpool.—Fares on the electric tramways will be considerably reduced during the winter months.

Aston Manor.—The Urban District Council are negotiating loans of £27,000 and £36,000 for tramway purposes.

Trawden.—The District Council have approved plans of the proposed single and double lines of tramways at Winewall.

Dewsbury.—The Gomersal section of the tramways is completed, and some successful trial trips have been made over the line.

Newark.—Promoters of a tramway scheme are seeking the support of the Urban District Council to a line through their district.

Kidderminster.—Damage to the extent of £1,000 has been done by a fire at the Kidderminster Electric Traction Company's depôt.

Burnley.—The 10 new cars which the Corporation are about to have constructed for them are to be fitted with glass wind-shields.

Guildford.—Plans of the proposed tramways between Stoughton, Merrow, and Guildford have been referred to a committee for consideration.

Rowley Regis.—The amount of the loan for which the Urban District Council are applying for tramway purposes, as mentioned last week, is £30,000.

Dover.—It was unanimously decided by the Corporation on Tuesday to run special workmen's cars on their electric tramway system at ½d. fares for the two miles' journey.

Rochdale.—It is stated that negotiations will be opened between the local authorities and the tramway company's directors in reference to the transfer of the company's undertaking.

Glasgow.—A deputation representing the Tramways Committee of the Glasgow Corporation has visited Huddersfield and Bradford and inspected the electric tramway systems there.

Bury.—In connection with the proposed tramways purchase the respective authorities of Bury and Heywood have been unable to agree, and the negotiations have been broken off.

St. Helens.—The borough treasurer's annual report shows that on the tramways the capital expenditure amounts to £123,153. The net profit for the year is put down at £118. 17s. 11d.

Llandudno.—A conference is to take place between representatives of the Town Council and the promoters of the Llandudno and Colwyn Bay light railway with reference to the carrying out of the scheme.

Torquay.—Representations are being made to the Town Council by the Motor Omnibus Company in favour of motor 'buses for the town instead of electric tramways. The matter is having the attention of the Council.

Middlesbrough.—An appeal has been lodged by the Imperial Tramway Company against a decision of the local Bench this week fining the company 10s. and 14s. 6d. costs for permitting overcrowding of the tramcars.

Stirling.—A report by the electrical engineer on the whole question of electric tramways between Stirling and Bannockburn, and Stirling and Bridge of Allan, was submitted at the last meeting of the Town Council and discussed in private.

Johnstone.—The preliminary arrangements are now so far advanced that operations are to be commenced next month for the construction of the tramways. Promise is made that the line will be opened about the end of May next or in June.

Leeds.—The Town Council on Wednesday decided to make application to the Board of Trade for sanction to borrow £125,890 for tramway purposes, the works proposed to be carried out having been previously approved by the Council.

Leeds-to-Wakefield.—Rapid progress is now being made with the tramway which will ultimately connect Leeds with Wakefield. This is part of the scheme which provides for a network of trams for the district of which Wakefield is the centre.

Tramways in the City.—The Common Council have decisively rejected a proposal to allow the County Council's tramway system to enter the City by way of Southwark Bridge in connection with the impending improvement of that structure.

Lowestoft.—During the week ending Saturday, Oct. 3, 51,585 persons patronised the trams, and the receipts amounted to £231. 11s. 9d. The total number of passengers carried since the opening day is 780,102, and the takings amount to £3,589. 12s. 11d.

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Hammersmith.—The Borough Council have refused their consent to the proposal of the London United Tramways Company, in connection with the laying of the tramlines crossing Goldhawk-road, to run the tramway in a transverse direction so as to do away with the use of points as originally proposed.

Beckenham.—At the last meeting of the Urban District Council an attempt was made to reopen the tramway question and have the subject of the Council's promotion of a Bill in Parliament discussed *de novo*. The proposal fell through, and the Council's decision in favour of a Bill was confirmed.

Trafford Park.—Last Friday the Light Railway Commissioners enquired into the merits of two rival schemes of light railways for Trafford Park—one promoted by the West Manchester Light Railway Company and the other by the Stretford Urban District Council. The Commissioners reserved their decision.

Newcastle.—Colonel von Donop has made an inspection of the new tramways recently laid down at Benwell, from the toll-gate to Condercum-road, on the Elswick-road and Westgate routes; also from the Byker car depôt to the Wallsend terminus, and also the extension from the Stack Hotel to a point near the railway station at Low Walker.

Sunderland.—The Corporation Tramways Committee have agreed to recommend the adoption of an increased scale of pay for conductors. Under the present scale the men start at 22s. 6d. per week, and the committee recommend that the wages shall start at 23s. 9d., rising at the end of three months' service to 25s., and after a further six months to 26s. 3d.

Metropolitan District Railway.—We understand that the work of electrically equipping the above line is proceeding rapidly. The sub-stations for the rotary converters are being placed above ground. A number of the sub-station buildings are well in hand, and the work of placing machinery in them is likely to be commenced at the end of this month.

Ashton.—The electric tramway system is now about completed, and a settlement has been arrived at in Stalybridge with regard to temporary through running cars on the basis that Ashton draws four-sevenths and Stalybridge three-sevenths of the receipts after deducting Ashton's share of interest and sinking fund and actual cost of working per car mile.

Ossett.—At a special meeting of the Town Council resolutions were passed authorising application to be made to the Board of Trade for a provisional order allowing the Corporation to construct tramways in the borough, commencing in the Market-place, and passing along Dale-street, Church-street, and Dewsbury-road, to the borough boundary at Chickenley.

Exeter.—Although pledged to carry out a tramway scheme for the city, the Corporation have not yet definitely decided on the system to be adopted. The overhead trolley is most favoured, but in order to be fully informed on the subject, a deputation of the Council has been appointed to inspect the surface-contact systems and the conduit system laid down at Bournemouth.

Reading.—The borough engineer reported to the last meeting of the Town Council on the fractured axles on some of the electric cars. These are now being replaced, but he gave it as his opinion that the gauge to which the wheels have been pressed is too full for the track. The old wheels, now they are being replaced on the new axles, are brought nearer together to allow of the flange having a proper play on the groove.

Hampstead Tube.—A correspondent to the *Times* states that sinking for the tube to Hampstead and Golder's Green has been suspended at the top of the High-street, Hampstead, because several feet of water have been encountered. This water is derived from springs, and it must be pumped out and its source emptied, or the channel diverted, before further operations become possible. There are a number of other known springs to be encountered, drained, or diverted between the High-street and North-end in the course of the proposed tube.

Liverpool.—At the last meeting of the Tramways Committee it was proposed that a double line of tramways be laid, at a cost of £4,000, along Everton-road, between West Derby-road and Fitzclarence-street. After discussion it was decided to request the general manager to report upon the proposal. The new service between Everton Church and the Pierhead has been inaugurated. At the meeting of the City Council on Wednesday it was decided to equip the tramway depôts with refreshment stalls on a self-paying basis, to be managed by the men.

Snowdon.—Messrs. A. Krauss and Son, of Bristol, have secured the contract for the construction of a light railway which will complete the scheme in connection with Snowdon. A connecting section will run from Portmadoc through Beddgelert to Rhyd-ddu to join the present narrow-gauge railway, the whole of which will be operated by electricity. The Snowdon Mountain Railway is also to be electrified, and electric power is to be supplied to the great quarries of the district. A generating station is to be erected at Llyn Llydau, a lake on the slopes of Snowdon, where a fall of 1,300ft. is obtainable, and which it is estimated will give 60,000 h.p. in electricity.

Cheltenham.—The Town Council have been informed by Mr. T. A. Nevins that he is now prepared to let the contracts for the construction of the proposed extensions of the tramway system to Charlton Kings and Leckhampton. At the meeting held this week plans for the proposed extensions were approved, subject to some minor alterations as to paving and design of poles. Some dissatisfaction was shown owing to the extensions not being carried out as were originally agreed, and a resolution was unanimously passed urging Mr. Nevins to construct the line in High-street as authorised. The plans for the extensions were prepared by Messrs. Dodd and Dodd, civil engineers, of Birmingham.

Cleckheaton.—At the last meeting of the District Council a member called attention to the fact that the British Electric Traction Company had postponed the construction of the intended branch lines to Hartshead Moor from Liversedge and Cleckheaton, and urged that as the completion of other lines was prejudically affecting trade in the town, the company should be urged to proceed with the branch in question without delay. It was rumoured, he added, that they intended to apply for a further extension of time. It was also decided to request the chamber of commerce and the tradesmen's association to make similar representations to the company.

Additional Traffic Returns.—Anglo-Argentine, £2,120 increase; Barcelona Ensanche y Gracia, £88 increase; Barcelona, £705 decrease; Brisbane, £242 increase (month of August, £11,736, increase £294); British Columbia Electric (month of March), gross earnings £10,352, net income £2,659; Buenos Ayres and Belgrano Electric, £348 increase (month of September, £13,793, increase £1,317); Calcutta, £399 increase; Cape Town (month of August), receipts £15,349, expenditure £8,696; Isle of Thanet Electric, £87 increase; Mexico Electric (month of August), receipts £48,600; expenses, £27,900; Perth Electric, £169 increase; Port Elizabeth (month of August), receipts £3,875, expenditure £2,305.

Sutton Coldfield.—The town clerk has received a communication from the City of Birmingham Tramways Company enquiring whether the Corporation would be prepared to consider an arrangement by which the company might be enabled to promote tramways in Sutton Coldfield to be constructed in continuation of the lines which will be for the next 21 years controlled by the company running from Birmingham through Aston as far as the Sutton boundary at Erdington. At the Council's meeting on Wednesday the General Purposes Committee, which had considered the communication, recommended that the company be informed that the Corporation cannot see their way at present to consider any arrangements for the construction of tramways within the borough.

Simplon Tunnel.—A Reuter's telegram from Berne says that the Grand Council of the Canton of Berne has agreed to grant a subvention for the construction of the projected Jura Tunnel for a line between Soleure and Muenster, which will give access to the proposed tunnel through the Bernese Alps for communication with the Simplon Tunnel. An agreement has also been arrived at between the Federal Council and the Simplon Tunnel Company, by which the latter will receive an increased amount for the construction of the Simplon Tunnel, but will not be liberated from its obligation to construct a second tunnel. On the other hand, the company agrees to the transfer of the tunnel to the Federal Government. The Federal Assembly will ratify the agreement at the end of this month.

Greenwich.—At the last meeting of the Borough Council the General Purposes Committee reported that they had had under consideration a further letter from the London County Council, enquiring whether the Council were prepared to give their consent to a proposed tramway from Deptford to the Herbert Hospital, *via* Blackheath, and to make a contribution thereto. On the proposition being first discussed, the London County Council were asked to consider a route through Westcombe Park, to which a reply was received that they were then unable to adopt the proposed alternative route. The committee recommended that, in the event of that Council deciding to construct a tramway from Deptford to the Herbert Hospital, this Council would have no objection to the tramway, but would not be prepared to contribute any sum for street widenings. After discussion the recommendation was adopted.

Wallsend.—It was reported at the last meeting of the Town Council that the Tyneside Electric Tramways Company intend to try and negotiate with Newcastle Corporation relative to an exchange of traffic over the systems, and if they fail they will seek fresh parliamentary powers in accordance with their undertaking to the Wallsend Council. In view of the electrification of the Tynemouth branch of the North-Eastern Railway, the Town Clerk stated he had received communications from the Board of Trade and the engineer to the railway company concerning the safety of the public at level crossings. The former stated that the responsibility for securing proper protection lay with the railway company, whom the Board presumed would be fully alive to their liability in the matter. The engineer to the company wrote saying that the exact nature of the protection had not yet been decided upon; but the Council were assured that everything possible would be done to safeguard the public.

Cardiff.—At a special meeting of the Tramways Committee a report prepared by Mr. Arthur Ellis, electrical engineer and manager, was considered in reference to a proposed revision of fares throughout the town. Mr. Ellis stated that his object in submitting the report was to avoid any further reduction of fares and to place each route on an equal basis. Referring to the new scale, Mr. Ellis said that he had as nearly as possible made the stages 2 200 yards for 1d. and 3,300 yards for 1½d. Some time ago, he said, the committee reduced the fare upon the Splott section to 1d., and the result was that on other routes passengers paid 2d. for shorter distances. He did not recommend ½d. fares for any stage, as he considered it an impossibility for the conductor to collect the whole of the fares, especially on busy days, but ½d. stages could be adopted with a minimum payment of two stages for 1d. or three stages for 1½d., and so on. The proposed new scale was gone through very carefully, and some alterations made in the stages. Mr. Ellis was then requested to include these alterations in a supplementary report, giving the length of each, and submit it to a future meeting.

Wolverhampton.—Another meeting of the Corporation Tramways Committee was held on Friday, when some discussion took place in regard to the proposed extensions to Dudley-road, Wednesfield-road, Willenhall-road, and Waterloo-road. A detailed comparative statement showing the estimated capital and annual cost of the overhead and Lorain systems, prepared by Mr. C. E. C. Shawfield, the borough

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electrical engineer, was placed before the members of the committee and considered. The question as to whether the extensions should be carried out on the overhead or the Lorain system was debated, and finally a resolution to equip the additional routes with the latter was carried. Not only was it decided to equip the extensions with the Lorain system, but to proceed with the work as early as possible Thus the town is committed to the Lorain up to the hilt. The Wolverhampton Tradesmen's Association forwarded to the Tramways Committee the following resolution: "That this meeting of the Wolverhampton Tradesmen's Association requests the Town Council to equip the Sedgley-road and Willenhall-road on the overhead system at the earliest possible moment, with a view to promptly securing proper and adequate intercommunication."

Pontypridd.—At the meeting of the Electrical Committee last week a letter was read from the British Electric Traction Company as to the purchase of their horse tramway undertaking within the Council's area between Pontypridd and Porth. The company stated that, subject to their agreeing with the Rhondda District Council for the purchase of the land, buildings, and premises at Porth, they were prepared to accept £6,050 for their undertaking in the Pontypridd district. This includes the permanent way, a proportion of the cost of the Act of Parliament, and half the estimated value of the rolling-stock, plant, machinery, and furniture at Porth. The committee decided to recommend the Council to take steps to get the property valued. The combined lighting and tramway scheme is now on the move, both the contractors for the permanent way and for the distributing cables being at work in the principal thoroughfare of the town. Many of the streets are in a deplorable condition, and the advent of the trams should be a great boon to Pontypridd and district. Numerous alterations will be necessary in the level of a good many of the streets, and there is no doubt that the permanent way will enormously improve the thoroughfares of the town.

Nevin Light Railway.—A public enquiry was held on Thursday week at Pwllheli by the Light Railway Commissioners into the expediency of granting the application which has been made by the North Wales and District Light Railway and Electric Power Syndicate for an order to authorise the Pwllheli, Nevin, and Portinlleyn light railway. It was explained that the proposed railway would run for a distance of 10 miles 4 furlongs past Morfa Nevin to Portinlleyn, and would have a branch of 1 mile 6 furlongs to Nevin. The district was agricultural, but there were slate and fishing industries, which could be developed greatly if railway facilities were afforded, the whole of the Lleyn peninsula being now without any form of railway service. Mr. E. Ward Thomas, the engineer to the scheme, estimated the cost at about £170,000, which included a deviation in the amended route. Colonel Boughey, after a short deliberation, said that the Commissioners thought further time should be given to consider the question of deviation. That deviation might be desirable if it could be carried out under two conditions—a junction with the Cambrian Railway Company, which would enable them to work, and that it should not involve too much expense. Failing that, it would mean the widening of Ala-road, and before giving a final decision the Commissioners would wait for the parties to come to an agreement.

Southwark.—The Works Committee reported at the last meeting of the Borough Council their consideration of a proposal by the London County Council to again seek powers to construct an electric tramway on the underground conduit system from the present tramways in Southwark-street, along that street westward across Blackfriars-road, along Stamford-street and York-road, to join the tramways in Westminster Bridge-road. The proposed tramway would have double lines, and was regarded by the County Council as of great value in affording means of communication between the main thoroughfares radiating from the Elephant and Castle to the river. In reply to the committee, who considered that double tramway lines would necessitate the widening of portions of the streets in which they would pass, the County Council said they did not contemplate undertaking such improvements. True, there are places where the width of the carriageway was a little less than that prescribed by the Tramway Acts, but this would not cause any inconvenience, nor was it anticipated that any difficulty would be raised by the frontagers to the construction of the tramway as proposed. The Works Committee, having very carefully considered the whole matter, were of opinion that the construction of the proposed tramway across Blackfriars-road would effectually block the traffic at this already congested spot. The borough engineer had also pointed out that the suggested lines would practically destroy the entrance to the railway goods depôt, and would in all probability necessitate the removal of the underground convenience at the corner of Southwark-street. Unless some substantial improvements were made towards obviating the difficulties alluded to, the committee could not recommend the Council to approve the scheme. It was decided to inform the County Council that the Council are unable to grant the necessary consent to the introduction of a Bill in Parliament for the necessary powers to construct such tramways.

London County Council.—The Board of Trade regulations for the running of the London County Council electric tramways have now been hung in all the trams. They are signed by Colonel Sir Herbert Jekyll, assistant secretary to the Board of Trade, and lay down the following as the rates of speed, which are not to be exceeded: 12 miles an hour on Clapham Common south side, between Clapham Park-road and Nightingale-lane. Eight miles an hour (*a*) in Kennington-road and Westminster Bridge-road, between the Horns and Stangate; (*b*) in Kennington Park-road, Newington-butts, London-road, St. George's-circus, and Blackfriars-road, between the Horns and the terminus; and (*c*) in Waterloo-road. Six miles an hour in Westminster Bridge-road, between Kennington-road and Waterloo-road; four miles an hour (*a*) through facing points, whether fixed or movable; (*b*) under the Balham railway bridge; (*c*) under the Clapham-road railway bridge; (*d*) on the curve leading to the Balham car-shed; and (*e*) on the curve leading to the Clapham car-shed. At all other places the speed shall not exceed the rate of 10 miles an hour. At the first meeting of the County Council after the summer vacation on Tuesday the Highways Committee presented a statement, in which they report that the reconstruction for electrical traction of the tramways (*a*) in Harleyford-street, Kennington Oval, and Harleyford-road—*i.e.*, between Brixton-road and Vauxhall Station—and (*b*) in Brixton-road, between Camberwell New-road and the commencement of the cable tramway near Handforth-road, has been completed; and the Board of Trade has, in the exercise of the powers conferred upon it by the London County Tramways (Electrical Power) Act, 1900, and the London County Council (Tramways and Improvements) Act, 1901, consented to, and approved of, the use of electrical power on these lines. The Board has also certified that the tramways in Harleyford-street, Kennington Oval, and Harleyford-road, which have been reconstructed as double lines under the powers conferred upon the Council by the Act of 1901, and not under the Electrical Power Act of 1900, as is the case with the Brixton-road line, are fit for public traffic. The Board has forwarded, with its consent, a copy of a minute by Lieut.-Colonel Yorke, R.E., stating the speed and stops which should be observed on the lines in question, and the Board's requirements upon these matters are being complied with. The tramways have been opened to the public, and through services of electrical cars are now run between Camberwell-green and Vauxhall, as well as from Westminster and Blackfriars bridges to the junction of the electric and cable lines in Brixton-road, where the electrical cars are fitted with cable-grippers to enable them to travel to and from the Streatham terminus. The Council have for some time past been giving careful consideration to the management of the advertising business in connection with their trams, and the committee who have had the matter under consideration have agreed to recommend the Council to appoint an officer at a salary of £300 a year and commission at the rate of 2½ per cent. on the actual receipts from advertisements. It is reported that the Council have decided to abandon the plan which has been in vogue for only a few weeks of carrying the electric cars over the cable route from Kennington to Streatham in consequence of the obstruction caused through changing from the electric system to the cable, and to the extra strain which the heavier electric cars put on the machinery which works the cable. The object, of course, was to enable passengers to make the through route from the London termini to the Streatham terminus in one car, but the arrangement has not worked well In future, therefore, passengers by the Council's system from the London termini to Brixton and Streatham, and *vice versa*, will have to change cars where the electric and cable systems join at Kennington. With reference to the complaints which have been made in the public Press and elsewhere as to the frequent blocks that occur on the main routes and the slow progress of the electric cars on the sections between Kennington and the London termini, we must entirely repudiate the suggestion that has got abroad that it is in any way due to the electric conduit system. Where horse and electric cars are running on the same lines, it is obvious that the rate of speed is set by the horse cars, which the electric cars are powerless to increase except when they get on the all-electric lines such as between Kennington and the Tooting terminus. The aspersions which have sometimes been cast at the electric system are entirely unwarranted, and we look forward to the time that the lines can be operated entirely by electricity, when it will be soon enough to say whether or not the electric system is a success or not. The following report was presented by the Highways Committee at Tuesday's meeting: "The construction of a portion of the tramway subway under the new thoroughfare between Southampton-row and the Victoria-embankment has been commenced, and it will be necessary for an engineer to be engaged temporarily to supervise the execution of the work. For this purpose we suggest that we should be authorised to obtain the services of a suitable person at the rate of pay of £6 per week. The necessary expenditure, which we anticipate will not exceed £375, is covered by the estimates approved by the Council on March 10, 1903 (p. 359). We recommend that the Highways Committee be authorised to arrange for the temporary employment of a resident engineer, at the rate of pay of £6 per week, to supervise the construction of a portion of the tramway subway under the new thoroughfare between Southampton-row and the Victoria-embankment." The committee also asked for authority to arrange for the temporary employment of a resident engineer, at the rate of pay of £8 per week, to supervise the construction of the pier and river-wall required in connection with the Greenwich generating station.

LIGHTING AND GENERAL.

Camberne.—Steps are being taken for the electric lighting of the new Council offices.

Leeds.—The Corporation are seeking powers to borrow £220,00 for electric lighting purposes.

Aston Manor.—The Urban District Council are negotiating a loan of £52,439 for the electric light undertaking.

Beckenham.—The Electric Lighting Committee are extending the cable in Croydon-road at an estimated cost of £50.

Wood Green.—The tenders for cables for the electricity supply have been left to the Electrical Committee, with power to act.

Brynmawr.—The Council have decided to at once apply for a provisional order to supply the urban district with electric light.

Embankment.—The City of London Electric Lighting Company intend to lay mains along a portion of the Victoria-embankment.

Pontypridd.—The Reading Town Council are lending the Urban District Council £2,000 for purposes of electricity and tramway undertakings.

Long-Distance Telephones. — Telephone connection between St. Petersburg and Berlin is contemplated, the cost being estimated at £40,000.

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Barnstaple.—A report on the electric lighting of the outside area has been referred back to the Electric Lighting Committee for further consideration.

Dudley.—The specification for proposed electric power and lighting at the workhouse, as submitted by the architect and amended, has been approved.

Bath.—The last report of the Electric Lighting Committee shows that the load is increasing very rapidly. It amounts at the present time to 638 kw.

Sale of Plant.—Particulars of sales of various electrical lighting plant and of a complete electric light generating plant will be found in another column.

Uxbridge.—The Urban District Council have appointed a committee to close an agreement with the Uxbridge and District Electric Lighting Company.

Dewsbury.—During the first fortnight in September 13,467 units of electricity (against 9,415) were used for lighting, and 16,834 units (against 16,398) for power.

Bray (Ireland).—The electric lighting extensions are to be undertaken by Mr. Evans, the assistant electrical engineer, under direction of Mr. M'Kenna, chief engineer.

Heysham.—At the next meeting of the Urban District Council the advisability of the Council applying for a provisional order for electric lighting will be discussed.

The Lizard Light.—The old double light at the Lizard has been replaced by a single electric five-seconds flash light, which is said to be the most powerful in the world.

Direct United States Cable Co.—The directors have declared an interim dividend of 3s. per share (being at the rate of 3 per cent. per annum (for the quarter ended Sept. 30.

St. Helens.—The last electricity account shows that the balance of assets has increased by £4,316. 6s. 6d., the total excess being £12,385. The capital expenditure now stands at £132,658.

Perth.—It has been remitted to the Sub-Lighting Committee to experiment and report to the Council as to the respective merits of electricity and incandescent gas for street-lighting.

Faversham.—The installation of the electric light is proceeding apace. It is rumoured that candidates are coming forward at the municipal election in favour of selling to a company.

Hastings.—The workshop at the electric light works is to be fitted with new lathes, shafting, etc., and application will be made for sanction to the borrowing of the estimated cost (£160).

Obituary.—We regret to learn of the death of Mr. J. T. Marsh, electrical engineer to the Dudley Corporation, caused by fractured limbs and internal injuries sustained by a fall from a horse.

Newark.—The form of agreement entered into between the Council and the Derbyshire and Notts Electric Power Company is being circulated amongst the members of the Urban District Council.

Edinburgh.—The number of 8-c.p. lamps applied for from Sept. 10 to 24 was 12,952, as against 2,527 for the same period of last year, making the total for the year 46,687, as against 35,620 last year.

Bootle.—With regard to the loan of £40,000 for electric lighting purposes, the Local Government Board have sanctioned the borrowing of £38,750, but have requested farther particulars with reference to the balance.

Water Power.—A 50,000-h.p. electric plant has been installed in the upper valley of the Hudson. Large power-houses utilising waterfalls to generate electricity are now so common in America as to cause little comment.

New Telephone Trunk Line.—The postal authorities have opened a new telephone trunk line connecting Pengam, New Tredegar, and Tredegar with Newport. This will relieve a great deal of the pressure in the Rhymney Valley.

Clitheroe.—The Town Council have decided to apply to the Board of Trade for a provisional order under the Electric Lighting Acts, 1882 and 1888, authorising the Corporation to supply electricity for public and private use within the borough.

Woolwich.—The clerk and electrical engineer have been instructed to obtain information from other boroughs relating to assisted wiring schemes in operation and report thereon, and a sub-committee is to formulate a scheme of assisted wiring.

Northallerton.—The postal authorities are now busily engaged in extending their trunk telephone line to Northallerton. All the necessary subscribers have been obtained, and it is expected the local exchange will be in working order next month.

Gloucester.—At the last meeting of the City Council several members spoke strongly in favour of improved lighting in various parts of the city, and Alderman Fielding took the opportunity of advocating the electric light being used wherever possible.

Bray (Berks).—The Council have decided not to object to the application from the borough of Maidenhead to the Board of Trade for a provisional order to authorise the supply of electricity for public and private purposes within the parishes of Cookham and Bray.

Mica Boiler Governing Co.—We are informed with regard to the Mansfield electricity works and also the Bexley electric lighting and tramway works that all the steam-pipes in both these installations and the boilers in the latter were covered by the above company.

Exeter.—Mr. Perry, in moving the adoption of the electric lighting report at the last Council meeting, said the profits earned by the plant of their inadequate station augured well for the future when the new electricity station was completed, and that would be very soon.

North Wilts.—Calne, Chippenham, and Devizes are considering, or about to consider, the advisability of having municipal installations of electric lighting. Chippenham is most advanced, Devizes comes next, and Calne is in the very earliest stages of consideration.

Bethnal Green.—This is the only borough in East and North-East London not lighted by electricity, but the Borough Council have secured a site for an installation, and have decided to apply to the London County Council for a loan of £15,750 for the purchase money.

Chester-le-Street.—At a recent very largely attended open-air meeting promoted by the Chester-le-Street Trades and Labour Council a resolution was passed calling upon the Parish Council to take the necessary steps to secure a supply of electric lighting for the streets and by-roads.

Colchester.—The electrical engineer in his last report gives the following figures: output of electricity in units during August, 1903, 19,099, 1902 12,043, 1901 6,578; number of consumers at end of August, 370, (299), (189); total number of 8-c.p. lamps connected, 23,206, (17,462), (13,322).

Middlesbrough.—The electrical engineer, Mr. Taylor, has been instructed to prepare specifications for extending the plant at the electric lighting station, it being pointed out that the extent to which the light would be used during the winter months would necessitate the use of the reserve plant.

Gateshead.—The North-Eastern Railway Company have decided to substitute electricity for steam power for the driving of the whole of the machinery comprised in the company's locomotive works at Gateshead-on-Tyne. Power will be supplied by the Tyneside Electrical Power Company from their Neptune Bank station.

Whitby.—The Urban District Council have decided to utilise electric power for the working of the pumps in connection with the sewage outfall works, and to apply for sanction to the raising of a further electric lighting loan of £5,000 for the extension of cables and additional plant in connection with the electric light undertaking.

St. Annes.—The electric engineer in his last report states that the units sold during August were 48,811, against 9,824 last year, and for the present year 153,300 against 37,313. The consumers now number 195 against 120. During the month applications have been made for 196 lamps. Additional Nernst lamps are to be fixed in various roads.

Whitehaven.—The Guardians have, we understand, adopted electric lighting for the workhouse under a contract by which they bind themselves (1) not to use any other light than electric light at the workhouse for a period of 10 years; (2) to pay not less than £100 a year; and (3) to commence this payment as soon as the work of laying the cable is completed.

Change of Address.—We are informed by Messrs. Wimshurst, Hollick, and Co., Limited, that on and after Oct. 9 all communications to them should be addressed to South Fambridge, near Rochford, Essex, the head office and works of the company. The firm's London office will be removed to 90, Cannon-street, E.C., telephone No. 937 Bank, from the same date.

Longton.—The manager in his last report states that the number of units of electricity generated during the past month was 4,237, being an increase of 1,195, compared with the corresponding period of last year; and that 57 16-c.p. lamps had been connected to the electricity mains during the month; and that an application had been received for current for motive power.

Islington.—It is proposed that to encourage an increased day load the uniform flat rate of 2d. per unit be modified for all electricity for power purposes consumed between the hours of midnight and 6 p.m. by the following sliding scale: for all units up to 2,000 per annum, 2d. per unit; from 2,000 to 20,000 units per annum, 1½d. per unit; from 20,000 and over per annum, 1¼d. per unit.

Hornsey.—The Council have adopted the following resolution: "That the time being opportune for the Council to give its assistance to the movement for introducing the telephones into the district, it be referred to the Highways and Lighting Committee to consider the advisability of urging his Majesty's Postmaster-General to include Hornsey in the Post Office system of telephones at an early date."

Wrexham.—The borough electrical engineer's last report contains the following figures: Connections and supply — units generated August, 1903, 31,804; units generated August, 1902, 8,737; used for tramways, 14,157; used for lighting, etc., 17,647. Connected during the month—one consumer with 44 lamps of 8 c.p. Total number of consumers connected to date 132, 10,610 lamps of 8 c.p.

Kingston.—The Town Council have received sanction to the borrowing of £7,784 for electric lighting. The Surbiton Urban District Council have given notice to the Corporation to terminate at the expiration of one month from the 1st inst. the supply of electricity to premises in Surbiton. An arrangement is to be made for taking over the cables laid by the Corporation to such premises. It is proposed to light St. Luke's Church clock by electricity.

York.—The report of the Electric Lighting Committee, presented to the City Council on Monday, states that the works on Foss Islands are proceeding in a satisfactory manner, and that the destructor, which has been undergoing repairs, is now in full working order. With a view to improving the lighting of certain parts of the city, the York Electric Lighting Committee have decided to alter certain public arc lamps at a cost of £28 per annum, and an outlay of £50.

Mansfield Woodhouse.—The Urban District Council have resolved to retain the services of Mr. Warden-Stevens as electrical engineer to advise the Council in their application to obtain a provisional order enabling them to supply electrical energy to the district. The surveyor has been requested to prepare plans, showing the compulsory area in which it is proposed to supply electrical energy within a period of two years from the date of obtaining the provisional order.

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Derby.—The Electric Lighting Committee have been in communication with the Local Government Board with respect to the appropriation for the purposes of an electricity generating station of the land in Full-street, acquired for the extension of the Full-street baths, and a letter has been received from the Board to the effect that having regard to the powers conferred upon the Council by Section 96 of the Derby Corporation Act, 1901, the approval of the Board is not necessary.

London County Council.—The Fire Brigade Committee, reporting on the Bayswater sub-station, stated that they proposed that the station should be lighted by electricity, and in due course they would obtain and submit tenders for the necessary wiring and fittings. An expenditure of £848 in connection with the electric light and electric bell installations at the Bayswater sub-station, and of incidental expenses arising out of the erection of the building, has been authorised.

King's Lynn.—At the meeting of the Guardians it was reported that the cost of electric lighting for the Michaelmas quarter was: workhouse and casual ward, £8. 7s. 3d.; infirmary, £11. 14s. 9d.; laundry motor, £13. 9s.—total, £20. 15s. 9d., as compared with £23. 14s. 8d., the cost of gas for the corresponding period 1901, and being a saving of £2. 18s. 11d. The Chairman said the report was very satisfactory, as in the new infirmary there were 45 lights, and these were not included in the 1901 cost.

Ramsgate.—The report of the committee of the whole Council adopted last week is as follows: "The town clerk submitted a draft agreement received from the Isle of Thanet Electric Tramways and Lighting Company, Limited, as to application by them for taking over the Ramsgate Electric Lighting Order, 1900, and it was resolved that Messrs. Edmundson's be asked to submit within seven days a draft agreement carrying out the proposals contained in Messrs. Pressland and Fippard's letter of the 21st inst."

Rotherham.—Important additions are being carried out by the Parkgate Iron and Steel Company, Limited, which will add considerably to the productive capacity of the works, and will also bring the plant thoroughly up to date. The plant is being increased by the construction of two "close-top" blast furnaces, equipped with Sahlin's water-cooled boshes, electric hoists, and automatic charging apparatus. This company were among the first iron and steel makers in England to introduce electric lighting and power into the works.

South Wales Electric Power Co.—The building near Pontypridd for the first generating station is practically completed. Several Galloway boilers have been delivered and are awaiting erection. A considerable mileage of mains is already laid. We understand that the Urban District Council of Ammanford is negotiating with the company to take a supply, and if terms can be arranged the Council will apply next year for a Board of Trade provisional order. Arrangements have also been entered into with Port Talbot, and they will most likely take a supply in bulk.

Glasgow.—At the last Council meeting Mr. Kennedy asked whether the £1 of free terminals granted to certain telephone subscribers was not equivalent to those subscribers getting the service at £4. 5s., while other users not requiring trunk services paid £5. 5s. He wished to know if this did not constitute an illegal preferment. Sir James Marwick, town clerk, stated that the telephones manager had been asked to make a report on the matter. The Electricity Committee's recommendation of a scheme for selling or hiring out electric motors and other fittings has been defeated.

Finchley.—A letter from the East Barnet Valley Urban District Council in reference to the supply of electricity is before the Electricity Committee. The Electricity Committee's estimate for the half-year ending March 31, 1904, is as follows: Expenditure—generation, £595; distribution, £60; public lighting, attendance and renewals, £60; management, £310; capital charges and contingencies, £179. 9s. 11d.—total, £1,204. 9s. 11d. Receipts—estimated receipts from private consumers for public lighting, rents of meters, etc., £965; estimated sum to be provided by rate, £239. 9s. 11d.

Black Forest Industries.—Owing to co-operative enterprise in the Southern Black Forest, the looms of upwards of 500 domestic weavers are to be driven by electricity. The total cost of establishment for the power plant is estimated at about £17,000, this sum to be supplied by the Wald-Elektra Saekingen Waldshut Power Company, apart from a subvention granted by the Baden Government. The great advantage of this enterprise will be that silk ribbon weaving will be enabled to be preserved as a domestic industry, securing a yearly income of about £15,000 to the poor inhabitants of the forest.

Dundee.—The Works Committee of the District Lunacy Board have asked Mr. Richardson, the burgh electrical engineer, as to whether the present electric lighting installation should be repaired or a supply of energy got from the town. Mr. Richardson has now reported that he could not give a statement of the relative cost of the two schemes as there was no data to estimate the cost of the present supply, and he suggested that arrangements should be made for keeping a record of the energy consumed during the next 12 months, when the question could be more satisfactorily dealt with. This has been agreed to.

Belfast.—The minutes of the Gas and Electric Committee contains the following paragraph: "It had come to the knowledge of the committee that the Law Committee proposed retaining the services of an expert electrical engineer who had had experience in connection with tramway and electrical undertakings, to prepare plans and make a preliminary report for the guidance of the Council. It was resolved that the Law Committee be informed that that committee was quite prepared to undertake through its officers the electrical portion of the work, and saw no necessity for engaging costly outside assistance."

University College of North Wales Electrical Engineering Department.—With the opening of the college on Oct. 1 the electrical engineering department will enter upon its fourteenth session. Two of the students who left last session have been admitted to the British Westinghouse Works at Trafford Park, Manchester, and two into the British Thomson-Houston Works at Rugby. The department is maintained by means of a grant made by the Worshipful Company of Drapers, London, which enables the college to appoint as an assistant to Prof. Taylor Jones a special assistant lecturer in electrical engineering.

Brighton Accounts.—With reference to the abstract of accounts of the Brighton electric lighting undertaking which appeared in our last issue, we have now received a corrected proof from Mr. A. Wright, the consulting engineer. The chief alteration occurs in the revenue account in the repairs items. These figures should read as follows: repairs to buildings, £361. 9s. 2d.; repairs to machinery, £2,492. 0s. 8d.; repairs to mains, £1,687. 12s. 2d. (less £627. 13s. 4d., amount charged to tramways department for overhauling mains). The sum total, however, remains the same. The revised figure in respect of total capital expenditure to date is £463,374, in place of £466,746 originally given.

Hammersmith.—Since the last Council meeting 10 additional consumers have been connected, representing a maximum of 619 8-c.p. lamps. Nine consumers have been disconnected. The present number of consumers now taking current from the mains is 1,289. The engineer has a quantity of plant in the station which is not now used, and is of no use to the department—viz., No. 1 set, pumps, etc.—and Messrs. Wheatley, Price, and Kirk have been instructed to dispose of the same for a commission of 5 per cent. on the amount realised. The postal authorities are about to take up the footway on the west side of Bamborough-gardens for the purpose of laying a line of underground telegraph.

Sunbury.—The Twickenham and Teddington Electric Supply Company are prepared to supply electric current for public lighting over the entire district. In regard to the company's application for a provisional order, they proposed to insert clauses which would give the Council power to purchase the undertaking at a valuation in 7, 14, or 21 years. Also to supply current to private consumers at 7d. per unit for the first hour per day as the maximum demand, and 8d. per unit for further quantities. They are prepared to enter into agreement to supply current for public lighting at a price not exceeding 2½d. per unit. The subject has been deferred, and the surveyor instructed to make enquiries.

Maidenhead.—On Sunday the electric light at St. Joseph's Church, Cookham-road, was used for the first time. The church is lighted by 16 lamps of 25 c.p. each. The contractor was Mr. F. J. Bloomfield, King-street. A committee has been appointed to arrange for the proposed street-lighting extensions. Messrs. Percy Johns, borough surveyor, and C. O. Milton, electrical engineer, propose seven 10-ampere 46-volt 2,000-c.p. arcs, two 35-n.c.p. Nernst, one 500-n.c.p. arc, one 230-volt 500-c.p. arc, one 115-volt 200-c.p. arc, one 32-c.p. British Prism Globe Company's incandescent, one 16-c.p. Imperial Electric Company's incandescent, two ½-ampere 35-c.p. Nernst. Together with the former scheme 54 lamps would be installed. A loan of £10,000 is being raised for the purpose.

Stock Exchange Settlements.—The Stock Exchange Committee has appointed Oct. 22 special settling day for Underground Electric Railways Company of London's fully and partly paid provisional certificates for £3,599,268 5 per cent. profit-sharing secured notes. The committee have also ordered the Metropolitan District Railway Company's £2,116,666 3 per cent. consolidated rent charge stock, in lieu (partly) of the 4½ per cent. Ealing rent charge stock and the 4½ per cent. Fulham rent charge stock now quoted, to be quoted in the official list. Application has been made to the Exchange Committee to appoint a special settling day in and to grant a quotation to the London United Tramways (1901), Limited, further issue of £206,000 4 per cent. first mortgage debenture stock.

Swansea Telephones.—Considerable progress has been made towards the completion of the system, and there appears to be some prospect of opening the exchange early next month. A large number of subscribers are already connected to the exchange, and will enjoy the free use of the system up to the date of the opening ceremony. Cables have been laid under the docks to connect up the eastern portion of the town and local exchanges established at Morriston and Oystermouth. Terminals will be charged to the Corporation telephone department by the National on all messages sent through the Corporation's system, and the Corporation will charge the National Company for all messages received from National subscribers in other towns. The subscribers who have been using the Corporation lines to speak to Cardiff, Liverpool, London, etc., have not been asked to pay anything more than the Post Office charge, which the National subscribers have to pay on all trunk messages.

Carnarvon.—The Town Council have received an offer from the North Wales Power and Traction Company to provide the borough with a continuous electrical supply suitable for both power and lighting, the company undertaking the erection of a distributing station within the borough and supplying the energy at a maximum rate of 3d. per unit for power and lighting, with a suitable discount for power consumers, the company conveying the current at their own expense to the station, delivering in bulk at a voltage suitable for both lighting and power, the distribution being done by and being the property of the town. The company also offered an alternative scheme, itself undertaking the distribution and delivering the wires to the consumers' terminals at a maximum rate of 4d. per unit for lighting and 2d. per unit for power, but the order and the whole undertaking becoming the company's property, the company re erving for the Corporation a call for any power required for tramway purposes at special rates. The Electric Committee have been empowered to employ an expert to report fully on the details of all the schemes now before the Council, and advise on their respective merits.

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Inverness.—The Town Council have resolved to accept the offer of Edmundson's Electricity Corporation, Limited, to establish and carry on the lighting of the town by electricity. The company will repay the costs incurred in connection with the provisional order, and they will have the option of terminating the permanent leave by giving 12 months' notice at the end of seven years, or at the end of any subsequent term of seven years, the price to be paid by the Town Council to be the capital expended by the company with the addition of 15 per cent., and a sum sufficient to make up profits to 5 per cent. per annum. The works must be completed within 12 months from the date of the lease. The company will adopt the system of free wiring. The Town Council selected the offer on the recommendation of Messrs. Buchan and Hogarth, consulting electrical engineers, Edinburgh.

Bridgend.—The agreement between the Council and the South Wales Electrical Power Distribution Company provides that the Council shall pay for electrical power 2½d. per unit, plus ¼d. for transformation, for 50,000 units, and that the price per unit shall decrease according to a scale agreed upon as the total amount of electricity taken increases. It is furthermore provided that when any similar body in the district obtains energy from the company at a lower rate the Council rate shall be similarly reduced. Some months ago the company voluntarily reduced the charge to 1⅜d. per unit, plus an eighth for transformation, upon which terms they had recently agreed to supply the asylums. Within the urban district the company have no right to supply energy for lighting purposes without the consent of the Council. They, therefore, represented to the Council that they would lose several large power customers whom they had in view, unless they were allowed to supply them with electricity for lighting purposes as well as power. The Council gave consent, but it was conditional upon their being allowed the ⅛d. which the company charged for transforming the town supply. This met with a refusal, and the Council have now decided to prohibit the company from supplying light to any firms within their district.

Fulham.—The borough electrical engineer has submitted the undermentioned statistics with regard to the quantity of refuse destroyed and connections for current:—Previously reported 5,794 loads (8,653 tons); from July 17 to 30, 1903, 722 (1,135½); from July 31 to Aug. 13, 664 (1,022); from Aug. 14 to 27, 606 (973); from Aug. 27 to Sept. 10, 652 (1,007½)—total, 8,438 (12.791). Trade refuse: previously reported, 104 loads (104½ tons); from July 17 to 30, 17 (18); from July 31 to Aug. 13, 12 (14½); from Aug. 13 to 27, 10 (9½); from Aug. 27 to Sept. 10, 14 (17) - total, 157 (163). Clinker disposed of: Previously reported, 3,931 tons; from July 17 to Sept. 10, 1,607—total, 5,538. Connections for current: Previously reported 752 = 33,578 8-c.p.; from July 12 to 30, 19 (572); from July 31 to Aug. 13, 24 (507); from Aug. 14 to 27, 37 (1,165); from Aug. 28 to Sept. 10, 25 (1,207)—total, 857 (87,029); consumers not ready for connection, 23; consumers not paid deposits, 9. Mr. J. H. Clack, the chief clerk of the electricity department, is to be allowed to continue the work of canvassing for consumers of electric light and power, and is to receive, in addition to his salary, 1d. per equivalent 8-c.p. lamp connected to the mains up to a connection of 5,000 lamps per annum, and ½d. per equivalent 8-c.p lamp connected to the mains for all connections above 5,000 lamps per annum.

London Gazette.—The first meeting in the estate of William Thomas, electrical engineer, 54, Bridge-street, Llandaff, lately residing at 13, Despenser-street, Cardiff, Glamorgan, will be held at 11.30 a.m. on Oct. 15 at 147, St. Mary-street, Cardiff. The partnership heretofore subsisting between Walter Andrew Mathew and Herbert Raymond Wilding, under the style or firm of W. A. Mathew and Co., at 59A, High-street, Beckenham, Kent, as motor, electrical, and general engineers, has been dissolved by mutual consent from Aug. 31, 1903. At an extraordinary general meeting of the members of the Renewable Electric Lamp Company, Limited, held at Brunswick Works, Brunswick-place, City-road, London, N., on Sept. 22, 1903, the following extraordinary resolution was passed: "That it has been proved to the satisfaction of this meeting that the company cannot, by reason of its liabilities, continue its business, and that it is advisable to wind up the same, and accordingly that the company be wound up voluntarily." Mr. D. L. Chalmers, of Vron House, Llangollen, was appointed liquidator for the purpose of such winding-up. A general meeting of the members of the English and General Tramways Company, Limited, will be held at 1 and 2, Great Winchester-street, London, E.C., on Nov. 9, 1903, at 3 p.m., for the purpose of having an account laid before them showing the manner in which the winding-up has been conducted and the property of the company disposed of, and of hearing any explanation that may be given by the liquidator, and to determine the manner in which the books of the company shall be disposed of.

Acton.—The Dowsing Radiant Heat Company, Limited, have written to the District Council with reference to the supply of electrical current for lighting, heating, and motive power at Oldfields, Acton-vale, as follows: "We are taking the above premises in Acton, and require a large supply of electrical current for lighting, heating, and motive power. We should, of course, be glad to take the current from your Council, but we are aware of the fact that you are unable to supply, as you have not yet put your electrical powers into force. As, however, the property referred to is within about 200 or 300 yards of the Hammersmith boundary, we have approached the Borough Council of that district, and are given to understand that they would be willing to supply us the electricity we require, if you will give your sanction to the necessary mains being laid along the footway from their boundary along Acton-vale up to Oldfields. We believe that the Hammersmith Corporation would require the right to supply for five years, and we trust that you will agree to give your sanction to the above, as it is most important so far as our business is concerned. We may state that the writer has been resident in Acton for some three years past, and has been compelled to put down machinery to generate the electricity, but in our new premises we shall require a much larger amount of current, and do not wish to go to the expense of putting down electrical machinery for the purpose." The Council have declined to consent.

London County Council.—On Tuesday it was agreed to lend the Hackney Borough Council £906 for electric lighting works, and the Fulham Borough Council £13,509 for electric lighting and other works in connection. A report was submitted on a notice served upon the Council by the Metropolitan District Railway Company of intention to proceed with the work, authorised by the Metropolitan District Railway Act, 1900, of laying electric mains along Fulham-road, King's-road, Uverdale-road, and Lots-road, Chelsea, as shown upon the plans which accompanied the notice. The Highways Committee on a former occasion stated that these plans did not indicate to what extent the Council's sewers would be affected by the proposed works, and they, as a matter of urgency, disapproved the works on behalf of the Council. The Underground Electric Railways Company of London, which was intimately connected with the company above named, has since submitted for the Council's approval cross-sections of Fulham-road, King's-road, and Lots-road, where the proposed mains would cross those thoroughfares, indicating the positions of the various sewers affected. Having considered these further particulars submitted by the company, there appeared to the committee to be no objection to the proposed works being put in hand, and, acting under the authority given by the Council to deal with urgent matters during the summer vacation, they approved the proposed works on behalf of the Council, subject to the works in Fulham-road, King's-road, and Lots-road being carried out in accordance with the cross-sections forwarded by the company, and to the road boxes being constructed at some distance on either side of the sewer in King's-road. The following notices to lay mains, etc., under Electric Lighting Acts and orders were also agreed to: from the Blackheath and Greenwich District Electric Light Company, Brompton and Kensington Electricity Supply Company, Charing Cross and Strand Electricity Supply Corporation, Kensington and Knightsbridge Electric Lighting Company, Lewisham and District Electric Supply Company, City of London Electric Lighting Company, County of London and Brush Provincial Electric Lighting Company, Metropolitan Electric Supply Company, Notting Hill Electric Lighting Company, Westminster Electric Supply Corporation, and St. Pancras Borough Council. The receipts of notices, as follows, served under orders granted to local authorities, and under which the Council has no power of approval or disapproval of works, was reported: from the Bermondsey Borough Council of intention to lay mains along Neckinger, Spa-road, Rouel-road, Dockley-road, St. James-road, Tranton-road, and Southwark Park-road; Hampstead Borough Council, to lay mains along portions of North-end, Hemstall-road, Belsize-road, and South-hill-park; Islington Borough Council, to lay mains along a portion of Wallace-road; Stepney Borough Council, to lay mains along portions of Cannon-street-road and Cable-street, and along portions of Upper East Smithfield, Three Colt-street, Watney-street, St. George's-street, and High-street, Shadwell.

Brighton.—The Council have confirmed the following proceedings of the Lighting Committee: With reference to Councillor Butt-Thompson's enquiry as to the amount of capital which would have to be gradually written off on the completion of the Southwick power station, Mr. Arthur Wright, consulting engineer and manager, reported to the committee that the original cost of the three tramway generating sets was £7,530, of which £205 has already been provided for by the sinking fund. In his opinion these sets would realise between £4,000 and £5,000 if sold any time during the next five years. The evaporative condenser referred to in his previous report had been in use for seven years, and cost, roughly, £1,500. Of this, about £200 had been provided for by the sinking fund, and the balance should, in his opinion, be written off during the next three years. The 270 meters which Mr. Christie had reported as being obsolete were of the Chamberlain and Hookham and Thomson types, and had been in use for about 10 years. The amount at which they stood in the ledgers was about £1,400, and this amount should, in his opinion, be at once written off, as they failed in selling any one of them after publicly advertising same. The consideration of the report was deferred by the committee. Mr. John Christie, resident engineer, reported that he found in actual practice that greater efficiency could be obtained out of the storage battery used in conjunction with the tramway supply if they added 12 more cells, which would enable them to take a much greater output from it, and maintain the full pressure to the tramways throughout the whole discharge. He had obtained prices from the Electrical Power Storage Company, who had at present men carrying out some alterations to the existing battery, and they stated that if they place the order with them while their men are here, they would erect them complete, and let them fall under the terms of the existing contract, for the sum of £14. 11s. 6d. per cell. He recommended acceptance of this offer, and suggested that the capital to pay for this should be borrowed on the same terms as the existing loan, when the next enquiry was being held. The committee resolved that the report should be approved and acted upon. For the carrying out of the numerous short extensions of the mains which were passed from time to time, Mr. Christie reported that he required for stock one mile of one triple-concentric lead-covered cable. He asked four of the leading firms to quote for the standard cable, which was now manufactured by all the cablemakers, and recommended the acceptance of the cheapest—viz., that of Messrs. Callenders, at £310 per mile. With reference to the supply and distribution by the Council of electricity in parishes outside the borough, the Town Clerk reported that under the Brighton Corporation Act of last session the Council were empowered to supply and distribute electricity within the parishes of Rottingdean, Ovingdean, Patcham, Falmer, Preston Rural, Hangleton, Portslade Rural, Old Shoreham, Kingston-by-Sea, Lancing, and West Blatchington, subject to compliance with certain provisions. It was resolved that application should be made to the Rural District Councils of Steyning East, Steyning West, and Newhaven for their consent to the supply by the Corporation of electricity to consumers within the

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parishes named in Section 30 of the Brighton Corporation Act, 1903, which are within their respective districts.

Reading.—At the last Council meeting a report from the sub-committee appointed to consider the advisability of purchasing the undertaking of the Reading Electric Supply Company, Limited, was read. It stated: "The terms upon which the Corporation may acquire the undertaking of the company are set out in Section 58 of the Reading Electric Supply Order, 1893, which provides as follows: (1) The local authority may at any time before the expiration of 42 years after the commencement of this order—namely, July 27, 1893—give notice in writing to the undertakers requiring them to sell the undertaking authorised by this order to the local authority, and thereupon the undertakers shall sell the same to the local authority upon the terms of the local authority paying to the undertakers an amount of money as shall be equal to a sum of £133 for every sum of £100 properly expended by the undertakers upon the said undertaking and chargeable to capital account . . . provided that if the local authority shall exercise the power conferred by this sub-section before the expiration of 21 years the local authority shall in addition to the amount of money to be paid to the undertakers as aforesaid pay to the undertakers a sum equal to the aggregate amount of a dividend of 5 per cent. per annum on the said capital expenditure less the aggregate amount of the dividends declared by the undertakers. (There are other provisions as to the purchase of the undertaking after the expiration of 21 or 31 years.) The sub-committee have considered a statement which has been prepared by the borough accountant from the published accounts of the company showing that the amount of stock which would probably be required to be raised for the purchase of the company's undertaking on the basis of the section above referred to would amount to the sum of £178,395. The following is a copy of the statement: The capital expenditure to Dec. 31, 1902, as stated in the last published balance-sheet of the company was £112,750; add 33 per cent. to the above amount in accordance with the purchase clause in the company's provisional order, £37,208—total, £149,958. In addition to the above sum of £37,208, the Corporation would have to pay the difference between the amount actually paid by the company for interest and dividends, and an amount calculated at 5 per cent. on the capital expenditure. 1894, capital expenditure £11,192, (equivalent to 5 per cent. dividends £280—half-year); 1895, £17,875 (£1,453), 1896, £6,146 (£1,761); 1897, £7,199 (£2,121); 1898. £11,776 (£2,709); 1899, £21,447 (£3,782); 1900, £15,663 (£4,565); 1901, £8,798 (£5,005); 1902, £12,654 (£5,634)—£112,750 (£27,313). Deduct dividends declared, year ended Dec. 31: 1899, £1,448; 1900, £3,184; 1901, £4,692; 1902, £5,096—£14,420. Interest on capital temporarily raised by the issue of debentures and bank interest: 1896, £147; 1897, £641; 1898, £864; 1899, £640; 1900, £3—£2,295—£16,715. Total cash payable to the Reading Electric Supply Company, Limited, in the event of purchasing their undertaking, £160,556; this would necessitate an issue of stock, assuming £90 net cash for each £100 of debt created amounting to £178,395; the annual charge for interest and sinking fund on the above sum at 5 per cent. repayment in 30 years would be £9,102; the profit declared by the company last year, being after the rate of 5 per cent. per annum was £5,006—difference, £4,006. Having regard to the fact that according to this statement the amount which would be required each year to provide sinking fund and interest would be very considerably in excess of the profit declared last year, the sub-committee are of opinion that the Corporation would not be justified in purchasing the company's undertaking under the terms of the order above referred to. They, however, recommend that the company be informed that the Corporation will be willing to consider any proposals which the company may make to the Corporation for the sale of their undertaking." It was resolved that the report be received and the recommendation adopted.

PROVISIONAL PATENTS, 1903.

SEPT. 28.

20788. Improvements in or relating to electric arc lamps. Adrian Denman Jones, Hartham Works, Hartham-road, Holloway, London.

20791. Improvements in terminals for wiring motors or any other electrical appliances. Ernest Henry Ainsworth, 21, Tindal-street, Chelmsford.

20806. Coherers for Hertzian wave telegraphy. V. W. Delves-Broughton, 80, Central-hill, Upper Norwood, London.

20820. Improvements in or relating to electric machines. Henry Chitty, Westinghouse-building, Norfolk-street, Strand, London.

20825. Improvements in and relating to electric lamps. Walter Charles Head and William Arthur Snape, 20, Filey-avenue, Clapton, London.

20834. Improvements relating to lamp casings and reflectors principally for incandescent electric lamps. Dennis Joseph O'Brien and Tullis Antonio Rotanzi, 18, Buckingham-street, Strand, London.

20836. Improvements in or relating to disinfecting fabrics and articles particularly applicable for telephonic and other apparatus. Alfred Julius Boult, 111, Hatton-garden, London. (Charles Fuchs and Henri Chrétien Kelterer, Belgium.)

SEPT. 29.

20875. Improvements in electric lamp holders and means for securing shades or globes thereto. John Thomas Lambert, 32, John William-street, Huddersfield.

20888. Improvements in and connected with a mechanism for ascertaining and recording thermic pressure, kinetic, and potential differences. John Fisher Le Page, 8, King-street, Manchester.

20907. Improvements in telegraph systems. Charles Kinney Jones, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

20916. Improvements in current regulators. Sydney Elliott Page, 28, New Bridge-street, London. (The International Electric Controller Company, United States.) (Complete specification.)

20921. Improvements in insulated electric conductors and method of producing the same. John Allen Heany, 18, Southampton-buildings, Chancery-lane, London. (Complete specification.)

20922. Improvements in magnetic separators. Julius Buss, 6, Great Winchester-street, London.

20926. An improved electric current converter. Albert Richard Müller, 6, Lord-street, Liverpool. (Complete specification.)

20933. Improvements in contact trolleys for electric tramcars and the like. Adalbert Domanski, 18, Buckingham-street, Strand, London.

20934. Improvements in electric switches, bell pushes, or fittings, and the like. Frederick Edward Dotchin, 18, Buckingham-street, Strand, London.

SEPT. 30.

20989. Improvements in or relating to electrolytic electricity meters. The Bastian Meter Company, Limited, and Charles Orme Bastian, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

20997. Automatic switch for control of starting electric motors. Frederick Collyer Newton, 30, Clovelly-road, Hornsey, London

21005. Improvements in and relating to alternating-current electric motors. The British Thomson-Houston Company, Limited, and Hans Sigismund Meyer, 83, Cannon-street, London.

21008. Improvements in mounting a number of electrical fittings or instruments upon a common base or panel. Renter Wolter Hendrick Hofstede Crull, 4, South-street, Finsbury, London.

21016. Improvements in or relating to alternate-current measuring apparatus. Arthur Francis Berry, 46, Lincoln's-inn-fields, London.

21027. Improvements in and relating to electricity meters. William Hamilton, 18, Southampton-buildings, Chancery-lane, London.

OCT. 1.

21043. Electromagnetic trolley rope check. Richard N. Eaton, 110A, Upper Leeson-street, Dublin.

21055. Improved methods of collecting currents of electricity in connection with a conduit system of tramways. Frederick John Anson and Joseph Walter Anson, 26, Mervan-road, Brixton, London.

21067. Improvements in electric motors. Joseph Henry Kaye, Commercial-street, Halifax.

21078. An improved party-line telephone system. Henry Conrad Heide, 1, Broad-street-buildings, Liverpool-street, London. (George Archibald Lowry, United States.)

21088. Improvements in and connected with telephone connections on the party-line system. Hermann Oppenheimer, 55, Redcross-street, Barbican, London. (Aktiengesellschaft Mix und Genest, Germany.)

21090. Improvements in or relating to dynamometers for electric currents. Alfred Julius Boult, 111, Hatton-garden, London. (Mathias E. Turner, United States.) (Complete specification.)

21093. Improvements in or relating to electrical switches (and their analogues). James Porter, 111, Hatton-garden, London.

21104. An improved electrolyte for electric batteries and method of preparing the ingredients composing said electrolyte. Alfred Blackman and Charles Ernest Warren, 45, Southampton-buildings, Chancery-lane, London.

21127. Improvements in controllers for electric motors. George Forbes, 24, Southampton-buildings, Chancery-lane, London.

OCT. 2.

21153. A splicing fitting for splicing or jointing trolley wires, cables, wire ropes, and metal rods of any description. Archibald Robert Dayson, Electric Car Depôt, North Bridge-street, Sunderland.

21194. Improvements in or relating to the method of transmitting printing telegraphic messages over long lines, and to the apparatus therefor. Antonio Battaglia-Guerrieri, 37, Essex-street, Strand, London. (Complete specification.)

21208. Improvements in alternating-current meters. The Compagnie pour la Fabrication des Compteurs et Material d'Usines a Gaz, 70, Chancery-lane, London. (Date applied for under Patents Act, 1901, Dec. 16, 1902, being date of application in France.) (Complete specification.)

21216. Improvements in electric railway systems. William Mantz Eader, Norfolk House, Norfolk-street, Strand, London. (Complete specification.)

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Oct. 3.

21219. Improvements in secondary batteries. Sherard Cowper-Coles and Co., Limited, and Sherard Cowper-Coles, 82, Victoria-street, Westminster, London.

21220. Improved process for recovering copper from its alloys. Sherard Cowper-Coles and Co., Limited, and Sherard Cowper-Coles, 82, Victoria-street, Westminster, London.

21227. Improvements in or relating to lifeguards for electric tramcars and other road vehicles. William Arthur Turner and George Alfred Webster Turner, 55, Market-street, Manchester.

21240. An improved starting switch and automatic cut-out adapted for series-wound electric motors. Arthur Denby Smith, Highfield-lane, Keighley.

21261. A new or improved indicating device for use in connection with the trolleys of electric tramcars. George Herbert Babb, 33, Chancery-lane, London.

21294. Improvements relating to dynamo-electric machines and electric motors. Erik Artur Fagerlund, 45, Southampton-buildings, Chancery-lane, London.

21302. Improvements in automatic telephonic installations. Bernhard Kugelmann, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

21304. Improvements in driving electrical machines by means of steam-turbines. Siemens Bros. and Co., Limited, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Siemens und Halske Actien-Gesellschaft, Germany.) (Complete specification.)

21305. Method of and apparatus for maintaining uniform speed in electric motors. Siemens Bros. and Co., Limited, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Siemens und Halske Actien-Gesellschaft, Germany.) (Complete specification.)

21306. Improvements in electric lamps. John Benjamin Butler Burke, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

COMPLETE SPECIFICATIONS ACCEPTED.

To be published Oct. 22, 1903.

1902.

21346. Electric arc lamps. Jandus Arc Lamp and Electric Company, Limited, and Jones.

22031. Mariner's compass. Baron Kelvin, Clarke and Kelvin, and James White, Limited.

22152. Telephone call boxes. Hall.

23231. Signal devices for telephone systems. Baird.

23504. Overhead lifeguards for the protection of passengers from broken trolley wires on electrically-driven tramways. Teers.

23933. Supports or hangers for overhead electric wires. Bentley.

24705. Contact clamps for electric conductors. Carolan. (General Electric Company.)

24712. Alternating-current electric motors also applicable to meters of the induction type. Carolan. (General Electric Company.)

24713. Induction electromotors. Carolan. (General Electric Company.)

24715. Systems of electrical distribution. Carolan. (General Electric Company.)

24750. Covering or insulating material for electric cables. Johnson and Paterson.

24829. Disconnecting and junction boxes for underground electric cables and manhole covers and frames for same. Sowden.

26032. Controlling the speed of electric motors. Carolan. (General Electric Company.)

26036. Means for automatically stopping an electric railway car or train. Carolan. (General Electric Company.)

26042. Electric motors. Carolan. (General Electric Company).

26043. Electrical synchronising devices. Carolan. (General Electric Company.)

26045. Electric rock drills. Carolan. (General Electric Company.)

26047. Electric transformers. Carolan. (General Electric Company.)

26272. Alternate-current motors. Ablett.

26375. Electrical connecters. Carolan. (General Electric Company.)

26376. Insulation of electrical switches and the like. Carolan. (General Electric Company.)

26382. Electric rheostats. Carolan. (General Electric Company.)

26429. Switchboard frames. Statter.

26455. Electrically-operated railway or tram rail point shifters and the like. Meatchem.

26694. Electrical appliances for controlling and lighting gas burners. Down. (Framzen.)

27089. Electric power transmitters for sewing machines and the like. Rosenberger.

27150. Electrical sparking plugs for explosion engines. Ramoneda.

27897. Electric ignition apparatus for internal-combustion engines. Pognon.

1903.

11552. Section insulating bridges for electric overhead conductors. Harris.

13221. Magneto semaphore mechanism. Magneto-Electric Company and Leonidus G. Wooley.

14106. Electrically-operated ventilating fans. Haddan. (Bergmann-Electricitäts-werke Aktien-gesellschaft.)

14979. Electricity meters. Aron

15337. Magneto-electric igniting apparatus for internal-combustion engines. Roos.

16132. Rectifying polyphase alternating currents by means of unipolar or aluminium cells. Evans. (Allgemeine Elektricitäts-Gesellschaft.)

16450. Signalling apparatus worked by alternating currents. Siemens Bros. and Co., Limited. (Siemens und Halske Aktien-gesellschaft.)

17072. Method of syntonising two electric circuits and apparatus for use therein. Payne. (Secret document under Section 44, Patents, etc., Act., 1883.)

18376. Connection block for electric conducters applicable also as an insertion contact and ceiling rosette. Thompson. (Firm of O. and H. Keller.)

18586. Porcelain and other electric insulators. Langdon, Fuller, and Fuller.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.		Last price
Commercial and Industrial.—	£		£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1	..	¼-¾
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1	..	¼-½
British Insulated and Helsby Cables, Ord., 1-100,000	5	..	6¼-7
—— 6 per cent. Cum. Pref., 1-100,000	5	..	5¼-5⅝
—— 4½ per cent. Mortgage Debentures	100	..	103-106
British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red.	100	..	104-106
British Westinghouse Elec. and Manuf., 6 per cent. Pref., 275,001-375,000	5	..	5¼-5½
—— 4 per cent. Mortgage Debenture Stock	100	..	100-102
Brush Electrical Engineering, Ordinary, Nos. 1-105,731	2	..	¾-1¼
—— Non. Cum., 6 per cent. Pref.	2	..	1-1¼
—— 4½ per cent. 1st Debenture Stock	100	..	97-100
—— 4½ per cent. 2nd Debenture Stock	100	..	85-90
Callender's Cable, Debentures	100	..	106-110
—— Ordinary	5	..	11¼-12¼
—— 5 per cent. Pref.	5	..	5¼-5⅝
Crompton and Co.	3	..	2-2¼
—— 5 per cent. Debentures	100	..	100-104
Edison and Swan United, "A" Shares, 1-99,261	3	..	¼
—— "A" Shares, 01-017,139	5	..	1¼-2¼
—— 5 per cent. Debentures	100	..	76-81 xd
—— 4 per cent. Deb. Stock, Red.	100	..	72-77
Electric Construction, Limited, Nos. 1 to 112,100	2	..	1¼-1⅝
—— 7 per cent. Cumulative Pref.	2	..	2¼-3
—— 4 per cent. Perp. 1st Mort. Deb.	100	..	97-100
Ferranti Limited, 5 per cent. 1st Mort. Deb. Stock, Red.	100	..	90-95
General Electric Company (1900), 5 per cent. Cum. Pref.	10	..	9¼-10
—— 4 per cent. 1st Mort. Deb. Stock	100	..	97-100 xd
W. T. Henley's Telegraph Works, Ordinary	5	..	14-15
—— 4½ per cent. Preference	5	..	5-5¼
—— 4½ per cent. Debentures	100	..	108-112
India Rubber, Gutta Percha, and Telegraph Works	10	..	18¼-19¼
—— 4 per cent. Debentures	100	..	100-103
Parker, Thos., Limited, Ordinary	10	..	14¼-15¼
Telegraph Construction and Maintenance	12	..	34-37
—— 5 per cent. Bonds	100	..	100-103
Electric Lighting and Supply.—			
Blackheath & Greenwich District Ordinary 1,201-101,200	1	..	⅛-¼
—— 4½ per cent. Deb. Stk. Certs., Red. and Conv.	100	..	116-119 xd
Bournemouth and Poole, Ordinary	10	..	12¼-13¼
—— 4½ per cent. Cum. Pref., 7,501-15,000	10	..	10-11
—— 6 per cent. Cum. Second Pref., 15,001-22,500	10	..	11-12
—— 4½ per cent. Debenture Stock, Red.	100	..	103-106
Bromley (Kent) Electric Light and Power Co., 4½ per cent. 1st Debenture Stock, Red.	100	..	102-105
Brompton and Kensington, Ordinary	5	..	10¼-11
—— 7 per cent. Preference	5	..	10¼-10⅝
Calcutta Electric Supply Corp., Ordinary, Nos. 1-40,000	5	..	7-7⅛
—— Nos. 20,001-30,000	5	..	7-8
Cambridge Electric Supply Company, Ltd., £10 Ord.	8	..	14¼
,, ,, ,, £10 Ord.	5	..	10⅝
Central Electric Supply, Ld., 4 per cent. Guar Deb. Stock	100	..	107-110
Charing Cross and Strand, Nos. 1-70,000	5	..	8⅛-9¼
—— 4½ per cent. Cum. Pref.	5	..	5¼-5⅝
—— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000	5	..	4⅛-5
—— 4 per cent. Debenture Stock, Red. (Prov. Certs.)	100	..	104-106
Chelsea Electricity Supply	5	..	5¼-5
—— 4½ per cent. Debentures	100	..	108-111
City of London, Ordinary	10	..	10¼-11
—— 6 per cent. Cumulative Pref.	10	..	13-14
—— 5 per cent. Debenture Stock	100	..	122-127
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100	..	102-105
County of London and Brush Provincial, Ordinary	10	..	7¼-8¼
—— 6 per cent. Cum. Pref.	10	..	11¼-12¼
—— 4½ per cent. Debentures Prov. Certs. All pd. Red.	100	..	109-112
Edmundsons' Electricity Corporation, Ordinary, 1-50,000	5	..	6¼-7
—— 6 per cent. Cum. Pref.	5	..	6¼-6⅝
—— 4½ per cent. First Mort. Deb.	100	..	106-109
Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-30,000	5	..	3¼-4⅛
—— 5 per cent. Debenture Stock, Red.	100	..	95-98
Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000	5	..	6-6¼
—— 4½ per cent. First Deb. Stock, Red.	100	..	100-105
Hove Electric Lighting, Limited, Ord., 1-13,000	5	..	7¼-8¼
Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000	5	..	10¼-11¼
—— 4 per cent. Debenture Stock Red.	100	..	103-105

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Name.	Amount paid.	Last price.
	£	£
Kensington and Knightsbridge and Notting Hill	100 ..	101-104 xd
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10 ..	9¾-10¼
London Electric, Ordinary	3 ..	1⅞-2¼
—— 6 per cent. Pref.	5 ..	5¾-6¼
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100 ..	100-102
Metropolitan, Ordinary	10 ..	17½-18½
——1½ per cent. First Mortgage Debenture Stock	100 ..	110-114
——3½ per cent. Mortgage Debenture, Red.	100 ..	97-100
Newcastle-upon-Tyne Electric Supply, Ordinary	5 ..	8-8101
—— Preference	4 ..	100-103
Notting Hill Electric Lighting	10 ..	13-14
—— 4 per cent. First Mort. Debs., Nos. 1-500 (Reg.)	100 ..	98-101 xd
Oxford Electric, Ordinary, 1-96 and 407-14,510	5	5¼-5⅜
—— 4 per cent. Debenture Stock	100	98-101
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100 ..	98-100 xd
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5 ..	3-3½
—— 4 per cent. Debenture Stock	100 ..	85-90
South London, Ordinary	5 ..	3½-4⅜
St. James's and Pall Mall, Ordinary, 101-20,080	5 ..	14½-15½
—— 7 per cent. Pref.	5 ..	8-9
—— 3½ per cent. Deb.	100 ..	98-101
Urban Electric Supply Co., Ordinary, 8-30,007	5 ..	4¼-5
—— 5 per cent. Cumulative Preference, 50,001-80,000	5 ..	4¾-5
Westminster, Ordinary	5 ..	13½-13½
—— 5 per cent. Cum. Pref., 110,101-138,251	5 ..	6-6½

Electric Railways.—

Central London, Ordinary	100 ..	94-97
—— 4 per cent. Pref.	100 ..	99-102
—— ,, ,, deferred	100 ..	99-102
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100 ..	115-118
City and South London, Consolidated Ordinary	100 ..	56-58
—— 4 per cent. Debenture Stock	100 ..	116-119
—— 5 per cent. Pref. Stock '91	100 ..	127-130
—— ,, ,, ,, '96	100 ..	126-129
—— ,, ,, ,, '01	100 ..	125-128
Liverpool Overhead, 5 per cent. Pref.	— ..	13-13½
—— Ordinary, 1-50,000	— ..	7⅞-8
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	— ..	102-104
Waterloo and City, Ordinary	100	93-96

Electric Tramways.—

Anglo-Argentine, 1-260,007	5 ..	4⅜-4⅝ xd
—— Permanent 6 per cent. Debenture Stock, 1888	100 ..	125-130
Blackpool and Fleetwood Tramroad	10 ..	13¾-14½
Brisbane Tramway Invest., Lim., Ord., 1-75,000	5 ..	2-3
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5 ..	4-4½
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100 ..	100-103
British Columbia Electric Railway Co., Ord., Nos. 1-20,000	100 ..	81-84
—— Non-Cum. 5 per cent. Pref., Nos. 25,001-38,600	100 ..	92-95
—— 4½ per cent. 1st Mt. Debs., Nos. 1-6,250, of £40 each	40 ..	104-106 p.c.

Name.	Amount paid.	Last price
	£	£
British Electric Traction, Ord. 1-300,000 & 60,001-90,000	10 —	12½-12⅝
—— 6 per cent. Cm. Pf., 30,001-60,000	10 —	11½-11⅝
—— 5 per cent. Perpetual Debenture Stock	100 ..	120-123 xd
Buenos Ayres and Belgrano Tram., Ord., 1-100,000	5 —	2⅜-2⅝
—— "A" 6 per cent. Cm. Pf., 1-40,000	5 —	5-5½
—— "B" 6 per cent. Cm. Pf., 1-27,500	5 —	4⅜-5¼
—— 5 per cent. Deb. Stock, Red.	100 ..	107-110
—— Prov. Cert., all paid	100 ..	99-102
Cape Electric Tramways, Nos. 1-480,000	1 —	2⅛-2⅜
City of Birmingham Tramways, 5 per cent. Cum. Pref.	10 ..	5-5½
—— 4 per cent. 1st Mortgage Deb., 1-3,000 (1917)	100 ..	99-102
Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red.	100 ..	102 105
Cork Electric Tramways and Lighting Co., Ordinary	10 ..	13-14
—— 5 per cent. Cum. Pref.	10 ..	11-12
—— Debentures	100 ..	96-99
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10 ..	12-13
—— 6 per cent. Pref., Nos. within 1-60,000	10 ..	15-16
—— 3½ per cent. Mort. Debs., 1-3,000, Red.	100 ..	94-97
Imperial Tramways Ordinary	all ..	22-22½
—— 6 per cent. Cum. Pref.	all ..	14½-15½
—— 4½ per cent. Deb Stock	100 ..	112-114
Isle of Thanet Electric Tramways and Lighting, 5 per cent. Cum. Pref., Nos. 30,001-60,000	5 ..	3¾-4¼
—— 4 per cent. Debenture Stock	100 ..	92-95
Kidderminster and District Lighting and Traction, Pref.	5 ..	3¾-4
London United Trys. (1901), 5 per cent. Cum. Pref.	10 ..	11½-12
—— 4 per cent. 1st Mt. Db. Stock, Red.	100 ..	103-105
Metropolitan Electric Trams., Deferred, 1,000 001-1,314,016	1 ..	3/16-5/16
—— 5 per cent. Cum. Pref., 500,001-814,016	1 ..	¾-1⅛
New General Traction, Ordinary	5 ..	2-3
—— 6 per cent. Cum. Pref.	5 ..	2-3
—— 5 per cent. Mortgage Debentures, 1-1,713 (Regd.)	100 ..	88-93
Oldham, Aston, and Hyde Tramway, Ordinary	10 —	10¾-10⅞
—— 5 per cent. Cum. Pref.	10 —	11¾-12¼
Perth Elec. Tramways (W.A.) 5 per cent. 1 Mort. Deb. Stk.	100 ..	99-102
Potteries Electric Traction, Ordinary, 20,001-40,000	10 —	9-10
—— 5 per cent. Cum. Pref., 1-20,000	10 —	8¼-8½
—— 4½ per cent. Debenture Stock	100 —	103-106
South Lancashire Electric Traction and Power Company—		
—— £250,000 Ordinary	1 —	1
—— £101,132 6 per cent. Preference	1 —	1
—— £528,093 4½ per cent. Debenture Stock	100 p.c. —	100 p.c.

Telephones.—

National Telephone, Preferred	100 —	99-101
—— Deferred Stock	100 ..	74-76
—— 6 per cent. Cum. First Pref.	10 —	13-14
—— 6 per cent. Cum. Second Pref.	10 —	13-14
—— 5 per cent. Non. Cum. Third Pref.	5 —	5-5¼
—— 5½ per cent. Deb. Stock, Red.	100 —	93 96
—— 4 per cent. Deb. Stock, Red.	100 —	101,103
Oriental Telephone and Electric Company	1 .	13/16-15/16

TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line	Traffic Returns for week			Increase or decrease.		Miles of single track open.		Accounts for past year.							Cost per car mile.
	Ending	1903.	1902.	Week.	Current year.	1903.	1902.	Ending	Total receipts	Passengers carried.	Car miles run.	Receipts per Pas-s'nger	Receipts per Car mile.	Receipts per Mile of track.	
		£	£	£	£				£			d.	d.	£	d.
Aberdeen Corporation	Oct. 3	1,305	997	+ 308	+ 3,272	19¼	17¼	May 31	37,931	9,099,715	794,641	0·98	13·02	1,970	6·14
Ayr Corporation	Sep. 28	283	267	+ 16	—	8	6	Sept. 25	12,503	2,979,276	290,099	1·00	10·34	1,560	4·7
Birmingham Tramways	Oct. 3	5,476	5,110	+ 366	+ 9,031	6½	6½	—	—	—	—	—	—	—	—
Blackburn Corporation	Sep. 25	844	831	+ 13	+ 657	24	24	March 25*a*	40,964	7,234,106	826,558	1·36	11·87	1,705	7·44
Blackpool Corporation	Oct. 1	1,120	1,086	+ 34	— 116	17½	16½	,, 31	211,168	6,169,121	784,443	1·52	10·8	—	—
Blackpool-Fleetwood Tramways	,, 3	762	667	+ 95	— 123	16½	16½	Dec. 31	30,923	2,049,677	584,989	3·62	12·68	1,932	6·99
Bolton Corporation	,, 4	1,872	1,547	+ 325	+ 6,785	38	25	March 31	85,704	17,761,605	1,896,247	1·15	10·75	3,430	5·87
Bournemouth Corporation	Sep. 30	1,120	—	—	—	10½	—	—	—	—	—	—	—	—	—
Bradford Corporation	Oct. 4	4,043	3,292	+ 751	+ 1	41	—	—	—	—	—	—	—	—	—
Brighton Corporation	,, 4	948	809	+ 139	+ 5,983	6½	—	,, 31	—	10,432,508	1,031,928	1·00	10·10	—	—
Bristol Tramways Company	,, 2	5,220	4,612	+ 608	—	51½	51½	Dec. 31	223,480	41,192,899	5,724,114	1·30	9·38	4,348	—
Burnley Corporation	,, 3	889	743	+ 143	—	—	—	—	—	—	—	—	—	—	—
Burton Corporation	,, 4	417	—	—	—	—	—	—	—	—	—	—	—	—	—
Cardiff Corporation	,, 3	2,059	1,459	+ 610	—	—	—	—	—	—	—	—	—	—	—
Carlisle Tramways Company	,, 3	215	184	+ 31	+ 539	—	—	,, 31	—	2,216,583	320,129*h*	—	—	—	—
Central London Railway	,, 3	6,183	6,902	— 719	— 4,202*h*	6	—	,, 31	367,225	45,305,110	1,276,971*a*	1·87	66·6*a*	59,076	35·6*a*
City and South London Railway	,, 4	2,544	3,033	— 489	— 4,702	6⅝	—	,, 31	165,003*a*	19,069,319*a*	—	—	—	—	—
Cork E. T. and L. Company	,, 1	560	777	— 217	— 2,498	—	—	—	—	—	—	—	—	—	—
Darwen Corporation	,, 2	228	241	— 13	— 723	7·23	—	March 31*g*	12,341	2,360,735	254,279	1·25	11·65	1,707	9·36
Dover Corporation	,, 3	249	209	+ 40	+ 97	3	—	—	—	—	—	—	—	—	—
Dublin & Lucan Electric Railway	,, 4	144	102	+ 32	+ 151*h*	—	—	Dec. 31	5,796	364,796	102,087	3·81	13·62	859	7·68
Dublin U. T., electric cars	,, 2	4,119	3,143	+ 976	—	46	46	March 31	126,121	24,553,133	3,429,356	1·23	8·82	2,741	5·06*h*
Dublin S. District, Electric	,, 2	938	845	+ 143	—	22	22	May 15	35,874	9,084,522	752,814	0·93	11·276	1,630	—
Dundee City Tramways	,, 1	937	844	+ 93	—	10·75	7·52	March 31	25,341	9,971,337	650,224	0·61	9·35	2,357	—
East Ham Corporation	Sep. 26	728	583	+ 140	+ 5,527	—	—	—	—	—	—	—	—	—	—
Farnworth U.D.C.	,, 23	176	134	+ 42	—	124	101	May 31*g*	656,572	177,179,549	14,008,750	0·88	11·25	5,489 *b*	7·40*d*
Glasgow Corporation	Oct. 3	15,667	13,486	+2,181	+37,330	30½	27½	—	—	—	—	—	—	—	—
Halifax Corporation	Sep. 23	1,451	1,253	+ 203	—	34	35	March 31	56,631*h*	9,758,213	1,218,539	1·4	11·14	1,618	6·38
Huddersfield Corporation	Oct. 3	1,228	1,100	+ 128	—										
Hull Corporation, E. S.	,, 3	1,906	1,758	+ 147	+ 2,495	19	19	,, 31	87,707*h*	21,065,999	2,218,696	1·00	9·49	5,004	5·07
Ilkeston Corporation	Sep. 30	181	—	—	—	—	—	—	—	—	—	—	—	—	—
Kirkcaldy Corporation	,, 30	176	—	—	—	—	—	—	—	—	—	—	—	—	—
Leeds Corporation	Oct. 3	6,099	5,160	+ 939	—	77	—	March 25	262,656	57,239,779	5,773,651	1·11	10·91	3,283	—
Liverpool Corporation	Sep. 26	11,072	10,473	+ 599	+12,542	101	95	Dec. 31	504,304	108,906,472	11,705,425	1·11	10·34	5,000	6·88
Liverpool Overhead Railway	Oct. 4	1,672	1,506	+ 166	+ 1,657	15½	15½	June 30	79,252	10,466,726	986,185*a*	1·82	19·30*a*	5,110	— *a*
Lowestoft Corporation	,, 3	231	—	—	—	—	—	—	—	—	—	—	—	—	—
Nelson Corporation	,, 3	98	—	—	—	3	—	—	—	—	—	—	—	—	—
Newcastle-on-Tyne Corporation	,, 3	3,680	3,024	+ 656	—	38½	36	March 25*g*	150,334	33,474,122	3,379,119	1·08	10·93	4,175	6·17
Portsmouth Corporation	,, 3	1,891	1,522	+ 369	—	29	29	Sept. 30	47,651	9,168,137	868,157	1·24	13·17	1,643	—
Rochdale Corporation	Sep. 21	138	133	+ 5	—	4½	—	March 31	5,416	925,281	127,456	1·38	10·27	—	7·66
Rotherham Corporation	Oct. 1	521	—	—	—	—	—	—	—	—	—	—	—	—	—
Salford Corporation	,, 5	4,084	2,797	+1,287	+32,084	—	—	—	—	—	—	—	—	—	—
Sheffield Corporation	,, 4	4,865	—	—	—	53½	46½	Mar. 25*g*	216,309	56,812,049	4,926,083	0·904	10·428	7,510	7·0
Southampton Corporation	,, 1	1,099	1,083	+ 16	—	11	11	,, 31	35,874	9,084,522	752,814	0·946	11·436	3,760	—
Sunderland Corporation	,, 4	1,218	1,046	+ 172	+ 1,835	18·48	17·18	,, 31	59,930	13,987,121	1,270,957	1·03	11·3	3,243	6·43
Wallasey U.D.C.	,, 3	706	603	+ 103	+ 2,545	10·5	10·5	,, 31*g*	31,307	5,690,378	654,550	1·32	11·47	2,981	6·97

* Includes maintenance of permanent way and proportion of profits paid to the tramway companies for term of unexpired lease. *a* Train mile.
b Per mile of single track. *c* Include rail and tram. *d* including depreciation. *f* Including one section of horse traction. *g* 1903. *h* Half-year's figures.

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UNIVERSITY OF MICHIGAN

NOTES.

Screw and Wire Gauges.—Our readers may be interested to know that Colonel A. H. Bagnold, R.E., of the Royal Arsenal, Woolwich, has specially compiled for the proprietors of the *Model Engineer* a table of small screw and wire gauges. From a hasty glance through the table it seems to be very complete in detail and carefully compiled. It may be obtained at the price of 3d. a copy.

Electric Telpherage.—We hear of a scheme which is now taking shape to instal a system of electric telpherage across the River Usk at Newport. The Alexandra Docks Company are the originators of the proposal, which has for its object the quick transport of goods across the river from the docks to the works on the east side. The scheme is as yet only in the initial stage, and we hope to be able to give details when something more definite has been decided on.

Radium.—The Vienna Academy of Sciences has appointed a committee to study pitchblende, the mineral from which the substance radium is derived. Baron Auer von Welsbach has placed his laboratories at the service of the committee during its researches. Pitchblende is one of the uranium series of minerals. It is of a greyish or brownish colour, and has a somewhat metallic lustre. It is found in Cornwall, Scandinavia, Germany, the United States, Hungary, and elsewhere.

Translation.—Opinion of the work by Charles Proteus Steinmetz, entitled "Theory and Calculation of Alternating-Current Phenomena," which was published originally in America, evidently ranks high in Germany, whence we have received a copy of a translation. To complete its German guise, the work has been rechristened "Theoretische Grundlagen der Starkstrom-Technik." Mr. J. Hefty is credited with the translation. We note that the symbols used for the calculations have been altered to conform with German practice; also that the chapter devoted to armature windings for direct-current machines has been revised by the translator. The publishers are Messrs. Friedrich Vieweg und Sohn, Braunschweig.

Tomb of Volta.—The bronze shield subscribed for by the students of the Institution of Electrical Engineers at the beginning of the present year has now been placed upon the tomb of Volta at Camnago, near Como. The ceremony of fixing it in place was performed on Sunday, Oct. 5, with many expressions of international good feeling, in the presence of Prof. Count Alessandro Volta, Cav. Franchi, the Sindaco of Camnago, with several members of the Volta family, and a number of other guests. The shield is mounted on a slab of green marble supported on granite in front of the tomb. The electrotype reproduction, which was officially deposited on the tomb on the occasion of the visit of the Institution in April last, has been transferred to the civic museum in Como, where it is placed in the collection of Volta relics.

Electrocution.—A well-meaning correspondent has sent us a copy of the *Ottawa Valley Journal* of Oct. 2, inviting—by means of the orthodox blue pencil—our attention to an announcement to the effect that "the Von Warmers" were executed by electrocution at Dannemara, N.Y., the previous day. Our correspondent evidently thinks that the event is of public if not of scientific interest, although one could imagine from the blunt, hard, matter-of-fact way in which the paper records the occasion that electrocution of criminals was an everyday occurrence over there. The one point of interest about the affair seems to be that three persons were electrocuted one after the other in the same chair in the space of 15½ minutes, but those who have a preference for the sensational may be more interested to learn that all three "died carelessly."

Marconi's Experiments.—Mr. Marconi arrived in this country on Saturday on board the "Lucania" from New York. It will have been noticed that in his utterances to the Press Mr. Marconi is nothing if not optimistic. In fact, even the recent wet weather does not seem to have damped his ardour, and he was again able on landing at Queenstown to predict that within two months his system will be sufficiently developed to start a commercial service of wireless telegraphy across the Atlantic. His experiments during the passage were most successful, and he was in daily communication with land during the entire voyage, the simultaneous reception of messages from Europe and America being effected for the first time. What most appealed to the passengers on the "Lucania," however, was that a summary of Mr. Chamberlain's Glasgow speech wa received on board on Thursday night when the vessel was many miles off the English coast.

A Snow Automobile.—During the coming winter the Allgemeine Elektricitäts-Gesellschaft will carry out some trials with a snow automobile or motor sleigh on what is known as the "Haidebahn"—a trolley omnibus line between Dresden and Klotzsche—on which electrically-propelled 'buses are run for passenger transport. The system of running electric 'buses fed from overhead trolley lines on the ordinary roads has more than once been described in this journal, and the same practice will be followed in the case of the snow automobile. The vehicle is very similar to the electric 'bus, with the difference that the hind pair of wheels is replaced by a pair of sleigh runners, while the driving wheels in front are fitted with tyres specially designed for taking hold of the slippery surfaces which have to be counted upon in Germany and France. The experiments which were made with this type of vehicle last winter were sufficiently successful to warrant further trials with it this year, and some interesting results are expected.

Motor Transport for Goods.—The possibilities of motor transport for goods as compared with horse transport over long distances and for heavy loads were discussed before the Society of Engineers last week in a paper contributed by Mr. Douglas Mackenzie. It is generally conceded that for loads less than 5 to 5½ tons weight the horse is cheaper than the motor, and Mr. Mackenzie puts the ideal load for motor transport at from 5 to 10 tons for distances exceeding 10 miles. Incidentally, the author urged upon inventors the great future that lies before the internal-combustion engine when it can be made to work with crude petroleum or residue. Another point which Mr. Mackenzie emphasised was that the speed of motor-wagons should be left unrestricted, so that each size could be run at the speed that proved most economical and most suited to the traffic encountered; also that motors should be confined to hard roads. Discussing the wear and tear produced on the roads, Mr. Mackenzie concluded that if the roads be of a proper standard, there is less wear and tear from the use of motor vehicles than from any other form of transport.

Underground Telegraphs.—In the Post Office estimates this year, Mr. Austen Chamberlain obtained the money for completing the connections between Warrington and Carlisle and between Manchester and Leeds of the underground telegraph system to the North. The cost of the work, together with a 20-mile extension at Beattock Rise, in the south of Moffat, was estimated at £135,000,

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as against £160,000, which the 113 miles from London to Birmingham cost. The three new sections referred to cover about 120 miles, so that it will be seen that the cost of construction now is considerably less than a few years ago, due to the cheapening of materials. The Post Office authorities are urging on the contractors to complete the new pipes along the north-west route to Glasgow and Edinburgh. Practically all the exposed parts in the North of England will be dealt with in this manner before the end of next year, when the whole scheme will probably be completed. It is more than likely that the next extension of the underground system to be undertaken will be in the direction of Portsmouth, Bristol, and Land's End, recent storms having shown the susceptibility of the wires in the South of England.

Institution of Civil Engineers.—This institution will begin its winter session on Tuesday, Nov. 3, when the president, Sir Wm. H. White, K.C.B., will deliver his inaugural address. There will be a reception in the library at eight o'clock, followed by the presentation of the council's awards. The council have, in addition to the medals and prizes given for communications discussed at the meetings of the institution in the last session, made the following awards in respect of other papers dealt with in 1902-3: a Telford gold medal to George Deuchars (London); Crampton prizes to A. B. Brady (Brisbane) and G. Maxwell Lawford (London); Telford premiums to T. Johnstone Bourne (Tientsin), R. H. Rhind (London), H. T. Hincks (Marikuppam), G. A. Hobler (Cairns), A. J. Goldsmith (Brisbane), F. H. Frere (Derby), R. Appleyard (London), and P. Hamilton, B.Sc. (London). For students' papers the awards are: the James Forrest medal and a Miller prize to Waude Thompson (Burton-on-Trent); the James Prescott Joule medal and a Miller prize to I. V. Robinson (West Hartlepool); Miller prizes to H. A. Bartlett (London), J. D. Morgan (Glasgow), H. S. Watson (London), J. V. Thomas (Gloucester), O. B. Rattenbury (Doncaster), and C. M. Skinner (Newcastle-on-Tyne).

St. Louis Exhibition.—We have received a list of the rules laid down for governing the supply of electricity for light and power purposes during the continuance of the World's Fair at St. Louis next year. There are 18 of them in all, and the length to which the instruction goes in some cases should remove all ambiguity as to their meaning. To cite a few of the points insisted on, the charges for light and power are to be on a flat rate, and must be paid monthly in advance. No electric service will be furnished through meter except for storage batteries. The rates for incandescent lighting for the period of the exposition have been fixed as follows: for 16-c.p. lamps, not exceeding 60 watts per lamp, 28s.; for 8-c.p. lamps, not exceeding 30 watts per lamp, 16s.; and for 4-c.p. lamps, not exceeding 22 watts per lamp, 12s. A 5 per cent. discount will be allowed on accounts amounting for the term of the exposition to £35, 7½ per cent. on £70, 10 per cent. on £140, 12½ per cent. on £210, and 15 per cent. on £280. A minimum charge for current for any motor for the exposition term will be £2. 16s. The above are the general charges to be enforced, and the rest of the rules apply to special cases. We may state for the information of manufacturers on this side that a company has been formed in St. Louis under the name of the Electrical Exhibitors' Representative Company, the purpose of which is to represent small and medium-sized electrical firms in the Palace of Electricity during the exhibition.

Electric Power from Space.—Such is the wild dream of an American "inventor," who says he is able to draw electricity from the heavens above in unlimited quantities. We remember the New York correspondents of the London papers sending to this country long accounts of how this gentleman was going to revolutionise the electrical industry, but since then things seem to have prospered a little, and details of the inventor's scheme have found their way into the columns of the New York technical Press. The proposal is nothing more nor less than to fire a cylinder vertically into the air containing a magnet, a coil of strong copper wire, and a time clock. When a height of two miles is reached, the clock (if still in running order) will open the cylinder, and the wire will begin falling and uncoiling as the magnet ascends. Finally, the magnet will reach the ether and be held there, while the end of the coil of wire touches the earth. The unbelieving may, perhaps, wonder why the wire should fall and not the cylinder, but the reason for this, we are told, is the presence of the magnet in the cylinder, which at that height, according to the originator of the scheme, is attracted strongly up into the ether. One of our New York technical contemporaries satirically warns aeronauts of having any magnetic material used in the construction of their machines. They should remember, as stated in the inventor's prospectus, that "from the earth's mass outward in every direction the mind of man contemplates persistent and insatiable distance, engulfing persistent and insatiable distances," lest they too be caught up by the mighty ether, that "unfathomable mystery," which as it "rolls along swallows up, in utter contempt of their magnitude, all these distances and passes on."

Ventilation of the House of Commons.—Although from a scientific standpoint the method of ventilation in vogue at the House of Commons might be considered all that could be desired, it has, after exhaustive enquiry, been found to be deficient and inadequate for the requirements. Indeed, this enquiry has been going on for nearly 18 months, and it was only quite recently that the recommendations of the committee appointed to consider the question were made known. Electrical engineers will not be surprised to learn that the committee's first suggestion is that electrical fans should be substituted for the exhaust furnaces at present in use. Among the other recommendations is one that a more powerful intake fan should be provided, and that an officer of recognised scientific knowledge and experience should be appointed specially to watch the ventilation. Under the present system of ventilation air taken in on the river front and in certain courtyards is washed by a spray of water and passed through a layer of scim cloth to remove solid particles. After being heated by steam batteries it enters the chamber through grids under the matting of the gangways and through panels at the ends of the hall. In foggy weather the air is passed through 6in. of cotton wool, and in summer it can be cooled by blocks of ice placed in the airway. Under this system the air was found to contain, with half the seats in the chamber occupied, five parts per 10,000 of carbonic acid, and to have a mean temperature of 62deg. F., with a humidity of from 60 to 72 per cent. Altogether, the committee declare, the air as regards purity may be said to far exceed that found in many such buildings. Unfortunately, however, this conclusion is not confirmed by the subjective test of the members' own feelings.

English Transporter Bridge.—Since we last wrote on the subject—more than a year ago—much progress has been made with the construction of the transporter bridge which is to span the River Mersey between Widnes and Runcorn. The Bill authorising the structure was passed in the 1900 session of Parliament, and no time was lost in

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proceeding with the scheme. The type of bridge adopted is familiar enough in the States, but we believe is the first example of its kind in this country. In general design the bridge consists of a suspension bridge stiffened with side girders, having a platform and car suspended below the bridge. This platform and car are moved from end to end of the bridge by means of a trolley resting on track rails on the bridge, and the motive power is electricity. The river at this spot is about half a mile in width, and the span is of 1,000ft.—the greatest span of any bridge in the United Kingdom carrying road traffic. The towers, of which there are two on each bank, rise to 190ft. above high-water level. Two electric motors of about 36 b.h.p. will be provided to work the trolley, and will give a large margin of power. The motors are fixed in a kind of bogie in the trolley, so constructed that in the event of any curvature of the bottom boom the driving wheels will remain hard on the rails. The operator's cabin will be placed on the top of the car, and will contain a switch-board, by means of which the motors and the movements of trolley and car can be controlled. The bottom of the car will be about 12ft. above high-water level, and each journey will occupy about 2½ minutes; or, allowing for loading and unloading, about nine or ten trips will be made an hour. The total cost of the scheme will likely run into £130,000, and it will inaugurate a type of bridge which will probably come into larger use in this country for conveying low-level traffic over estuaries frequented by shipping.

The Smoke Nuisance.—It was only last week that a London magistrate, in a prosecution for smoke nuisance, was asked to say that a "funnel" was a "chimney" for the purposes of the Act, and that a steamer going down the Thames had infringed the statute by emitting black smoke from its funnels. This rather liberal translation of the word "chimney" was accepted by the magistrate, who in doing so no doubt had the common good at heart. There are some, however, who would hesitate to declare a ship's funnel to be a chimney, and something more may be heard of the matter in an appeal which has been lodged to a higher tribunal. We are reminded of this case by a suggestion thrown out by the *Lancet* this week that smoke need not necessarily be black to constitute an offence, and calling for a more liberal construction of Section 24 (*b*) in the Public Health (London) Act, where the word "black" as applied to offensive smoke is retained. Our contemporary is presumably inspired by the Society for the Prevention of the Smoke Nuisance when it quotes Dr. W. Collingridge as saying, "Many complaints are received of smoke nuisances which we are at present unable to deal with by reason of the fact that the smoke emitted—although intolerably objectionable—is not black, but of some less pronounced tint, as yellow or brown. On occasions we get complaints of nuisance from even white smoke." It is noteworthy that the Westminster City Council and the Corporation of London are anxious that the word "black" should be deleted from that section of the Public Health Act dealing with the smoke nuisance. The ultimate object, no doubt, is to rid thickly populated areas, like the city of London, of smoke altogether; otherwise it would hardly seem to be common fairness to put it in the hands of the authorities to prosecute in all cases of the emission of smoke within the prescribed area, whether it be black, yellow, brown, blue, or white smoke. Such a state of things would lead to authorities prosecuting everyone who had a fire within their area, and hence would paralyse industries which at present are quite sufficiently hampered.

Acheson Electric Furnaces.—At the Niagara Falls meeting of the American Electro-Chemical Society last month, Mr. Francis A. J. Fitzgerald read a paper in which he discussed the conditions for efficiency of several forms of electric furnaces of the type in which the current passes along a definite path or paths, thus localising the heat. The author gave a description of the various types of electric furnaces developed by Mr. E. G. Acheson, including the graphite, the electrode, the carborundum furnaces, and the furnace for moderately high temperatures. In all of these furnaces there is one common characteristic—the electrical resistance is a variable quantity, and after any furnace is started there are no means of adjusting internal conditions so as to effect regulation in this respect. In general, the resistance of these furnaces is high at the beginning of a run and low at the end. Therefore, means of varying the voltage at the furnace terminals must be used. The resistance of the furnace may be varied by altering the dimensions of the core, or that part of the furnace which acts as an electrical conductor. There are limits to the variations that can be made in this respect on account of other considerations, but the resistivity of a mass of carbon granules varies with the size of the latter, and further variation may be obtained by the judicious choice of different forms of carbon, which themselves have different resistivities. By taking advantage of this, any desirable variations in the resistance of the furnace may be obtained. The case of the electrode furnace is a special one, the adjusting of the resistance being obtained to a certain extent by the spacing between the piles of electrodes. The paper then proceeds to develop equations involving the various variable factors, from which deductions are made as to the practical limits of improvement in furnace regulation. In no case considered are the various fundamental equations rigorously applicable, for these involve numerous assumptions that do not represent the actual conditions, and take no account of certain conditions that are invariably present. Nevertheless, by keeping the theoretical considerations in view, a great help will be obtained in the building of furnaces and waste of time prevented in experimenting with designs that cannot possibly be satisfactory.

Tramways in London.—In the approaching municipal elections in the London boroughs the tramway question promises to be one of the chief, if not the chief bone of contention. Since the first set of London borough councils was elected three years ago the tramway system in the South of London has made great strides under the management of the London County Council, and there is one factor which may be expected to weigh heavily with the electors—*i.e.*, that since the County Council took over the control of the tramways, nearly £300,000 has been set aside in relief of rates. Mr. J. Williams Benn, the indefatigable chairman of the London County Council's Highways Committee, has prepared an interesting pamphlet on the tramway question which is being widely circulated. In it he deals more particularly with the "partnership" which he says exists between the borough councils and the County Council. He says: "The position with regard to tramways in London is completely changed since the London County Council became the tramway authority. Formerly the vestries made the tramway companies seeking powers pay as much as possible for the use of the streets. Now the London County Council and the borough councils are in partnership: first, to complete and electrify our tramway system. The central body does the work, and the profit balance is placed at the disposal of the borough councils. For financial reasons, as well as many others, it is to their interest to assist the London County Council to multiply tramways. Further, this partnership

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in the ownership and use of the streets is of the greatest value in keeping them free from disturbance by companies, who naturally work for dividends rather than the convenience of the public. The Metropolitan Board of Works, and later the London County Council, have contributed one-half of the cost to street improvements of a local or semi-local character. Now, owing to the opportunity of earning tramway profits, the London County Council bears two-thirds of the cost, leaving the road authority to find one-third only. This, of course, only applies to cases where tramways are permitted. Some districts, through refusing such a contribution, have lost, for the present, both street improvement and tramway. Any saving in cost of these tramways goes, of course, to increase the profits, which are eventually divided among the borough councils."

St. Marylebone Electric Lighting.—Still more about the St. Marylebone muddle. Having failed to influence either the Board of Trade or the Local Government Board in their behalf, the Borough Council are forced to take the only course left open to them—*i.e.*, to seek statutory powers in the next session to borrow the necessary moneys for enabling them to acquire the St. Marylebone property of the Metropolitan Electric Supply Company which they have agreed to purchase. Even now it is not all smooth sailing, as the propriety of promoting a Bill for this purpose must be submitted to a special meeting, and carried "by an absolute majority of the whole number of the members of the Council." Then, having been deposited for public inspection, the Bill will have to be considered by the new Council after the November elections, and confirmed again by "an absolute majority." A public meeting of the electors must also be held to get their approval of the Bill, and, unless a poll is demanded, the decision of this meeting will be final. When the matter at last comes to be discussed in the parliamentary committee-rooms, there may or may not be much opposition, but in any case the measure cannot possibly receive the Royal assent and become operative before well on towards the end of the session. Of course, the main object of the Bill is to get rid of the technical difficulty which the London County Council say prevents their granting the required loan, but the Borough Council are also seeking powers with regard to the control and direction of the undertaking when it comes into their hands. For instance, Parliament will be asked to make special provision with regard to the repayment of the moneys borrowed, and for the application of the revenue arising from the undertaking; again, to authorise an increase in the maximum charge for the supply of electricity, to alter the method of charging, to empower the Council to change the pressure and mode of supply, and to make special provision in the case of premises having a separate supply. Among other powers sought are authority to enter into arrangements with contractors for the installation on consumers' premises of motors, wires, and other apparatus; to purchase lands and to erect generating stations thereon; and to alter and amend certain provisions of the Electric Lighting Acts and the St. Marylebone Electric Lighting Order, 1901. There is little doubt but that the Council will unhesitatingly agree to the promotion of the Bill, but when the ratepayers come to be consulted matters may assume a different complexion. There will probably be things said at the public meeting which should be worth reporting.

Controlling Motors from a Distance.—Often it is desirable to control a motor or several motors from some central position at a considerable distance from the machines. To avoid the necessity of conveying the whole working current to and from the point of control, which would involve the use of heavy cables and a large controller, a device has been patented by William Baxter, jun., of Jersey City. A small current derived from the main current is transmitted in a unidirectional constantly closed parallel set of small conductors and distributed to the various controller movers by a small switch, there being but three small wires necessary to effect entire control of the apparatus. From a description of the invention in the *Western Electrician*, it seems that situated at each motor is a controlling device for varying the current in the armature or field windings. Either geared or direct connected to the shaft of the controller is a "mover." The outer ring of the mover is a field magnet, and is magnetised by two sets of coils. One set of coils acting alone will develop a magnetic flux that will cross the central space in one direction. The other two coils acting alone will develop magnetic lines of force that will cross the central space in a direction at right angles. If the two sets of coils have the same number of turns, and are traversed by currents of equal strength, their magnetising forces will be equal, and as a result, if both act at the same time, the actual field will be the resultant of these two magnetisations, and in a direction midway between the two. If the current flowing through one set of coils is stronger than that flowing through the other, the resultant field will be in a direction somewhere between the two forces, but nearer the greater force. From these facts it follows that by increasing the current in one or the other set of field coils, the direction of the magnetic field can be caused to swing around from a position nearly in line with one of the component forces to a position nearly in line with the other. The field ring consists of an iron core, upon which the coils are wound. The armature is made of iron, and as the air-gaps between its pole-faces and the core of the field ring are shorter than the distance between the sides of the core and the field, it will be drawn into a position parallel with the field magnet's lines of force. Hence to be able to move the armature to any desired position, all that is necessary is to provide means whereby the currents flowing through the coils may be proportioned so as to swing the field magnetisation into that position. The armature being in turn connected to the controlling apparatus, the motor may be controlled from the distant point with only the interposition of such small wires as are necessary to operate the mover. An operating switch located at the central point controls the flow of current through the windings of the mover, controlling the magnetic flux so as to swing the armature in either direction, and thus move the motor controller as desired.

Elmore Copper-Depositing Process.—At the present time, when the commercial application of the Elmore patents for the manufacture of copper tubes by electrolysis is assuming extensive proportions, it will not be without interest to give a short account of the present position of the process. According to the *Electro-Chemist and Metallurgist*, the process emanated from patents by Stanley and Frank Elmore, and is shortly as follows: The positive pole of a dynamo is connected to an anode of raw granulated or block copper laid at the bottom of a pitched wooden vat containing an acidulated solution of copper sulphate. About 1·2in. away from this anode a copper or iron cylinder, forming the cathode and connected to the negative pole of the dynamo, is rotated at a suitable speed. In order to give the copper thus deposited on this cylinder or mandril a firm and dense structure, and to prevent any crystalline forming, an agate burnisher travels up and down the length of the cylinder and exerts a constant pressure on the surface; and as the conditions are regulated in such a way that the layer at any point only increases in thick-

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ness by some ·0013in. before the agate brush has again returned there, the depositing copper is obtained in a homogeneous state. A comparatively light current density, 56 amperes per square foot, is employed, so that the deposition of a copper tube ·2in. thick would take just under a week. With ordinary processes of copper refining, the current density employed is about a tenth of the above. When the deposited tube has attained the desired thickness, it is stripped from the mandril and is ready for the market. Tubes of small diameter are comparatively more expensive to manufacture by the process, so that the German Elmore Company turn their attention more particularly to those of larger diameter. As an example of this, our contemporary illustrates what is claimed to be the biggest seamless copper tube in the world, which was manufactured by the Elmore process and exhibited at the Düsseldorf Exhibition. It was designed for a condenser cover, and weighs 7,940lb., is 16·4ft. long, 8·2ft. in diameter, and has a thickness of ·39in. The copper obtained by the Elmore process has very satisfactory mechanical properties. For example, a tube of 11·8in. diameter and ·12in. thick, when subjected to hydraulic pressure, expanded to 13in. at 14 atmospheres, and did not finally burst until the pressure had reached 52 atmospheres. At present there exist three Elmore works—one at Schladern, in Germany, one at Leeds, in England, and one at Havre, in France—having a total weekly capacity for producing 396,000lb. of copper, and a total amount of power available amounting to 5,600 h.p.

American Institute of Electrical Engineers.—Upon assuming the presidency of the American Institute of Electrical Engineers for the current year at the first meeting of the winter session, Mr. Bion. J. Arnold gave a short address, in which he commented on the remarkable development and growth of that body during the past two years. He also gave a general *résumé* of what the institute was doing at the present time, and the several objects to which its energies were being directed. He cautioned the members against allowing their enthusiasm in the local sections, born of novelty, to wear off, and urged the husbanding of the institute's financial resources on the ground that the recent great rate of increase of membership could not continue indefinitely. The new president further advocated allowing authors more time for reading their papers and the meetings more time for discussing them. All this is good and level-headed advice, but the point in the address to which we particularly want to draw attention is the reference to a scheme in which the institute is participating to build a "union engineering building," which will be jointly owned and used by several of the large engineering and kindred societies in the States. The idea appeals to us as being exceptionally good, and one that carries equal benefit to all concerned. As an illustration of what we mean, we may take the case of the large engineering societies in this country which have their headquarters in London. There are several large and well-equipped buildings in London to-day owned by individual bodies, such as the Institution of Civil Engineers, the Institution of Mechanical Engineers, etc. Each is provided with a large central hall or theatre in which the weekly, fortnightly, or monthly meetings, as the case may be, are held. Practically speaking, these magnificent halls are unused except at these times and others when they are kindly lent to sister societies for the purposes of similar gatherings. Now, the Institution of Electrical Engineers is collecting a fund to be applied to providing a central building of its own in which to hold the usual fortnightly meetings and transact the ordinary business of such an Institution, which is now very capably conducted from private offices in Victoria-street. We say no more than that the course which the American Institute is taking in this matter may cause engineering societies on this side to reconsider their position, and weigh up the possibilities of combining in erecting a common engineering building in London which would give equal advantages and meet the ends of all. The American Institute has started a special fund with this object, to which will be credited all moneys received for building purposes now on hand. The general preliminaries of the scheme have been perfected, and the work of the coming year will consist in the crystallisation of the plans and the originating of definite means and methods for raising funds and for promoting the material progress of the work.

Dielectric Hysteresis.—Steinmetz's work has shown that alternating-current cables become hot, even in the case of their transmitting no work. This phenomenon is chiefly noted with higher tension, the opinions as to the causes of this heating effect being different. Some experimenters, in fact, consider insulating materials as high-resistance conductors traversed by a current, though of very feeble value, and giving rise to a Joule heat effect. According to another interpretation adopted by most, the heating found by experiment would be explained as a sort of dielectric hysteresis in the insulating material, the heat developed being out of proportion to the amount of heat corresponding to the resistance measured on Joule's formula. Though this cause of heating is of a more theoretical interest, Dr. P. Holitscher (see *Elektrotechnische Zeitschrift*, No. 33), has made in the laboratory of the Elektricitäts Actien-Gesellschaft vorm. W. Lahmeyer und Co. some special experiments in this direction on high-tension machines, with a view to obtaining for these losses some constants independent of the volume for the different metals, this affording a means of testing the products used and the thickness of the latter. An important point for practice was the design of a measuring method allowing of the energy loss in insulating materials being determined with the greatest possible accuracy and without much apparatus. From these experiments it is inferred: (1) That a relatively accurate and convenient method for determining great losses by dielectric hysteresis, as is the case with great strain on the dielectric, is obtained by applying the capacity to be tested to the high tension of a transformer, the losses of the transformer being deducted from the output supplied to the latter. (2) With smaller losses measurements are made direct in the high-tension circuit by means of a wattmeter, the high and low tension coils of which are interchanged. Incandescent lamps are used as shunt resistance in the pressure circuit. (3) The losses met with are practically proportional to the number of periods, a loss by the passage of current being negligible as compared with dielectric hysteresis. (4) The capacity and accordingly dielectric constant is with the material tested (micanite) by no means a constant quantity, being altered within appreciable limits according to the electrostatic strain. (5) The variation of the capacity being an unknown quantity, it is impossible to determine in anticipation the increase in the dielectric hysteresis with the increase of the pressures. The usual law, according to which the loss by hysteresis would be $c\,E^2$, is only approximately true with materials the capacity of which is not altered—*i.e.*, with small electrostatic strains. (6) In high-tension machines with micanite tubes, the dielectric hysteresis loss with higher strains on the micanite is approximately proportional to the third power of the tension. (7) In determining the efficiency of a high-tension machine, the loss by dielectric hysteresis is absolutely negligible, comparatively thick material being mostly chosen on account of their safety against piercing.

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POWER SIGNALLING.

An interesting installation of power signalling is being erected by the North-Eastern Railway Company at their Severus Junction, York, where some 12,000 vehicles are marshalled every 24 hours. The installation was brought into partial use on Sept. 20, and the work is being rapidly completed by the contractors, the Railway Signal Company, of Fazakerley. The system selected is that known as the "Crewe," and is similar to that already installed at Crewe on the London and North-Western Railway. With the exception of the mechanical interlocking of the points and signals, all operations are performed by electric power.

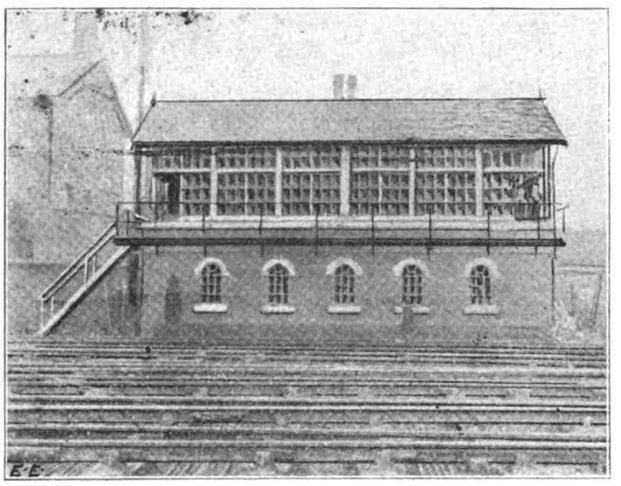

FIG. 1.

Fig. 1 is a view of the signal cabin, and Fig. 2 shows the lever frame operated by the signalman. The frame carries 133 levers arranged in two tiers, and has a length of nearly 22ft. The levers are only used to operate the electric switches controlling the motor and signal apparatus and the mechanical interlocking, and the physical labour entailed is therefore very much smaller than with the ordinary type of frame.

Fig. 3 is a diagram of the lines. Fig. 4 shows the relative positions of the mechanical interlocking, *a*, the switches, *b*,

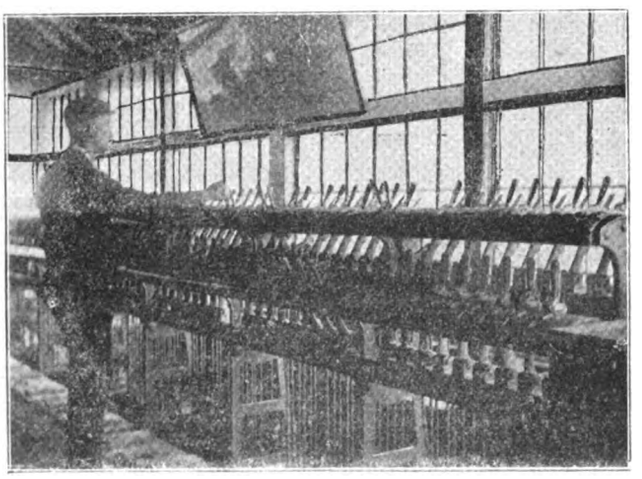

FIG. 2.

and the check locks, *c*. Fig. 5 shows the sunk box containing the motor for operating the points, and the mechanism is shown more detail by Fig. 6. Fig. 7 shows the long-pull Timmis electromagnet by which the signals are operated, and the switch by which the resistance introduced into the circuit when the arm has been lowered is inserted. Fig. 8 shows the circuit switches for both motors and signal magnets. Both the moving and stationary contacts are of carbon. Fig. 9 is a more detailed drawing of the check locks for controlling the motor circuits. Fig. 10 shows the detector switches for the points, and Fig. 11 shows the general arrangement of the circuits. The

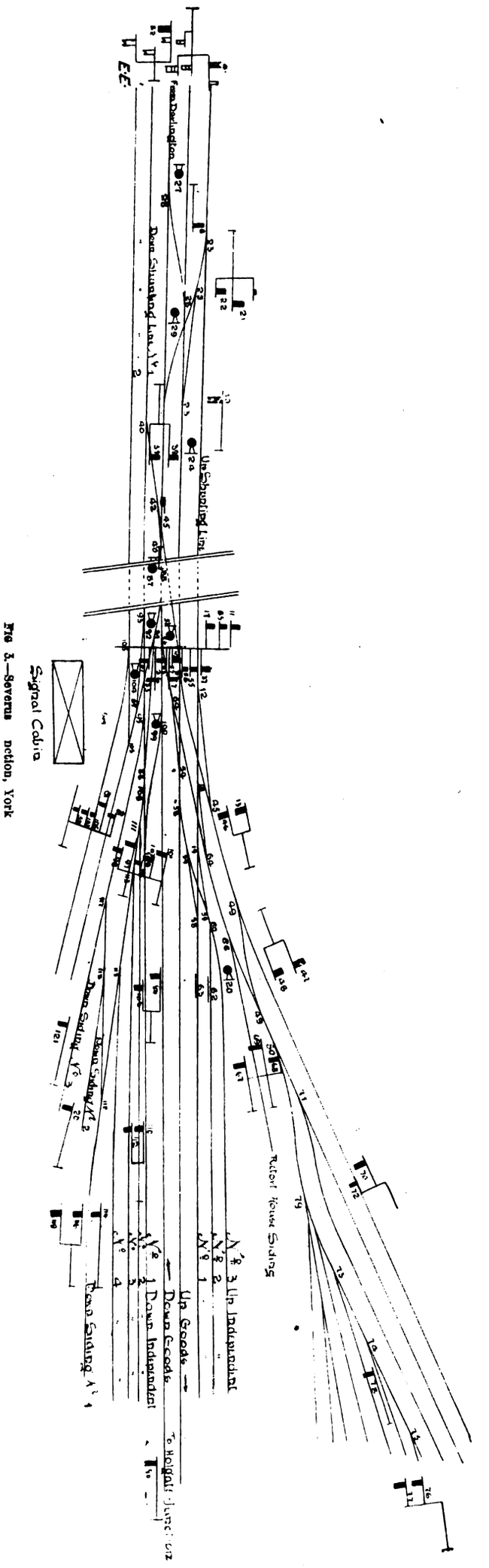

FIG. 3.—Severus Junction, York

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motors for operating the points are of 2½ h.p. The long-pull magnets take five amperes to operate the signal arm and about ·5 ampere to hold it in the off position. Supply is taken from the North-Eastern Railway Company's power station at 200 volts.

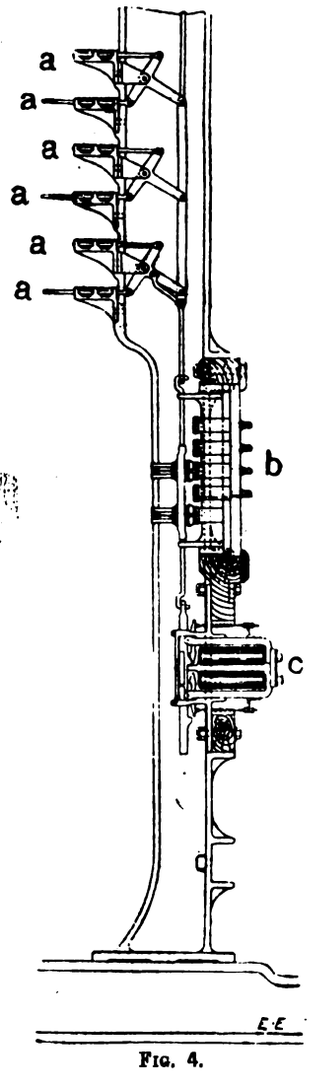

FIG. 4.

The motors for working the points are reversible, and are geared through a worm and worm-wheel and automatic clutches to a cam wheel, by which the rods operating the point locks, safety bars, and the points themselves are worked. The clutches are brought into operation in turn

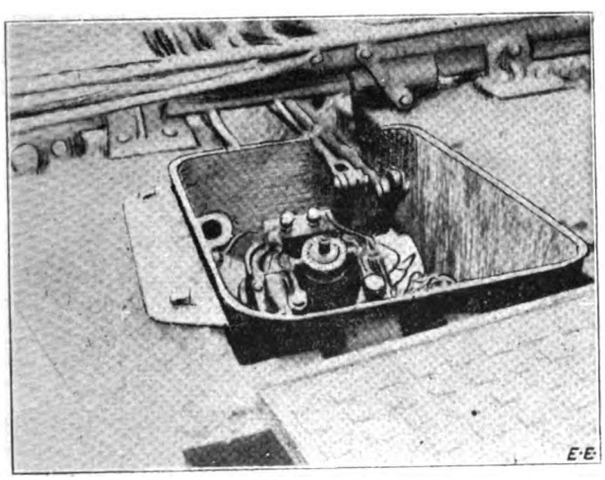

FIG. 5.

by a striker bar, *b*, shown in the plan and section (Fig. 6), which is appropriately moved at the end of each operation of the points by the curved projection, *d*, on the periphery of the cam wheel. The motor runs free and out of gear with both clutches when the striker bar has been moved, which the mechanism is arranged to do when the operation of the points is complete.

It is of the utmost importance that there should be no fear of the completion of the various operations for moving the points without the points being fully closed, and this is effected by the check locks and detectors. The latter are shown by Fig. 10, and consists of a two-way switch, one way of which is always closed, except during the actual operation of the points.

A reference to Figs. 4 and 9 will show that the lever in the cabin cannot be fully pulled over or put back by the

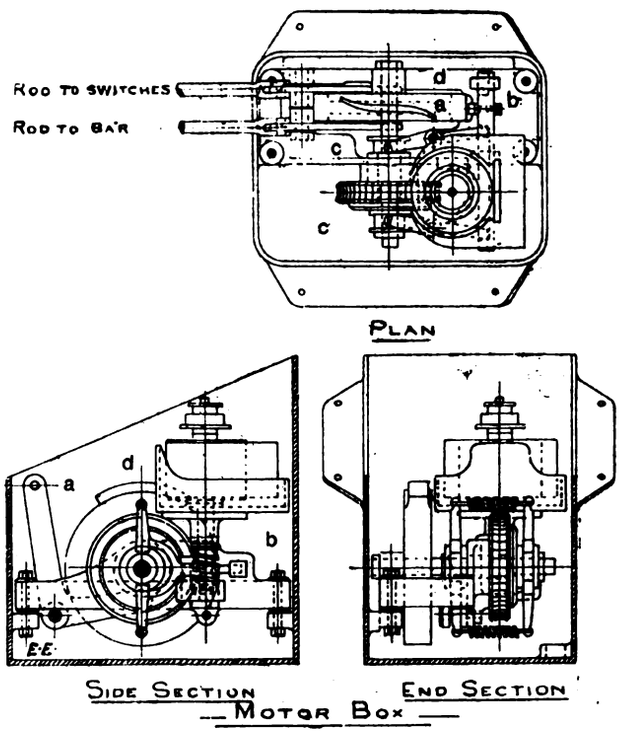

FIG. 6.

signalman unless the armature of the proper check block is attracted by the check lock magnet. The movement necessary to close the switch can, however, be made, and the motor moves the points. When this is completed, the

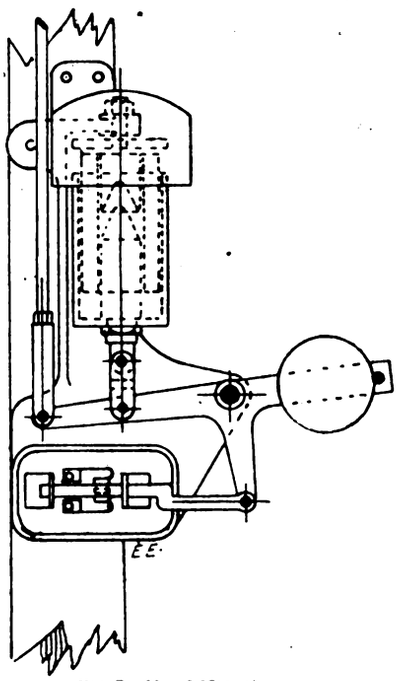

FIG. 7.—Signal Magnet.

check lock circuit controlling the completion of the lever movement is closed, and the armature is attracted. The motion of the lever can now be completed, and the motor circuit is broken. Hence it is necessary for the signalman to pause in the operation of the points lever until he hears

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the click of the check lock armature permitting the completion of the movement.

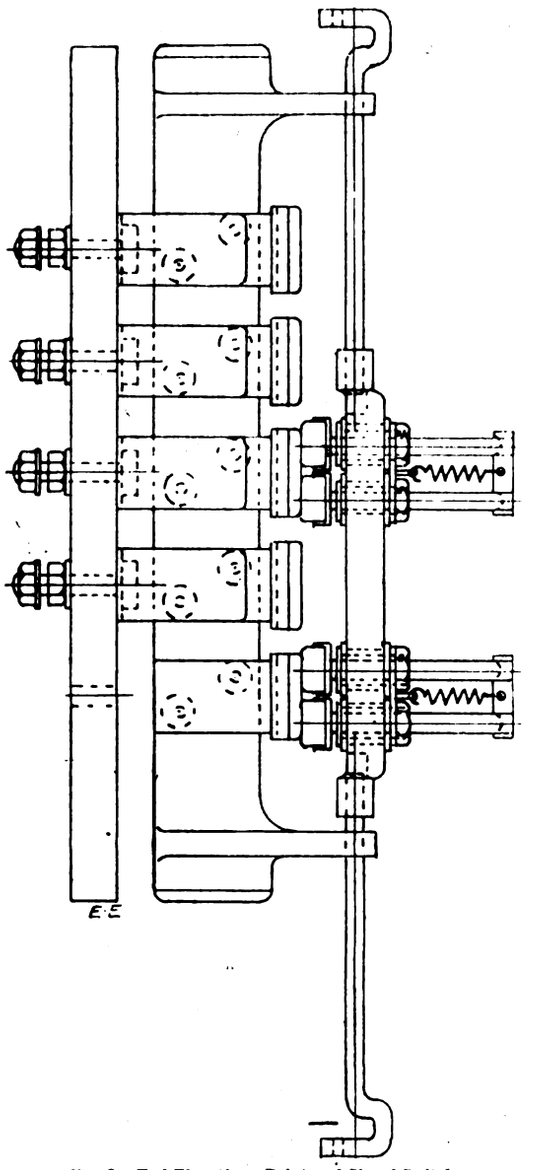

FIG. 8.—End Elevation—Point and Signal Switch.

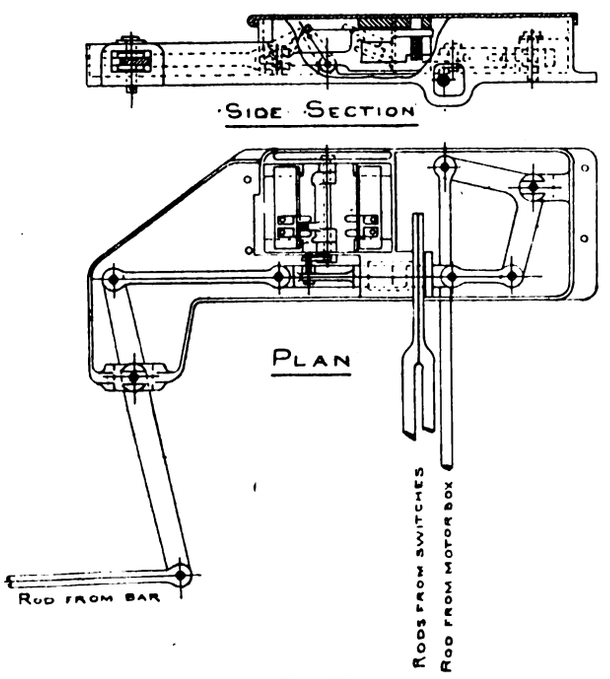

FIG. 10.

The completion of the lever movement actuates a two-way switch fixed on the check lock magnet, shown in diagram in Fig. 11, by which the check lock circuit is set for the next operation. Hence, after the commencement of an operation of a set of points, the movement cannot be stopped

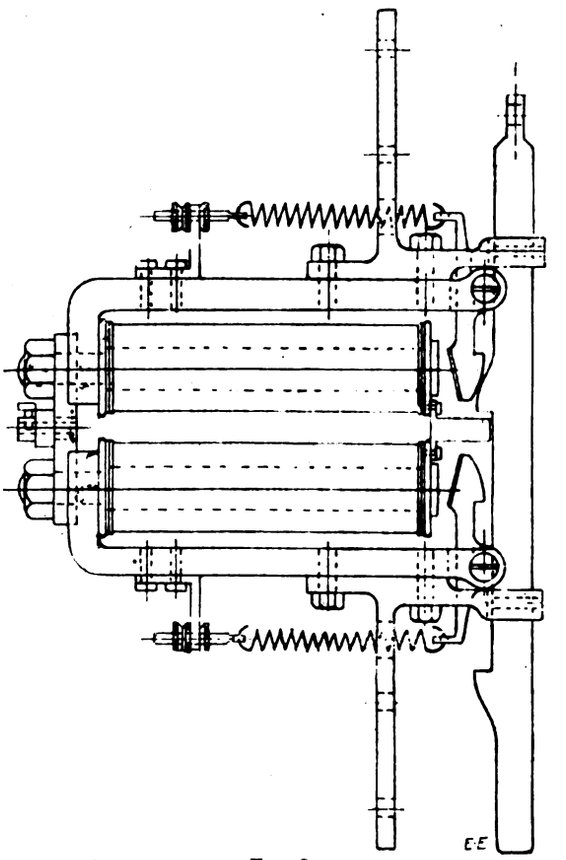

FIG. 9.

until the points are indicated to be in the position desired. Further, a reversal of the movement cannot be made unless the previous operation has been fully completed. All this, of course, is in addition to the safeguards provided by safety bar and point lock on the line, and mechanical interlocking between the points and signal levers in the cabin.

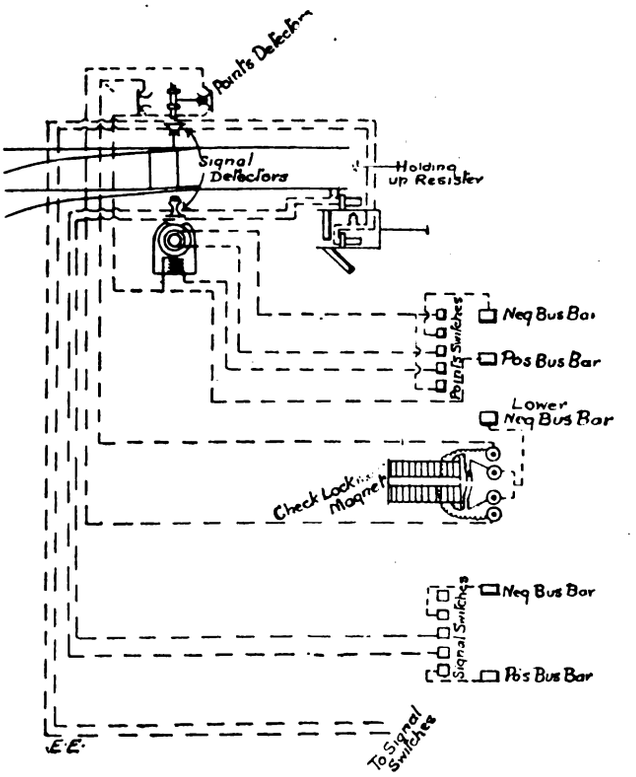

FIG. 11.—Diagram of Circuits.

The operation of the signal levers is made at one movement, there being no check locks in connection with them. An examination of the circuit diagram (Fig. 11), however,

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will show that the circuit of any signal cannot be completed unless the points are laid in the proper position and the signal detector switch closed.

The use of power for the operation of points and signals in preference to hand labour is becoming very pronounced, and it will be interesting to see how far such systems are able to justify their existence. Advocates of power signalling have many powerful arguments in favour of their opinion, not the least of which is that a diminution of physical labour leaves the signalman at a busy junction more alert, mentally, for his duties. For such a system as that described an electric power supply is indispensable and it can only, therefore, as matters are at present, find a somewhat limited application, as the establishment of a generating station for this purpose alone is unthinkable. It is, however, likely in the near future that railway companies will have a much more general supply of electric power than they have at present, and a large extension of the system may be looked for.

INDEPENDENT TELEPHONY IN GREAT BRITAIN

BY GARDNER AND HOLME.

(Continued from page 508.)

2. Maintenance of Exchanges.

Before entering into the details of the maintenance of an exchange it is necessary to arrive at a unit exchange which can be worked by a given staff. A village exchange of 25 subscribers, if completely isolated as regards technical staff, would cost approximately the same to maintain as an exchange of 250 subscribers, and so a central exchange should be taken where the staff can supervise the smaller exchanges. From actual experience it is found that an exchange of 300 direct lines is self-supporting with its own staff, at low tariffs. This is the smallest exchange a local authority should establish as the central, and surrounding villages can then be supplied with smaller exchanges controlled by the central technical staff.

With reference to the details of maintenance, exchanges should not be opened up where there are insufficient railway facilities, as the cost becomes heavy owing to the travelling expenses. With the development of light railways this is becoming almost an impossible case.

The best material should be used and great care exercised in inspecting deliveries, thorough tests being made as to insulation; a little extra time devoted to this particular alone being amply repaid in the process of time. Great care should also be exercised in the handling of stores, as much loss can result from carelessness in this direction. A record of stores should be kept at the store, the quantities being booked out on the card system, and duplicated on requisition notes, handed in by the inspectors, and kept at the office, so that quantities may be ascertained apart from visiting the stores and new supplies ordered in time. Running out of a class of stores and consequent waiting for new deliveries is a loss to the undertaking which frequently happens where a good card system with duplication is not in existence

Apart from a good organisation, the main question of maintenance is the subscriber, and when planning new methods the subscriber's point of view should not be lost sight of; and it should also be borne in mind that a subscriber has his own business to look after, and the least you give him to do or think about when using the telephone the more he will appreciate it, provided at the same time he gets good attention and efficient speaking.

Leaving this part of the subject for the present, we will take the expenses in material for upkeeping a system. First, as to the outside work. If a good portion of this is overhead, the expense of keeping it in repair and clearing faults is heavy, and as much of the wire as possible should be placed underground. The use of standards on roofs for carrying the wires should also be avoided wherever a ground pole can be used, as, although the ground pole is much more expensive, the roof repairs entailed by the standard if capitalised would exceed the cost of the pole.

The Portsmouth Corporation in their telephone system have only used four standards, and these are all placed on flat lead-lined roofs, whereas several hundred of poles have been erected. In any case, the roof repairs should be carried out by the department's own staff, and not let out to contract. Heavy junction routes should also be erected on taller poles than the country surrounding necessitates, as it is found a little extra height greatly diminishes insulator breakages due to stone-throwing. The insulators themselves should also be thoroughly tested on delivery before being used.

Another constant maintenance charge is the inspection and renewal of materials in the local batteries of the subscribers' instruments. With the common battery system this is reduced to practically nothing, owing to the concentration of the electrical energy in accumulators at the central exchange. The question then arises as to whether this saving is at the expense of the subscriber, as the talking efficiency of a common battery exchange is not so good as a local battery system, and the failure of the battery connections, although remote, would be very serious, in so far as the whole exchange would be cut off. It is, therefore, very doubtful, except in the case of the capitals of the world, where the upkeep of 100,000 local batteries is a serious item, whether the cheapness of maintenance charges of a common battery system should be considered. Local battery inspection when well organised is also not quite as heavy a charge as would at first appear, good primary cells lasting a considerable time without attention. A card system should be used giving the dates of the visits of the battery inspector and the condition in which he found the battery.

.... Corporation Telephone Department. No....
Fault Form.

Name.	Nature of Fault.
Reported by	Rectified by..... .....
Date..... Time.....	Date..... Time.....

Fig. 3.

With regard to faults in general, a subscriber, when he has a complaint to make, does not stop to think to whom to make it; consequently faults may come into one department and be lost sight of. For instance, a subscriber may send one of his clerks round to the office to make a complaint; he may go to a neighbouring instrument and ring up the manager, chief operator, or complaints department. Consequently some means must be devised whereby these complaints may be centralised and recorded. The best method is to have intercommunicating lines between the several departments and the complaint clerk, whose duty it is to test out and record the faults, so that whenever a fault is reported it can be transmitted to the responsible person at once. On receipt of a complaint, he should book the same on a form as shown in Fig. 3, ascertaining as far as possible the nature of the fault, as a smart test clerk from one or two words can locate the fault closely before testing. In large exchanges it is necessary also to employ a traffic superintendent to receive complaints regarding the service apart from the apparatus. Intercommunicating lines should run from his desk to the manager's, chief operator's, and complaint clerk's.

A strict analysis of the faults is also very necessary, as the record shows which parts of the apparatus are the weakest, and consequently guides the storekeeper or person responsible for testing new deliveries. A form similar to the one shown in Fig. 4 is very useful in this direction. On presentation to the committee at their monthly meeting they can immediately see the comparative efficiency of the exchange. Too much stress cannot be laid on the importance of keeping junctions in good working order. Whenever these pass an exchange to another one, they should be looped in for testing purposes. In fact, every oppor-

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tunity should be taken of looping them into a test box, as this not only affords a rapid method of clearing a fault when it occurs, but also reduces maintenance charges, as the outside faultsman can locate faults at a great saving of time. In an underground system periodic tests of the cables should be made and the insulation at the different

come on at the busy hours of the day to relieve the sections where the traffic is heaviest. A good means of showing the rise and fall of the traffic is to draw a "load" curve of the calls per hour received at the exchange, as shown in Fig. 6. To summarise, the following statistics prove a useful source of information as to the general

FAULT REGISTER.

Name of Exchange.	Number of Lines.	Number of Instruments.	Line Faults.	Instrument.			Exchange.		Tested O.K.	Percentage.
				Wiring.	Instrument.	H.-V. Guard.	Switch-board.	Test Room.		

Fig. 4.

dates carefully recorded. Pumping dry air into them should also be done constantly, so as to keep all moisture back. The condition of the accumulators at the central should also be recorded, as shown in Fig. 5. A recording milliampere meter should be fitted in the main circuit, so as to indicate any undue leakage of current.

working of a system: (1) analysis of faults; (2) cable tests; (3) accumulator tests; (4) "load" curve.

Having now gone into the various details as to the maintenance of an exchange, it is necessary to arrive at the maintenance per instrument in money value, so that a fair tariff to charge subscribers may be deduced. This,

ACCUMULATOR RECORD.

Maximum charge rate .....
Minimum charge rate .....
Maximum discharge rate .....
Minimum discharge rate .....
Ampere-hours .....

Date.	Number of Cells.	Before Charging.		After Charging.		Remarks on Condition of Plates.
		Specific Gravity.	Volts.	Specific Gravity.	Volts.	

Fig. 5.

Various methods have been tried from time to time to distribute the operating evenly. Some subscribers use the telephone more frequently than others, and sometimes these busy lines are concentrated on one or two sections, the operators of these sections being very busy while the traffic at the remaining sections is very quiet. At some exchanges an intermediate distributing board is placed

of course, can only be done from actual experience. The working cost per station at Glasgow, apart from interest, sinking fund, and depreciation charges, is £2. 5s. 9d., and at Portsmouth £2. 4s. 11d. From the Postmaster-General's forty-ninth report it seems that the maintenance of the London telephone system, apart from interest, sinking fund, and depreciation charges, to March 31, 1903,

..... Corporation Telephone Department.

LOAD CURVE.

..... Exchange. ..... 19 .....

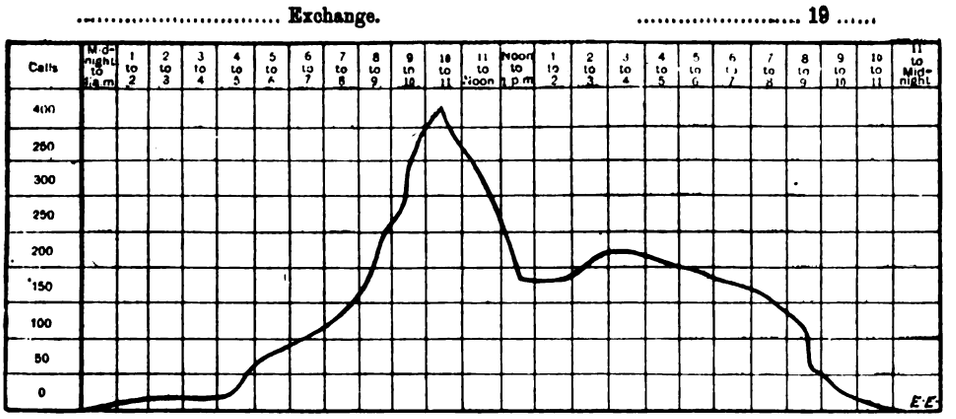

Fig. 6.

between the main distributing board and the switchboard, and the lines here can be easily taken from one section and transferred to another, and the traffic thereby evenly distributed, but the numbers do not run consecutively, and testing is thereby slower.

Another method, and from several points of view a better one, is to employ half-time operators, as learners, to

amounted to £23,278, and the number of instruments working was 9,122, which gives £2. 11s. per station. The next question is the amount of reserve to be set aside in addition to the sinking fund in order to provide against new inventions and depreciation. Opinion varies considerably as to the actual life of telephone plant, but practically all are agreed that the life of cables, which represent 50 per

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cent. of the total capital cost in a good underground system, is unlimited, and at any rate more than 25 years, the time generally given in which to repay the loan. With regard to the switchboard and instruments, the actual life has been given varying from 15 to 30 years, but much stress has been laid by opponents of municipal telephones on the supposition that in case of a new invention the switchboard and instruments may have to be replaced before they have been in use many years. Even supposing they had to be entirely replaced every 12 years (a very remote contingency), the sinking fund would have reached 50 per cent. of the capital cost, and would consequently be more than sufficient to entirely replace them. Of course, the sinking fund is to repay the loan, and if a corporation wishes to be safe against the remotest of contingencies, it will be necessary to open a reserve account at $2\frac{1}{2}$ per cent. in addition to the sinking fund. There has been considerable discussion on the depreciation of a telephone plant, opponents of municipal telephones contending that 10 per cent. depreciation is necessary. A similar discussion is proceeding in America, and on looking closely into the matter it will be found that a sinking fund of $2\frac{1}{2}$ per cent. and a reserve fund of $2\frac{1}{2}$ per cent. on the capital cost for 20 years, total up to considerably more than 10 per cent. depreciation.

The one-time monopolists in America are the Bell Company, and the following tabulation is extracted from the sworn testimony of a Bell treasurer. In giving evidence he stated: "This charge of 10 per cent. is in addition to the regular maintenance charge. What you find in our regular pay rolls for maintenance is simply general repairs to the system, as it is then running. Beyond that there is the new construction that has to be done for the entire change of system—small poles taken down and big poles put up in their places, and finally big poles taken down altogether and underground work put in."

	Cost of plant, Jan. 1.	Cost of construction during year.	Cost of plant, Dec. 31.	Depreciation 10 per cent.
	dol.	dol.	dol.	dol.
1881 ...	—	40,900·00	40,900·00	4,090·00
1882 ...	36,810·00	12,455 57	49,265·67	4,926·56
1883 ...	44,339·01	14,771·67	59,110 68	5,911·07
1884 ...	53,199·61	21,756·91	74,956·62	7,495·65
1885 ...	67,460·87	20,145·75	87,606·62	8,760·66
1886 ...	78,845·96	49,109·70	127,955·66	12,795·57
1887 ...	115,160·09	40,129·15	155,289·24	15,528·92
1888 ...	139,760·92	33,863·98	173,624·30	17,362·43
1889 ...	156,281·87	54,732·37	211,094·24	21,109·42
1890 ...	189,984·82	81,158·21	271,143·03	27,114·30
1891 ...	244,028·73	127,022·82	371,051·55	37,105·15
1892 ...	333,946 40	176,831·46	510,777·86	51 077·79
1893 ...	459,700·06	170,633·77	630,333 83	63,033·38
1894 ...	567,300·45	146,283·76	713,539·21	71,353·92
1895 ...	642,185·29	59,622·33	701,707·62	—

In explaining the tabulated data, the treasurer testified as follows: "We commenced our construction in 1881, and we went on constructing and expending different amounts in different years until 1895. At the end of 1895 we had completed a new system, and to be sure that it agreed with what we had in our books on account of capital expenditure, we had it revalued, and the valuation came then to 648,232dol. We then took the amounts that had been spent year by year, and took off 10 per cent. each year, and added the new construction; and the amount that it showed was, according to that, 701,707·62dol. These amounts are so nearly correct that it confirmed what we had previously arrived at generally and in other places, that 10 per cent. was the proper amount for depreciation of telephone plants for that time."

On examining the figures, it will be observed that the preceding year's depreciation fund is subtracted from the year following, and then 10 per cent. taken off the remainder. Consequently the depreciation slowly diminishes. Taking plant worth £100 and depreciating it in this manner, only £80. 2s. would have been written off in 20 years, whereas with a sinking fund of $2\frac{1}{2}$ per cent. and a reserve fund of $2\frac{1}{2}$ per cent. on the capital cost, the whole £100 would be written off in 20 years.

The Postmaster-General has stated in his forty-ninth report that 36 years is the average life of a telephone plant. The Bell Company method of depreciation is very interesting, as it will be found on working out the calculation that the number of years required to write off £90 to £100 would be somewhere between 90 and 100 years. It will thus be seen that a sinking fund of $2\frac{1}{2}$ per cent. and reserve fund of $2\frac{1}{2}$ per cent. is very liberal, and these figures will consequently be given.

Taking the exchange system of 920 lines, already referred to, the total maintenance charges would work out as follows:

Interest, 3 per cent.; sinking fund, $2\frac{5}{8}$ per cent.			
Special reserve fund, $2\frac{1}{2}$ per cent. = $8\frac{1}{8}$ per cent. on £20,680	£1,680	5	0
Maintenance of 920 stations at £2. 7s. each (the average of Portsmouth, Glasgow, and London)	2,162	0	0
Total	£3,842	5	0

Or £4. 3s. 6d. per station.

From these figures it is now possible to arrive at a fair tariff to be charged for the rental of telephones.

(To be continued.)

THE HARISON AUTOMATIC SIGNAL.

It will be remembered that we commented favourably upon the working of the Harison automatic signal so far back as June 13, 1902, in connection with its installation at Portsmouth, but full details of the invention were not

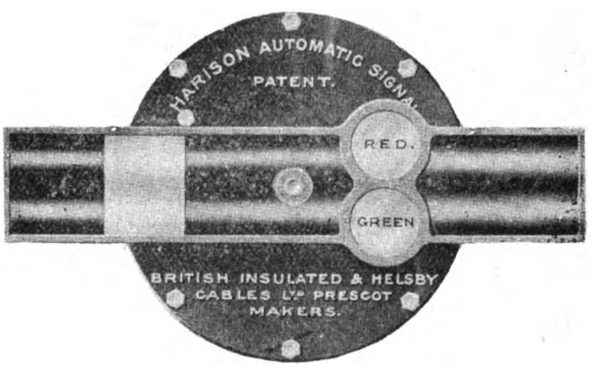

FIG. 1.—View of Signal with arm and lid in position—Harrison Automatic Signal.

at that time available for publication. Referring to Figs. 1 and 2 herewith, it will be seen that the signal is arranged with the usual semaphore, fitted with red and green spectacles, for the illumination of which incandescent lamps are provided. This semaphore arm is weighted so

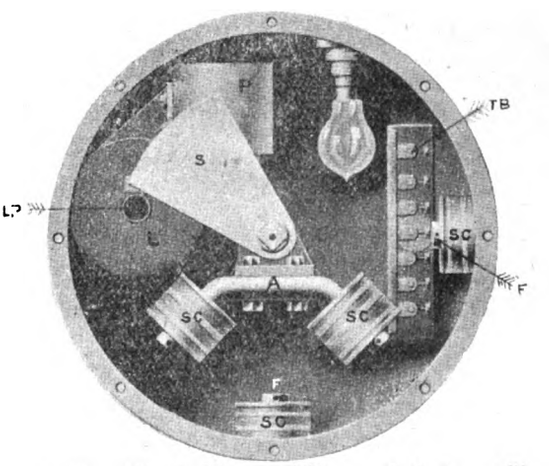

FIG. 2.—View of Signal with arm and lid removed, showing position of mechanism when arm is at danger—Harrison Automatic Signal. S C, signal coils; A, armature; F, fixed pole-pieces; L P, locking plunger; S, shield; L, locking solenoid; P, preference solenoid; T B, terminal board.

as to return from the "line clear" position to "danger" entirely by gravity, thus complying with the Board of Trade regulations. On a current being passed through the signal coils, S C, the armature, A, carrying the semaphore arm is attracted by the fixed pole-pieces, F, thereby lowering the arm to the "safety" or "line clear" position. The arrangement for locking the arm at the "danger" position and unlocking the same, is accomplished by two

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solenoids provided with a common plunger, L P. When current is passed through the front or locking solenoid, L, the plunger is drawn into it and engages with the "shield," S, on the shaft carrying the arm, thereby preventing it from lowering. When a current is allowed to pass through the rear or unlocking solenoid, the plunger is drawn back into it and disengages from the shield, and the arm is left free to lower. The preference solenoid, P, is provided in one only of the two signals protecting a section. It is a device for preventing the preference signal from being locked, and comes into action when two cars are trying to enter the protected section at opposite ends at the same instant. It has no effect if the preference signal is already locked, nor till it is unlocked. The mechanism of the signal proper is, therefore, extremely simple, there being no electrical contacts to wear, spark, or get out of order.

The whole of the mechanism is worked by current from the trolley wire, third rail, or other source of energy at hand—that is to say, there is no need for batteries, either primary or secondary. The installation can be carried out either on the shunt or series system, both of which are applicable to single or double trolley lines, while the shunt is best suited for underground lines employing the third rail. The shunt system, as applied to single lines with turnouts, is shown diagrammatically in Fig. 3. For this arrangement the erection in a suitable position of special overhead contacts, operated by the trolley head or wheel, is necessary. Connection is made between the trolley wire and the overhead contact, and a shunt circuit established through the signals to earth during the time the car is under the contacts. Four auxiliary leads, made up in one cable, are also required between the signals, these being of small cross-section, as the amount of current used is only about 2½ amperes. Contacts 1 and 4 (see Fig. 3) are arranged so that a car always stops underneath them whilst waiting on the turnout. Contacts 2, 3, 5, and 6 are placed so that there is no possibility of a car stopping underneath them. Suppose a car arrives at A and makes contact with 1, the circuit completed is P, S_1, and L_2 to earth. If

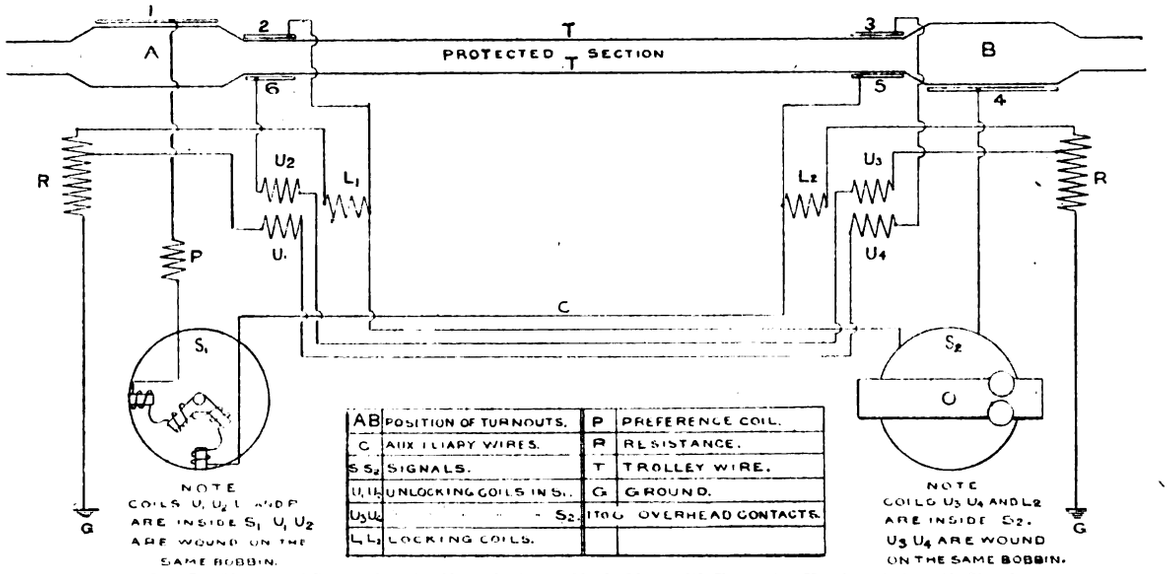

FIG. 3.—Diagram of Connections for Shunt System. Single Lines with Turnouts—Harrison Automatic Signal.

the line is clear S_1 is lowered and S_2 is locked. The car then proceeds to 2, where the circuit made is L_1 to earth, thereby locking S_1 behind it; the line is now blocked. When it arrives at 3 the circuit made is U_4 U_1 to earth, and thus both signals are unlocked. The operations of Nos. 4, 5, and 6 contacts are identical with Nos. 1, 2, and 3 respectively. It will be noticed that 3 and 6 are provided with separate unlocking circuits, which can never be alive at the same time. The windings

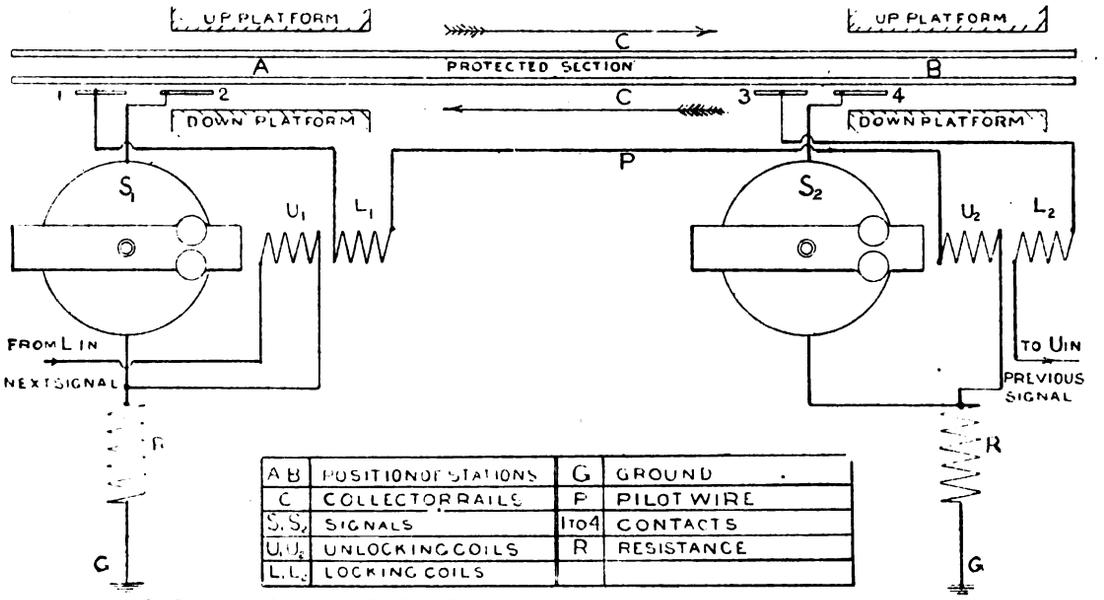

FIG. 4.—Diagram of Connections for Shunt System for Double-Line Tube Railways—Harrison Automatic Signal

of the locking and unlocking solenoids are so arranged that if

U_1 and L_1 are both energised, S_1 remains locked.
U_2 and L_1 „ „ „ S_1 is unlocked.
U_3 and L_2 „ „ „ S_2 remains locked.
U_4 and L_2 „ „ „ S_2 is unlocked.

Also, if L_1 and L_2 are dead, U_1, U_2, U_3, U_4 are each by themselves capable of unlocking their respective signals. The following cases may be taken by way of illustrating the action of the signal: (1) Suppose car A reaches 1 before car B reaches 4, S_1 is lowered, S_2 is locked. (2) If

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car B reaches 4 before car A reaches 1, S_2 is lowered and S_1 is locked. (3) If cars A and B arrive at 1 and 4 simultaneously, S_2 is locked but S_1 is not, since the preference coil prevents it, car A thereby having the preference over car B. (4) If car A and car B are waiting at 1 and 4, and a third car C is on the protected section, then if car C arrives at 3 S_3 is unlocked, but not S_1. If, however, car C is going in the other direction and arrives at 6, S_1 is unlocked and not S_2.

The same system as applied to double-line underground tube railways is shown diagrammatically in Fig. 4. In this case special contacts worked by the train are required to effect contact with the third rail or other source of energy. These establish shunt circuits in the signals while the train is on the contacts. Here only one small auxiliary lead is required between the signals. Referring to Fig. 4, suppose a block to comprise the distance between two stations—*e.g.*, A and B. A train arrives at station B and makes contact with B_4, thereby establishing a circuit through S_2 to earth. The signal arm of S_2 (presumed to be unlocked) is lowered and the train proceeds, allowing S_2 to return to danger. The train then reaches B_3, causing current to flow through L_2 and U in the signal behind to earth. S_2 is therefore locked and the last signal unlocked. The arrival of the train at station A on A_2 contact, causes S_1 to lower if unlocked. The cycle of operations in then repeated at A_1, where S_1 is locked and S_2 is unlocked, thus ensuring that no train can leave station B until a train on any portion of the line between B_3 and A_1 has left station A and locked signal S_1.

It is unnecessary to describe the series systems in equal detail here. Suffice it to say it is so termed on account of the signal windings being in series with the overhead trolley wires, an arrangement which involves the erection of a few section insulators and the use of two auxiliary wires.

The chief advantage claimed for the Harison system of automatic signalling over other systems of its kind, is that it provides for the contingency of two cars on a single-line system trying to enter the protected section from opposite ends simultaneously. It may be added, in conclusion, that the British Insulated and Helsby Cables, Limited, Prescot, Lancs., are now the sole makers of these signals, which are working not only at Portsmouth, but also at Batley, Wallasey, etc.

QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any questions should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

627. What are the advantages and disadvantages of the underfed type of mechanical stoker, as compared with the moving grate and shifting firebar types?—R. M.

628. What is the best method of improving the draught in a central station which at present has a very poor natural draught?—R. M.

ANSWERS.

Question No. 619.—How can the pressure and vacuum gauges be calibrated in the station without the use of standard instruments?

Answer to No. 619 (*awarded* 7*s.* 6*d.*).—The most convenient method of testing pressure gauges without using a standard instrument is by means of the "dead-weight gauge tester." Fig. 1 is a diagrammatic sketch of the apparatus, and will give an idea of its action. The piston is a good fit, generally of an area equal to one square inch, and may be loaded with weights as desired up to a pressure of several tons to the square inch. The pipes connecting piston with the gauge under test are filled with glycerine, a cock below the gauge cuts off pressure due to the weights. The gauge may then be checked through the whole of its scale. Gauges are adjusted by moving the needle or pointer on its spindle; it is generally driven on a taper and by altering positions of the linked levers which actuate the rack. In bad cases, when it is impossible to get

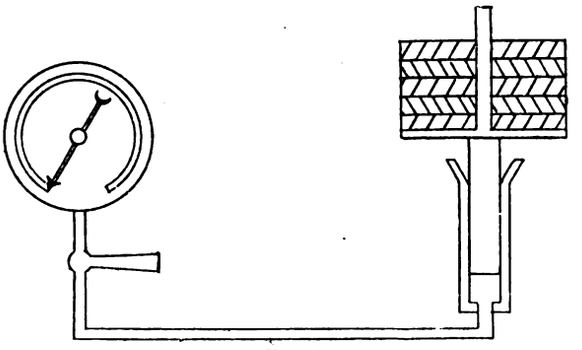

FIG. 1.

correct readings all round the scale, one may generally get the gauge fairly accurate for some distance on each side of the average working pressure. Of course, if a new scale is made this approximation will be unnecessary. Some engineering establishments use a mercury column. (A sketch of such an arrangement is given in Fig. 2.) With this apparatus, by allowing for temperature and barometric pressure, the length of the mercury column provides an accurate method of calibration. A drawback to this arrangement is the height of column required when testing gauges for high pressures. Approximately, each 30in. of mercury give a pressure of 15lb. per square inch. It is, therefore, a question of a convenient wall and a ladder. The plunger is moved by means of a screw and hand-wheel; the operator is thus enabled to alter the pressure to suit work in hand. In place of water, air is sometimes employed

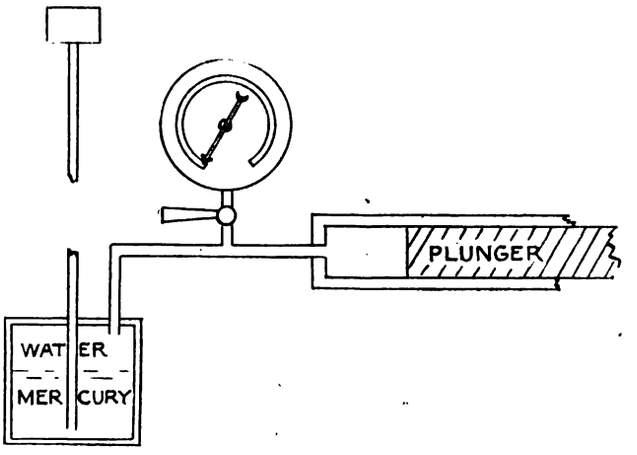

FIG. 2.

to transit pressure from plunger to mercury. Even with practice the calibration of gauges is at best a tedious process; to obtain good results the pointer should be taken round the scale two or three times, and both rising and falling pressures carefully noted.

For the vacuum gauges an air-pump is required; the gauge is connected with a mercury column rather more than 30in. in length and the pump worked. As exhaustion proceeds, the gauge is calibrated against the varying length of the column of mercury. There is a very compact testing machine on the market for the combined purpose of checking both pressure and vacuum gauges in a similar manner to the above description.—M. M.

Answer to No. 619 (*awarded* 7*s.* 6*d.*).—The most direct method for calibrating pressure gauges is by means of the open mercurial gauge as sketched in Fig. 1, in which the column of mercury in the glass tube, A, is a direct and unimpeachable index to the pressure in the vessel, B, and

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the gauge to be tested, C. The lower part of the vessel, B, is filled with mercury, the tap, D, opened, and water is pumped into the tube at E. An ordinary hydraulic force pump will do for this purpose, and, all joints being tight, pumping water in will, of course, drive the mercury up the tube, A, which is open to the atmosphere, as shown. F is a glass to show the height of the mercury in the vessel, B, which for high pressure should be made of iron, because iron is not attacked by mercury and is strong. The height of the column of mercury in the tube, A, must be read in inches, starting from the level of the mercury in the glass, F; when 10in. height of mercury will indicate a

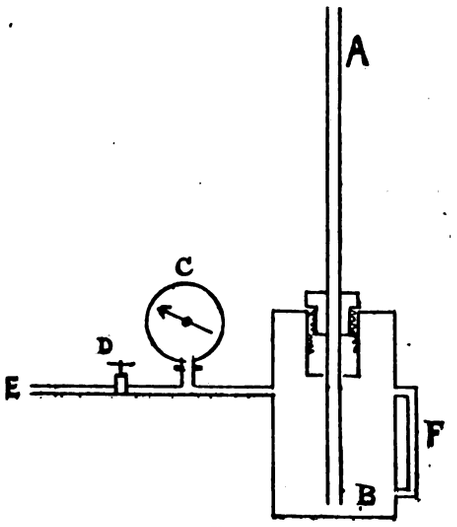

FIG. 1.

pressure of 5lb. per square inch, 20in. a pressure of 10lb. per square inch, and 30in. a pressure of 15lb. per square inch, and so on in proportion. This is a very nice way of calibrating pressure gauges up to moderate pressures, but when high pressures are required the column of mercury in the tube, A, becomes inconveniently long. For example, 100lb. pressure per square inch would require 16ft. 8in. of mercury, and 150lb. per square inch would require 25ft. of mercury in the tube, A. Mercury being very heavy, a very strong tube must be used, and it must be well supported if of great length by being carefully bedded in a groove made of wood and well fastened to a substantial wall.

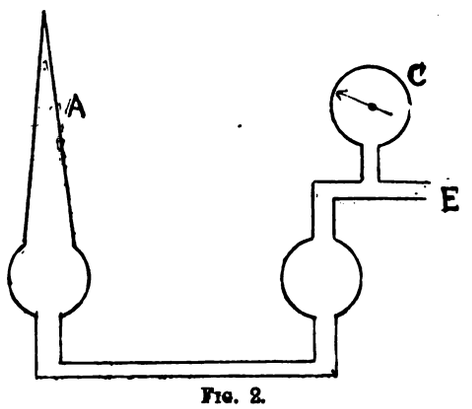

FIG. 2.

However, there is a way of obviating the inconvenient length of tube when dealing with high pressures, and the instrument is called a manometer. It depends upon Boyle's or Marriotte's law, which shows that atmospheric air when under pressure occupies a space in inverse ratio to the amount of the pressure—*e.g.*, a vessel of air exactly full at, say, 3lb. per square inch, would only be half full of air if the pressure were increased to 6lb. per square inch. The best form of this manometer is shown in Fig. 2, where the indicating tube, A, is shown tapering towards the top, so that the highest readings may be on a fairly open scale. The difficulties in using it are to get the mercury level in the two bulbs with the certainty that there is no pressure in the tapered tube, and then, of course, a small addition must be added to the reading on the scale in proportion to the height of the column of mercury—viz., 5lb. presure for every 10in.—in order that the gauge to be adjusted may be accurate. Further, of course, there is a risk of explosion, as the tapered tube must be made of glass. Altogether this instrument is not so good or so accurate as Fig. 1. C is the gauge to be calibrated. The same force pump as suggested for Fig. 1 may be used. Time must be allowed for the compressed air to cool before taking a reading.

For calibrating the vacuum gauges we require an air-pump, as, of course, we must make a vacuum. Any efficient air-pump will do—*e.g.*, one already on the engine. The rest is very simple, as almost all vacuum gauges are graduated in inches of mercury. Fig. 3 almost explains

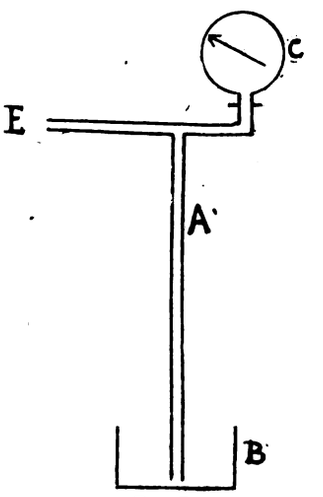

FIG. 3.

itself. E is the tube to which the air-pump is attached, A is a glass tube dipping into a basin of mercury, B, and C is the gauge to be calibrated. On starting the air-pump, the mercury begins to rise in the glass tube, A. When it has risen 1in. above the level of the mercury in the basin, B, we mark the dial of the new gauge 1, and so on until we reach 30in., beyond which we can seldom go—*i.e.*, only when the barometer is standing at more than 30in. Of course, it is very important that there should be no leak in the apparatus. If it is desired to graduate the gauge to pounds as well as inches, the same proportion as that given for Fig. 1 will be correct for all practical purposes; but if the utmost precision is required, then one atmosphere is generally reckoned as 14·7lb. per square inch, and this would make 30·053in. of mercury equal to 15lb. per square inch.—F. G. A.

Answer to No. 619 (*awarded* 5*s.*).—If "W. F. F." has a good steam-engine indicator at hand, he can use it to calibrate the station steam gauges as follows: Attach the indicator to boiler or steam-pipe close to gauge to be calibrated, say in the top or steam opening of water-gauge glass; one glass can be removed for this purpose. After the indicator has been fixed, put a paper on to paper drum and raise steam slowly; heat indicator, and take atmospheric line in usual way; the short movement required can either be done by hand, or the drum can be rotated by any simple and smooth mechanical device. Apply the pencil at regular intervals, and repeat the movement of paper drum. At the instant the drum is moved, the gauge under test must be marked in a similar manner, the marks being made directly under the pointer at the moment of taking. Take a series of readings thus, with a slow and steady rising pressure, until range of the indicator is reached, or, if possible, up to the lifting of boiler relief-valve, afterwards working out pressures in the usual way. The intermediate points between test marks can be proportioned off according to calibration desired. Marking in steps of 5lb is quite close enough scale for central stations, and the test points may be approximately in 10lb. or 20lb. values. In addition to indicator, the bulb of a mercurial thermometer should be inserted in steam space of boiler and simultaneous readings taken from all three instruments. Pressures of steam at temperatures ranging from 10lb. to 300lb. can be got from tables in any engineering pocket-book, and the readings

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compared with those obtained with the indicator. The mean of the two readings may be accepted as correct. With a good type of indicator (such only should be used in a central station) and thermometer the amount of error if carefully taken should not exceed one half of 1 per cent.

To calibrate the vacuum gauges, the indicator will require a lighter spring, but the best method would be to use a mercury column in the form of a V tube. Fix tube with the bent leg into condenser, then run up air-pump slowly, marking mercury column and vacuum gauge as before. Measure off distances between marks on V tube, and then proportion scale of vacuum gauge in inches of mercury, and divide according to scale desired. To reduce to pounds pressure below atmosphere, multiply the readings by ·49. Take barometer reading.—J. C. STEWART.

Answer to No. 619 (*awarded* 5*s.*).—Pressure gauges are usually calibrated by reference to the height of mercury in a vertical U tube, pressure being applied to the mercury in one leg of tube, and the value read off on a scale attached to the tube. This system would not be applicable very readily in a central station; as, for instance, a tube of 25ft. in height would be required for a pressure of 150lb. per square inch. The easiest way, although not so accurate, would be to adjust pressure of steam in the boiler (to which gauge to be calibrated is attached) by means of the safety valve. This can be done so as to mark the gauge from a very low pressure up to point at which the valve usually releases, by altering the weight on a dead-weight safety valve so as to make the boiler "blow" at various pressures, and marking the gauge face with pressure value at the position which pointer is at when the valve releases at the various pressures. In the case of a lever type of safety valve, the alteration can be effected by sliding weight along lever, or by altering the weight at the end of the lever. The releasing pressure in each case is got in the usual way by calculation, and care should be taken not to load the valve above its original blowing "off" limit.

The best way to calibrate a vacuum gauge would be to construct a mercurial vacuum gauge. This consists of a vertical glass tube a little over 30in. long, with its lower end dipping into mercury contained in an iron bottle, while its upper end is connected to the same condenser as the gauge to be adjusted. The more perfect the vacuum in the condenser, the higher the mercury will rise in the tube, due to atmospheric pressure on the mercury in the bottle. As the mercury rises, the gauge can be marked at the various pointer positions as follows: when the mercury has risen 1in., the position occupied by pointer should be marked 1, and when it has risen 10in. the pointer position should be marked 10, and so on until the complete range had been gone through.—J. WALKER.

Question No. 620.—With a shunt-wound motor it is found that the no-volt release on the starting switch takes an appreciable time to act after the current is broken to motor. If the motor is heavily loaded when current is broken, it has stopped running before the switch arm is released. But if main current is left on, and circuit broken at field shunt connection or starter, the no-volt release immediately releases switch arm, but the motor takes much longer to stop than when main current was broken. Explain this fully.

Best Answer to No. 620 (*awarded* 10*s.*).—The probable reason for the peculiar action of the no-volt release on the starting switch observed by "C. W. G." (assuming that the connections are as shown in Fig. 1), is that the

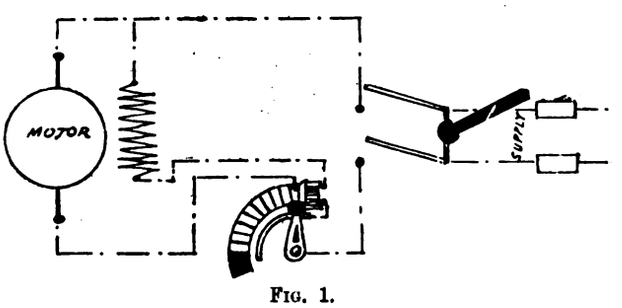


FIG. 1.

momentum of the apparatus coupled to the motor is sufficient to drive the latter for a short time as a shunt-wound dynamo, and it would supply current to the field circuit and also energise the hold-on magnet, but this magnetism would, of course, die away as the apparatus slowed down, until the strength of the hold-on magnet was not sufficient to hold the switch arm, which would then fly back to the "off" position. The motor being driven as a generator would form an electric brake, the momentum stored up in the apparatus being transformed into the electric energy passing round the field circuit, and this load would, therefore, pull up the apparatus sooner than if it simply had to turn the motor round with the field circuit broken.

From the foregoing remarks it will be noticed that if the field circuit was broken immediately after the supply cut off from the motor, the hold-on magnet would not have any current passing round it, and would be demagnetised immediately; also the apparatus would not have any load upon it, and would run for a longer period than if it had to drive the motor as a dynamo and supply current to the field circuit. Fig. 2 shows a main switch and starter which

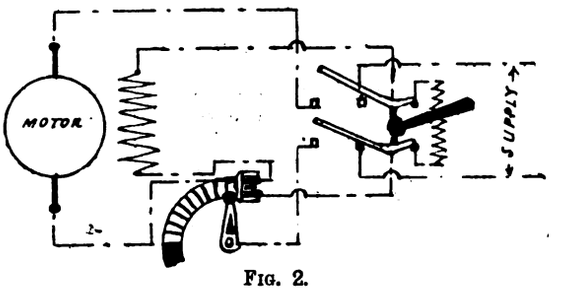
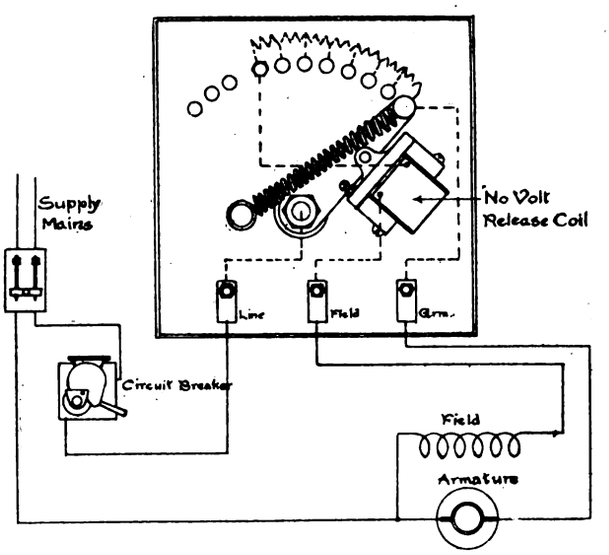


FIG. 2.

would cause the switch arm to fly to "off" position immediately the supply was cut off, which is essential, as the supply might be resumed before all resistance cut in armature circuit. It will be noticed that, on closing the main switch, the field circuit is first energised, and then the armature circuit; and on opening switch the armature current is first cut off, then the non-inductive resistance is put in parallel with the field, the supply then being cut off from the latter, and the induced E.M.F. due to breaking the field circuit allowed to die away through the resistance, which prevents the insulation of field coils being broken down.—A. T.

Answer to No. 620 (*awarded* 7*s.* 6*d.*).—The phenomena stated above may be explained best by a diagram of the internal connections of a motor-starting rheostat. The accompanying figure shows the complete connections of a starting rheostat for a shunt motor with "no-volt" release. It will be seen on reference to the figure that the release coil is in series with the shunt field. This coil is proportioned so as to "hold up" with the smallest field current taken by the motor for which the switch is rated for, and adjusted to release when the motor has slowed down to about quarter speed when running light.* We



will suppose that the motor is running light, and the main D.P. switch is thrown off. The motor still continues

* The object of the "no-volt" coil (as its name implies) is to cut the motor out of circuit should the machine lose its field.

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to run, and the arm of starting switch is still held up. This is readily accounted for when the connections are traced out, for if this be done it will be found that when the arm is held up there is a path from one brush to the field spools, and thence to field terminal on rheostat, no-volt coil, and starting resistance to armature terminal, and back to the other brush. Thus the machine runs as a generator with self-excited field (the residual magnetism in the fields being sufficient to cause the machine to "build up"). It should be pointed out that the direction of rotation is the *same* for a shunt machine when run as a motor or a generator if the polarity of the brushes is the same. Hence a shunt motor (of moderate size) when run as a generator will build up if the direction of rotation is the same in each case (provided, of course, that the field connections are all right). With a series machine the converse is the case. Release of the arm of starting switch takes place when the field current (and likewise speed) falls to a certain value. The machine then continues to run (on account of the kinetic energy of the revolving armature) until stopped by its own friction.

The retarding forces at work in the first case, when the motor is running light, are: (1) the current in the armature for exciting the field; (2) the core loss; and (3) the friction losses (including bearing and brush friction). When the arm is released, the only retarding force is the friction of the machine (3). In the second case, when the motor is heavily loaded, the load rapidly absorbs the kinetic energy of the armature, and the latter very quickly stops. The rate of decrease of magnetism in the "no-volt" coil with regard to time is, in this case, not so great as the rate of decrease of speed with regard to time, and consequently the "no-volt" coil is slow at releasing. In the first case, however, the rate of decrease of the magnetism with regard to time is greater than the rate of decrease of speed with regard to time, and hence release takes place when the motor is running at a fair speed. When the circuit is broken at the field terminal of the machine, as in the third case, the arm is at once released, for the motor cannot generate, on account of the field circuit being disconnected, and hence there will be no current in the holding-up coil on the starter. In this case the only retarding force at work is the friction of the machine (which is generally small compared with (1) and (2) above) and the machine, therefore, takes a much longer time to stop. The time taken by a motor in stopping under these conditions depends on the speed it is running at and the square of the diameter of the armature (approximately), and thus it will be seen that motors with armatures of large diameters will take a longer time in stopping than those of the same size and speed with small diameter armatures. The writer has come across cases where the time taken by a moderate sized motor to stop has been two to three minutes after the machine has been switched out. In the second case the arm may be made to release sooner by increasing the air-gap between the poles of the hold-up coil and the contact arm. In starting rheostats by some makers a small brass set screw and locking nut will be found on the contact arm, which is arranged to come in the middle of one of the pole-pieces of the hold-up coil (see figure). By adjusting this screw the arm may be released at any speed desired. Of course, it should be seen that the point of the set screw always projects slightly on the "holding-on" side of the contact arm, otherwise the latter may be held up by the residual magnetism in the iron.—A. D.

Answer to No. 620 (*awarded* 7*s.* 6*d.*).—The time taken for the no-volt release to act is probably due to three causes—(1) the residual magnetism in the keeper of the release; (2) the self-induction of the coil; (3) the small current flowing through the field. Taking the first cause, when a piece of iron or steel is subjected to an increasing magnetising force, and then this magnetising force is decreased to zero, some magnetism remains in the metal, and is known as residual magnetism. The remanence, or residual value of B, depends on the material partially and on the degree of investigation (B). From the curves (Fig. 1) it can be seen that these values of B vary in different metals for a given value of the magnetising force, H, and that the ratio of B : H, known as the permeability, also differs. This residual magnetism causes the no-volt release to maintain its action as a magnet after the current has been broken, but, of course, only momentarily. There is always a certain amount of self-induction in any coil, which tends to oppose the current and prevent it from either growing or dying away. Thus, when the circuit is broken, the current does not die away instantaneously.

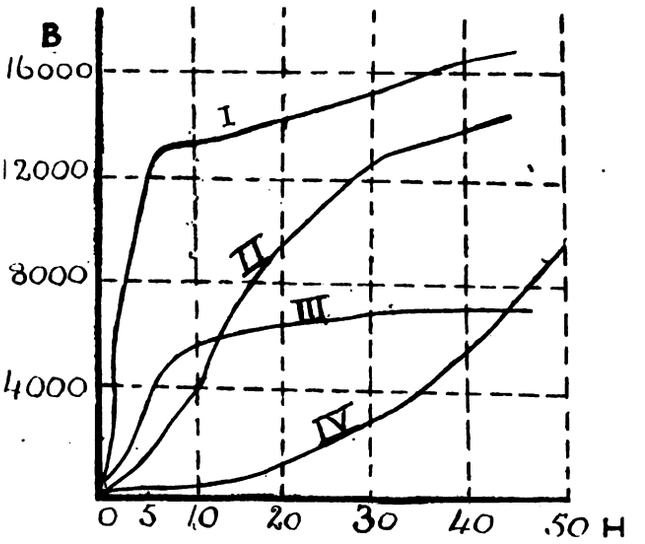

FIG. 1.—I., soft annealed iron; II., steel annealed; III., cast iron; IV., steel glass, hard.

Now, in this instance, where current is broken to the *motor*, the momentum of the armature causes it to continue revolving, and a current, though small, is being sent round the field circuit by the back E.M.F. of the motor. From Figs. 2 and 3 it is clear that the direction of this current is not reversed, one of the

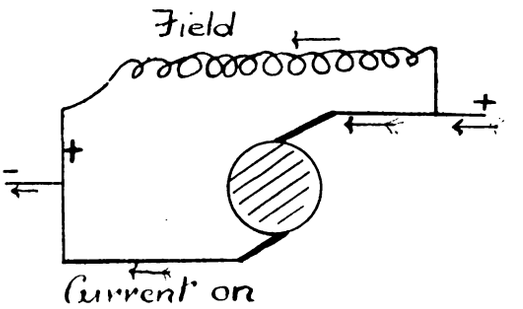

FIG. 2.

characteristics of a shunt motor being that the current in the field is never reversed. Hence the switch arm is held in place until the residual magnetism in the keeper has weakened (the time taken being increased owing to the effect of self-induction), and until the speed of the armature has slowed down sufficiently to weaken the back E.M.F. to

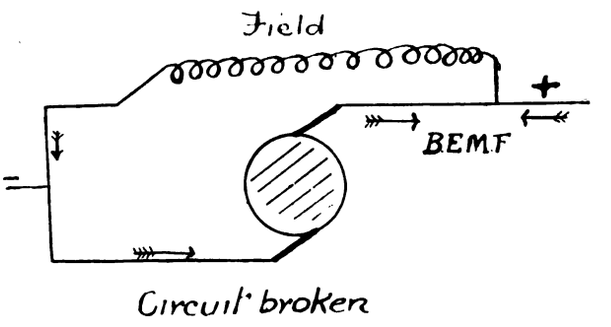

FIG. 3.

such an extent that it can no longer drive sufficient current through the high resistance of the field. In a good starter, the spring of the switch arm is strong enough to overcome some of these effects. In general, when a motor is heavily loaded (the field is always practically constant in a shunt

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motor) on constant-potential system, the speed is at once reduced. But this lowers the back E.M.F., since speed is proportional to back E.M.F. in a motor. Consequently the armature current rises and the torque is increased.

In this case, therefore, the armature, owing to the heavy load, would quickly be brought to rest when the circuit was broken, and, the conditions of the field circuit being the same as before, the arm would be released slightly after the armature had ceased to revolve, especially if the switch arm spring were weak. When the field circuit is broken, either at the shunt connection or at the starter, the no-volt release at once ceases to act as an electro-magnet (as the retardation of the current due to self-induction is almost imperceptible), and the residual magnetism of itself is insufficient to hold the arm, and the latter immediately flies back. From Fig. 4 it can be seen how breaking the field circuit affects the no-volt release.

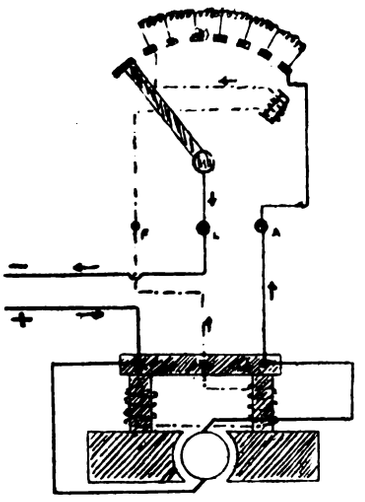

FIG. 4.

Where the field of a motor is weakened, the speed is increased; hence, in this case, there being no field, the speed will be very great, and the motor, owing to its increased momentum, will revolve for a greater length of time.—HYSTERESIS.

Answer to No. 620 (*awarded* 5*s.*).—The reason why the no-volt arm on switch does not release on breaking current to motor is not far to seek, and may be clearly understood, in the first place, by referring to the sketch (Fig. 1) of the

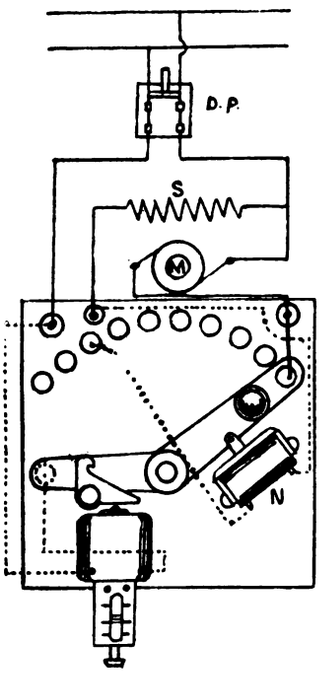

FIG. 1.—D P, double-pole switch; S, shunt; M, motor armature; N, no-volt coil.

starter and motor connections, from which it will be seen that immediately the current is cut off at double-pole switch the armature is still left connected up with the shunt in a complete circuit. The motor keeps on running for an appreciable time, due to its momentum and of machines it is driving, and it is therefore acting as a generator. The no-volt coil has a current flowing through as before, and in the same direction. As mentioned in the question, it will be held on even after the motor has stopped if the current was cut off whilst the motor was heavily loaded. This is undoubtedly due to the lag of the magnetism in the fields setting up a current, the length of time the arm is held on depending upon the design—*i.e.*, the quantity of iron in the fields of the motor.

This may be further verified by the following simple arrangement: Fix a switch in the shunt circuit between the shunt terminal on starter and end of shunt wire connected to former. Now, with motor up to full speed, cut current off at D.P. switch, and when motor has slowed down to, say, half speed, open small temporary switch. The no-volt arm will then immediately release. Try this with heavy load on motor, but open temporary switch between the time of motor having stopped and no-volt arm being released. It will again be released almost immediately. A small flash will be noticed at temporary switch, evidently due to self-induction.

The last part of the question, why the no-volt immediately releases on breaking at shunt connection, is obviously due to current being completely cut off from no-volt coil almost immediately. The effect of self-induction is not so effective as before, there being now no closed circuit. The motor will in this case run for a longer time because there is now no breaking effort due to running as a generator as in the first case, there being also no field and no eddy currents, etc. The momentum of the motor and parts it is driving is now all being wasted in friction only at bearings, and, therefore, runs for a greater length of time.—F. H. R.

FORTHCOMING EVENTS.

FRIDAY, OCT. 16.

Institution of Mechanical Engineers.—At 8 p.m., ordinary meeting. Paper: "The Newcomen Engine," by Mr. Henry Davey.

SATURDAY, OCT. 17.

Junior Institution of Engineers.—At 3 p.m., visit to the New Vauxhall Bridge Works. Assemble at the Westminster entrance.

WEDNESDAY, OCT. 21.

Association of Municipal Corporations.—Annual meeting, Westminster Palace Hotel.

THURSDAY, OCT. 22.

Institution of Electrical Engineers (Leeds Section).—Ordinary meeting. Paper: "Some Notes on Steam Turbo-Electric Generating Plants," by Mr. G. Wilkinson.

FRIDAY, OCT. 23.

Junior Institution of Engineers.—At 8 p.m., annual general meeting, Westminster Palace Hotel.

PERSONAL.

Mr. P. H. Roscoe, son of the sewerage surveyor of the Corporation of Liverpool, and lately cable engineer with the British Insulated and Helsby Cables Company, is leaving to act as assistant tramway engineer at Portsmouth. As a parting gift, the men employed under him at Brighton have presented him with a smoker's cabinet in oak, a meerschaum pipe, cigars, and Phillip Dawson's "Engineering."

Mr. Blake, electrical engineer, has been appointed temporarily to do the work of the borough surveyor of the Monmouth Town Council.

The successful candidate for the post of senior charge engineer at Taunton was Mr. H. E. Sharp, from the Bristol city electricity works.

Mr. Sydney H. Barber was presented last week with a silver cigarette case and match box on the occasion of his relinquishing the chief assistantship at the Shipley electricity works to join the outside staff of W. T. Glover and Co.

On Wednesday a farewell presentation was made by the indoor staff of the South London (London County Council) Tramways to Mr. Alfred Baker on the occasion of his approaching removal to Birmingham. The gifts comprised a drawing-room clock and brass ornaments to match and a tantalus, together with an afternoon tea service and case of silver spoons for Mrs. Baker.

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THE
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TO CORRESPONDENTS.

All Rights Reserved. Secretaries and Managers of Companies are invited to furnish Notices of Meetings, Issues of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration.

All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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FINANCIAL TROUBLES AHEAD.

During the past week the London County Council has made two changes in financial matters which will have a much wider interest than to those immediately under the control of that Council, and the ultimate consequence of which can hardly be seen at the present time. It is well known that the London County Council is practically the central banking establishment for all the local authorities within the metropolitan area. Scarcely a week passes but that the Council advances loans to other authorities. It is now finding that there exists a pinch in the money market, and that money which could a few years ago be obtained at a moderate rate of interest, is not now to be so obtained. Thus, at the last meeting of the Council, the Finance Committee reported that they had been considering the rate of interest under which advances should in the immediate future be granted, and suggested that the present rate of 3½ per cent. could no longer be regarded as sufficient, and that they should increase the rate of interest to 3¾ per cent. per annum. The Council adopted the report of the committee. This increase in the rate of interest has long been foreseen, and under existing circumstances was inevitable. It is in the ordinary nature of business, and may perhaps cause a few of the authorities to think a little more before they enter into big obligations. We doubt, however, whether anything in the shape of interest would be effective in restraining what is termed the progressive policy. In many instances, unfortunately, we are almost bound to believe that other questions than the due spending of money takes precedence in the councils.

The second move of the London County Council, however, may be far more effective than the raising the rate of interest. Loans are obtained for specific purposes, and these loans have to be repaid within a certain number of years, the number of years depending upon the work for which the money is required. Hitherto we believe that in many instances loans have been too easily granted, and the time for which they have run has been too long. The particular case which the Council has decided may not seem very important, or to bear any far-reaching results. It is the case of a certain kind of paving which hitherto has been estimated to last ten years, and the loans granted for it have run during the period. It is suggested that the duration of loan for this particular kind of paving be limited to five years, in that experience has found that within the metropolitan area the paving was worn out before the expiration of a longer time. To us it seems that it is not the particular case that is of so great interest, but the principle involved, which is to ensure that no portion of the loan be outstanding when the work for which it has been obtained is useless. It may be taken for granted that what the London County Council has introduced will be continued by the Local Government Board which has to sanction the loans of municipal authorities required for the various works they undertake. In the near future undoubtedly a far greater examination will be taken in order to determine, not the maximum life of a works, but the average life, and this determines the period during which the loan may be running. We know that there are great differences of opinion as regards electrical undertakings. Many who have carefully studied the question think that the period during which loans are granted is too short, and desire to see the period extended. We doubt if at the present moment we have enough cumulative evidence to determine anything, and we may take it that the policy hitherto pursued is liable to modification. It is somewhat unfortunate that these questions of finance cannot be dealt with without loss

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of temper, for on the one hand we have many strong statements by interested parties of the manner in which municipal enterprise is conducted, and we are told that when the financial conditions can be thoroughly examined many of these enterprises are in a state of bankruptcy. On the other hand, it is pointed out that the very people who so strongly criticise do not practice what they preach. It is evident by the action of the London County Council that we are on the eve of change, and we think it would be well if all the responsible officials who have charge of central stations would follow the example of Mr. J. Snell, the president of the Municipal Electrical Engineers' Association, and collect all the information and all the figures pertaining to their own installation which bear upon this subject.

QUACKS AND QUACKERY.

On May 22 we made an emphatic protest against the policy of respectable daily papers inserting advertisements about quack remedies. The use of electrical appliances by duly qualified men is to be commended, and every effort should be made to extend their beneficent use; but the quack advertises appliances which are known by qualified men to be remedially useless, and indeed in some cases to be positively harmful. These quacks depend for success upon the ignorance of the general public, and this ignorance is fostered by the criminal negligence of proprietors of papers and periodicals. Anyone who cares to examine the so-called current literature will find that a large part, probably one-half, of its advertisement income is derived from payment by quacks. Some years since, through the action of our contemporary the *Electrical Review*, the value of so-called magnetic and electric belts was thoroughly thrashed out before a legal tribunal; hence it is too late in the day to plead ignorance of the question, yet for months past glaring advertisements have been inserted on the old lines. Fortunately, or unfortunately, the Medical Defence Union have been able in one case to step in, so that probably for a time at least the advertisements will stop. It is too much to hope for finality. Newspaper proprietors will say they are not called upon to discriminate, and why should they refuse good money. Mr. Bodkin, explaining the summonses taken out because of a misdescription, said: "In every one of these advertisements which related to the power of a so-called electric belt to cure every known or unknown disease from which human beings suffered within the shortest possible time." . . . . In reply to a question by the magistrate, Mr. Bodkin said "he had been given to understand that these belts were so absolutely free from electricity that they were just as if a person wrapped a piece of paper round the body." Of course, that was a dogmatic statement, and of no value in evidence. Our quotation in May was, "But a physician can apply the current in a very mild form from the battery." "Yes, but not so mild as it should be to do any good." This question and answer, quoted from an advertisement in the *Standard*, shows conclusively that the writer was very imperfectly acquainted with his subject. Civilisation seems to trend backwards, and the value of modern education cannot be very great when it is seen that the remedies of ignorant quacks are eagerly sought after.

ROTHERHAM.—The Corporation have decided to apply to the Local Government Board for sanction to borrow £14,670 for extension of their electric supply works.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

A SELF-DRIVING MACHINE.

SIR,—I beg to send you the following correspondence, which may be interesting to your readers.—Yours, etc.,
ARTHUR E. GILBERT.

23, King John-terrace, Heaton, Newcastle-on-Tyne,
Oct. 13, 1903.

B. C. Pole, Esq., London.

Dear Sir,—I quite agree in what you say in yours of 8th inst., to the effect that it is possible to construct a machine to work by its own mechanical parts, without any external aid—*i.e.*, mechanically-made power. I have devoted 30 years' study, off and on, to the problem, and am now preparing drawings of "a self-driving machine," which will, I venture to say, be considered one of the greatest inventions of the twentieth century. But being single-handed, and not my own master, the details take some time to work out. When my drawings are completed I should much prefer you to examine them, because your ideas coincide with mine, and in the event of your thinking favourably of the principle of the machine we might come to terms. What do you say? With our two heads together I feel that we could soon produce a working model without costly experiments. *Do I understand that your momentum engine works without boilers, steam, and fuel?*—Faithfully yours,
ARTHUR E. GILBERT,
Oct. 10, 1903. Electrical Engineer.

19-19A, Imperial buildings, Ludgate-circus,
London, E.C., Oct. 12, 1903.

Arthur E. Gilbert, Esq.,
23, King John-terrace, Heaton, Newcastle-on-Tyne.

Dear Sir,—In answer to your letter of the 10th, the momentum engine can be worked without boiler, steam, or fuel by the laws of gravity, also the tides, also the solar motor. I do not wish to see any drawings, as the mechanical development of power is now discovered by me, and I claim all the rewards and statutes which are offered in this country for the discovery.—Yours truly,
(Signed) B. C. POLE.

[This correspondence is *too* good to be lost to the world, and, failing its insertion in *Punch*, we venture to give it room—though it savours too much of "counting chickens before they are hatched."—ED. *E. E.*]

THE RELIABILITY TRIALS OF MOTORCARS.

SIR,—The Automobile Club having now issued their preliminary report upon the above trials, I am glad to note from it that the officials have at last come to recognise the primary importance of the value of non-stop runs. So long ago as 1898, in a letter to the technical journals, I suggested the non-stop idea as applied to the testing of motorcars, but it is only comparatively recently that the Automobile Club and the public have commenced to fully realise what an instructive and a conclusive test a non-stop run really constitutes.

Although the public may have the fullest confidence in the decision of such judges as were appointed to watch the recent trials, yet the formula by which they are supposed to have arrived at their decisions is utterly unintelligible to the ordinary run of interested amateurs, whereas nobody is so dull as to fail to appreciate the meaning of a right-away non-stop run and its immense value in determining the reliability of any particular make of vehicle. There is no doubt about it, reliability is what the British public require before every other quality which a motorcar may possess.

One can tolerate a certain amount of odour, noise, vapour, or vibration, as one does upon a railway, but so long as these objections are confined within the limits of moderation, reliability is the one thing needed, and nothing can demonstrate the possession of this quality so simply, thoroughly, and conclusively as a non-stop absolute run. But such trials as those recently instituted by the club,

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whilst forming an excellent advertisement to the club itself and constituting some slight basis, perhaps, for its *raison d'être*, are, nevertheless, a terrible drain upon an industry whose object it should be to supply the public with reliable vehicles at a reasonable price. When manufacturers and agents are called upon to pay sums varying from £30 to £100 for the mere permission to participate in these trials (hampered as they appear to me to be by strikingly useless conditions), besides the costs attendant upon the running of the vehicles, it is obvious that such expenses must be piled upon the cost price of the cars, which eventual purchasers must reimburse in the sums they pay for their vehicles. I should like to suggest that the public should in future very carefully note the results demonstrated in all properly authenticated non-stop runs, as these, in my opinion, form a sufficiently conclusive test of the one feature required above all others in the work of a motorcar—reliability. The costs of such a test are infinitesimal compared with the entry-fees exacted for participation in "official" tests, and cannot, therefore, indirectly increase the price of motorcars, which even now, in most cases, is too high to allow the public to derive from them the advantages and enjoyment which they might otherwise legitimately be able to afford.—Yours, etc.,

London, W.C., Oct. 13, 1903. R. MOFFAT FORD.

A FORECAST.

You may talk of any engines
Of reciprocating type
That have ever been constructed
Or have blossomed forth to life:
From the stately-moving triple
To the giddy high-speed thing
Which runs with peace angelic,
Though, like Jehu, travelling;
From the "Eiffel Tower" vertical,
Which necessitates a guy
Rope upon the topmost cylinder
Whene'er the speed is high,
To the horizontal Corliss
Spreading out across the floor
And covering the good half of an acre—sometimes more.
All the beauties and the virtues
Of this ancient, honoured throng
Will be buried and forgotten like the past before so long.
For a rival has arisen,
And i' faith it's going strong,
And the ancient engine builders
Wear their faces very long;
For they don't like to admit it,
But the fact is very plain
That the use of turbine engines
Means a most substantial gain
In floor space, stores, and lubricant.
Besides, they save the pain
Of witnessing the breakdowns
Which again and yet again
Come through heated top and bottom ends,
And other things insane,
Which are attributes of all the brutes
Which reciprocate in vain.
For their day is past and over—
'Tis the turbine come to stop,
For when once you start him running
He'll continue 'till you drop.

—F. T. C.

This is not poetry, but it may be prophetic.—ED. *E. E.*]

Magnetic Survey of the Dutch Archipelago.—According to *Terrestrial Magnetism*, the Dutch Government has granted the means for a new magnetic survey of the Dutch Archipelago during the years 1904-7. During each of these years the field work is to cover two to four months, only a general survey being possible with the present means. A beginning has already been made, observations having been commenced on the "tin island," Billiton, and at some points in the neighbourhood of Batavia.

LOCOMOTIVES OR MOTORCARS?

BY B PONTIFEX.

There are different answers to the above question, which depend on the class of traffic and length of runs, conditions which separate the problem into three headings: (*a*) fast long-distance passenger and goods traffic, (*b*) local passenger traffic, (*c*) slow goods.

For all these, but especially for express traffic, electrical engineers need to be reminded that the track on which the trains run requires to be taken into consideration. Engineers who can—and do—design good working railway motors seem to regard their position on the cars or trains as a matter of secondary importance, and, consequently, put them anywhere solely with a view to convenience and economy of locomotive and carriage design. Even a member of the general public knows that main-line expresses take facing points at a speed of over 30 miles an hour (whether they are supposed to do so is another story); would a train of motorcars, or mixed carriages and motorcars, keep the metals under these conditions? The best answer is that no train on a steam railway would attempt to take facing points except at a crawling pace, if it were being pushed, and what certainty would there be that in a train of motorcars the fastest would invariably lead? Traffic on an important main line would be too complicated if it were carried on by a succession of motorcars running on a very short headway, apart from any difficulty in the way of picking up passengers and their luggage in the limited time that could be allowed for stops. If these assumptions are correct—and they are deduced from the present standard railway practice—long-distance express traffic, which has necessarily to run through junctions at a fairly high speed, will have to be drawn by locomotives. If a train of motorcars were used, the resulting increase in acceleration would be more than outweighed by the danger of jumping the track at crossings, and it is also open to question whether the Board of Trade would sanction extra high voltage on cars that were carrying passengers, since long journeys imply long distances for transmission of power, which in turn require high voltage.

(*b*) For local passenger traffic the conditions are almost reversed Quick acceleration is a matter that directly affects the average speed of the trains,* and a train composed, wholly or largely, of motorcars can always get up speed quicker than a train drawn by a locomotive, while shunting at the termini is reduced 80 per cent. or abolished altogether if the trains start and arrive at the same platform. Added to these advantages is the ease with which a motorcar train can be split up at suburban junctions for serving small branch lines, which is the strong point of any system of multiple control such as that introduced by Mr. Sprague. But even for local traffic some consideration for the track has to be shown to get the best results. A common arrangement is to put a motor on every axle of the leading and trailing bogies, which from my own experience I can say does not give the best results. A train composed of two motorcars, with an idle car between them, was equipped with four motors, two on the leading bogie and two on the trailing bogie; but under the most favourable conditions failed during several trials to quite come up to the contract speed over the whole route, which included 13 stops per journey, while the permanent way was rather knocked about. The motors were then shifted, one to each bogie of the leading and trailing coaches, and fixed on the inner axles of each, so that the leading wheels were always idle, whether the train was moving forwards or backwards. The better distribution of the motors gave increased acceleration, as was expected, but there was also a decided improvement in the condition of the track and in smoothness of running, due to the decrease of hammering at curves and points owing to the removal of the motors from the leading axles.

(*c*) For slow goods traffic locomotives alone meet all requirements, owing to the class of rolling-stock in use and the fact that many goods wagons are owned by private firms. The cost of building and maintaining

*See "Notes on Electric Traction," *Electrical Engineer*, Vol. XXXI., page 150.

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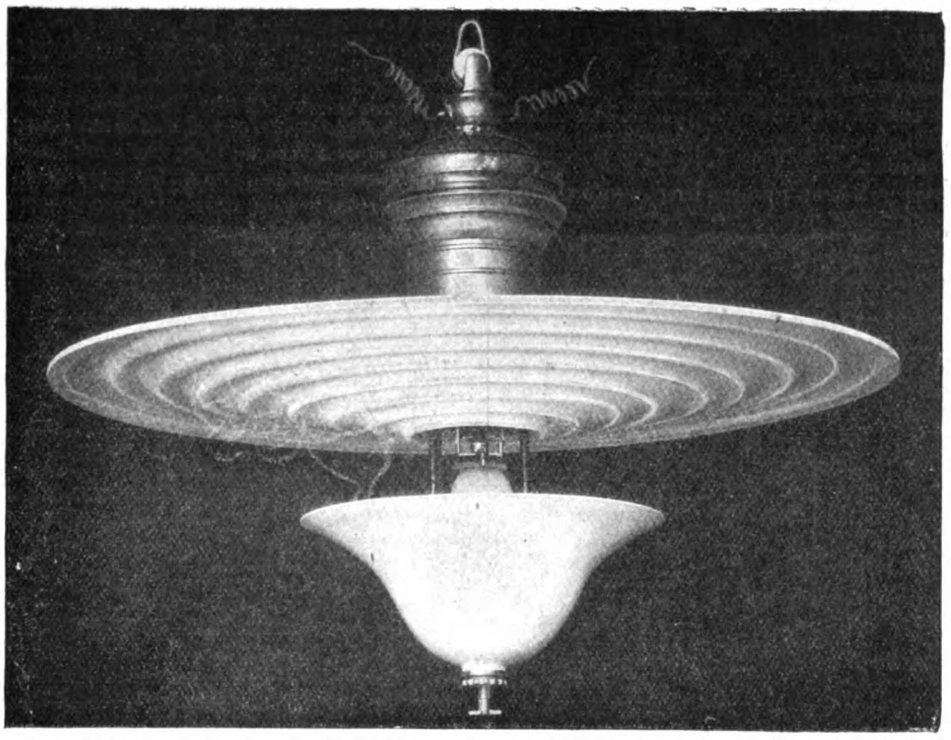
motorcars for slow goods traffic would only result in a heavy loss for the railway company that was rash enough to try the experiment.

TRADE NOTICES AND NOVELTIES.

The British Thomson-Houston Company's Concentric Light Diffuser for Enclosed Arc Lamps.

For interior shop-lighting the enclosed arc is generally recognised to possess advantages over the open type. While it does not give such a powerful light as does the open type for the same amount of energy, it possesses other advantages, such as cleanliness, convenience, safety, and requires a very small amount of attention and infrequent trimming. An objection to arc lamps for this kind of lighting, which applies more particularly to the open type, but also to some extent to the enclosed type, is that there is a tendency to concentrate the light in a circle beneath the lamp, and a perfectly even distribution of light is difficult to obtain. In many shops fatigue and subjective colour effects are partly overcome by the use of dense globes. This reduces the efficiency of the light, and there still remain defects in the distribution, due to the arc travelling around the carbon points.



Concentric Light Diffuser for Enclosed Arc Lamps.

In order to further improve the distribution of light with the enclosed arc lamp and adapt it to particularly severe requirements, the British Thomson-Houston Company, Limited, Rugby, after a careful study of this important problem, have introduced the concentric light diffuser, which is shown in the accompanying illustration. This apparatus, it is claimed, while of an exceptionally simple character, not only reduces sharp contrasts and diffuses the light equally in all directions, but the effect of the wandering of the arc has been reduced to a considerable degree, so that the light at any point is, to a great extent, independent of the position of the arc with respect to the carbon ends. The apparatus consists of a suitably-designed metal diffuser attached to the lamp casing in the same manner as an ordinary reflector or shade. In place of the outer globe a screening shade is used which performs the double function of subduing the light directly under the lamp, and reflecting a portion of it on to the diffuser. The light from the diffuser is white, even, well distributed, easy on the eyes, and particularly adapted to the matching of colours, which is of the utmost importance in a very large percentage of shop-lighting. Furthermore, the diffuser makes the illuminating power of the lamp independent of the nature or colour of the ceiling—that is to say, it is immaterial whether the ceiling is light or dark. With the diffuser the light will be about equally effective under all overhead conditions, as there will be practically no light lost by absorption in the ceiling itself. The concentric light diffuser is particularly adapted for use in rooms having low ceilings, and is specially recommended for drawing offices, shops, and in general for any interior lighting work where even distribution and steadiness of light are particularly important. It should never be used without the lower glass shade, and it is not suitable for use with outdoor lamps. The British Thomson-Houston Company, Limited, have devoted a great deal of attention to the proper lighting of interiors with enclosed arc lamps, and as a result of the experience obtained in this line the following useful table has been compiled showing the watts per square foot required to give good lighting for various classes of work. These figures are given merely as suggestions, and a maximum and minimum figure has been given in each case to cover extremely good or particularly bad conditions. The average of the figures given will serve as a general guide. The figures are given in watts per square foot, and are sufficiently accurate for ordinary purposes for both alternating and direct current arc lamps suspended at the usual distance from the floor.

Watts per Square Foot for High-Class Arc Lighting.

Building.	Average conditions.	Variation.
Machine shops, high roofs, electrically-driven machinery, no belts	* ·75	* ·5 to 1
Machine shops, low roofs, belts, and other obstructions	1·	·75 to 1·25
Boot and shoe shops	·75	·5 to 1
Large drapery shops, light materials, bric-a-brac	1	·75 to 1·25
Large drapery shops, coloured material	1·25	1 to 1·5
Mill-lighting, plain white goods	1·1	·9 to 1·3
Mill-lighting, coloured goods, high looms	1·3	1·1 to 1·5
General office, no incandescents	1·5	1·25 to 1·75
Drawing offices	1·75	1·5 to 2

* Energy based on watts at lamp terminals.

Langdon-Davies Motor.

We have received from the Langdon-Davies Electric Motor Company, Limited, 101, Southwark-street, London, S.E., a set of their new lists, dealing with direct-current motors, alternate-current two-phase motors, and single-phase motors. One of the lists includes illustrations of the works in which the motors are manufactured, and of some of the uses to which they have been put. In this latter connection, a separate leaflet containing examples of costs of working, furnished by users of the firm's motors, is worthy of note. In most of these examples the purpose to which the power is applied is given, together with the brake horse-power of the motor or motors, average units consumed per week of a given number of hours, and the cost per week as shown by the bills paid.

Spiral-Filament Incandescent Lamps.

The lamp expert of the Mackey's Electrical Lamp Company, Limited, recently called to show us a new type of lamp which his firm are about to put on the market. The lamp in question had a round bulb, and the filament was in the form of a double spiral. A thin glass rod projecting upwards from the base of the lamp served as a support for the upper looped end of the

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double spiral filament, and, by holding it, prevented excessive vibration in the same. The advantage of this form of filament is that the distribution of light is much more suitable for all lamps which are hung vertically downwards. With the ordinary form of filament, as shown in Fig. 1, the nominal candle-power is given in a horizontal direction, and the distribution of light at other angles such as is shown in this illustration. Fig. 2 gives the distribution of light from one of these lamps with spiral filaments now being introduced by the Mackey Company. In this case it will be seen that the maximum candle-power is given in the direction of the point of the lamp, and hence on all pendants this lamp will give

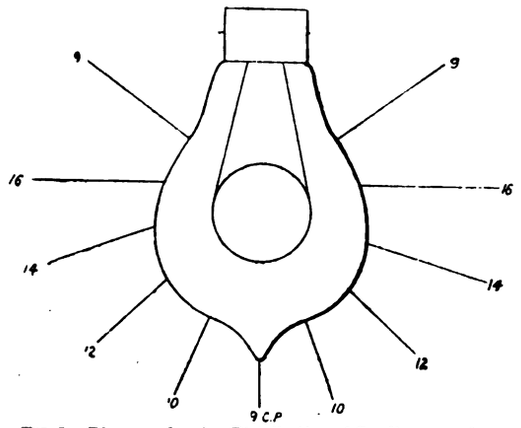

FIG. 1.—Diagram showing Distribution of Candle-power from Ordinary Filament.

more light vertically downwards. This curve (Fig. 2) is taken fom a report by Prof. Silvanus Thompson on a lamp which had a clear glass globe. From this report we gather that the lamp had a mean hemispherical candle-power of 14·62, but, as is seen from the curve, it produced 22·5 c.p. in the axial direction. The mean spherical candle-power of the lamp was 13·31. This independent test clearly shows the marked increase in the light in the axial direction due to the arrangement of the filament. Quite apart from the arrangement of this filament the new lamps will be of high efficiency, as they will be manufactured on lines dictated by long previous experience. It is claimed for these lamps that they largely do away with the need for a reflector. The best proof of this is to compare the light given

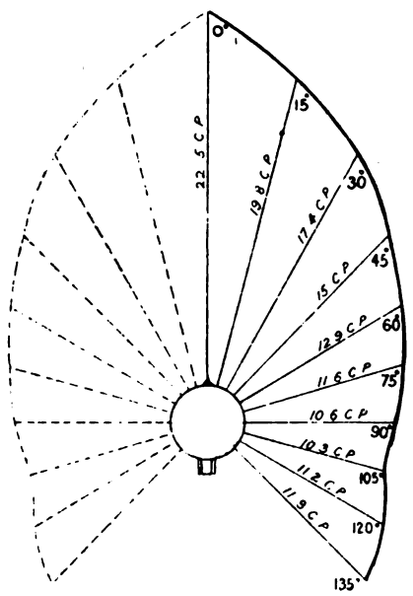

FIG. 2.—Polar Curve of Candle-power from a Spiral Filament Lamp.

on a writing table by one of these lamps without a reflector with that given by an ordinary lamp with a reflector over it.

The Union Electric Company, Limited.

The above company invited a number of electrical engineers to visit their showrooms at 151, Queen Victoria-street, on Wednesday and Thursday last week, in order to inspect a number of new arc lamps, electric motors, and other engineering appliances, which they are placing on the market. Through the courtesy of Mr. Justus Eck we were allowed a private view, which, although it deprived us of meeting the other friends of the company, afforded an opportunity of more close detailed examination. To deal with the electric motors first, the direct-current type are now standardised by the company for four different voltages—*i.e.*, 110, 220, 440, and 500. With this range practically every voltage in use on supply mains within the United Kingdom can be dealt with, and motors supplied from stock. If, however, the delivery is not urgent, it is usually advantageous to have a special winding on the field magnets if the voltage varies much from the above standards. To meet the varying views of consulting engineers, no less than seven different speeds are standardised for each motor frame. This combination in conjunction with the three main types—*i.e.*, open, semi-closed, and completely closed—renders the economical manufacture of electric motors no light matter.

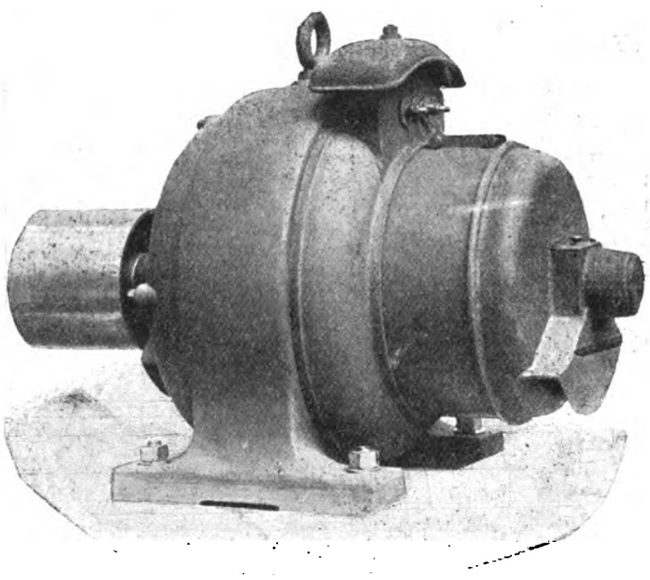

FIG. 1.—View of a Semi-Enclosed Motor by the Union Electric Co.

The difficulty, as far as the last three variants are concerned, is simplified by the Union Electric Company by the ingenious method of ventilating the semi-enclosed motors. This we illustrate in Fig. 1. The air for ventilating the interior of this motor is taken in at openings under the two bearings while the hot air is discharged from an opening under the hood, which is seen in front of the eye-bolt. In this way a good draught of air is ensured both over the commutator and through the armature. The natural inclination of the hot air to rise assists in keeping the armature cool, and it will be seen that the cold air is taken in at the lowest point of the case. The efficiency of cooling is such that the same size of frame, etc., will serve for both the open and semi-enclosed types. In all, except the smallest of these motors, the terminals are completely enclosed. Another feature in the motors is that of the design of the pole shoes. These are of laminated iron, and they are attached to brass rings, which go completely round the armature. In the two-pole machine these shoes are rotated in order to get the correct lead for the fixed brushes. As a rule, these motors are designed to have about 15 per cent. field regulation at normal volts. A new feature in the way of small arc lamps was on view at the same time, and one of these

FIG. 2.—Small-Current Arc Lamp.

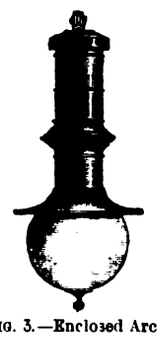

FIG. 3.—Enclosed Arc Lamp.

lamps is illustrated in Fig. 2. It consists of a small lamp, only 15in. over all, which will work most satisfactorily with two amperes. The lamp is of the enclosed type, and works with from 65 to 80 volts across the arc. In this way three lamps can be conveniently connected in series across 240-volt circuit. The white light from these lamps will render them of very great service for certain trades, such as jewellers, drapers, etc., and particularly in those establishments where large units of light cannot be employed. They are designed for both indoor and outdoor working. Fig. 3 is a view of the latest type of enclosed arc lamp manufactured by this firm, but the greatest novelty was their new type of flame lamp, a description of which we must reserve until our next issue. We need only add that anyone who has to design a lighting system for a large workshop or factory, will find the more opportunity of judgment between the relative advantages of the different

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arc lighting systems at the showrooms of the Union Electric Company than in most other places.

"Permiol."

The above is the name given to a new paint which is being introduced by the Permiol Manufacturing Company, Limited, Croft-street Works, Pendleton, Manchester. It is claimed that this paint does not contain any poison, such as is generally embodied in other paints, compared with which it is also 50 per cent. lighter volume for volume, and therefore any given weight or quantity will cover a much greater surface than ordinary paint. Further, that it possesses extraordinary acid-resisting qualities, and may be used with advantage for the protection of exposed metalwork, including trolley poles, etc.

KEIGHLEY ELECTRICITY UNDERTAKING.

Mr. J. M. Smyth, the borough electrical engineer of Keighley, has presented to his committee his report on the working of the electricity department for the past 12 months ended June 30, together with an abstract of the accounts. The capital account shows receipts amounting to £47,606, as against expenditure to the amount of £47,595. 19s. 10d., leaving a balance in hand of £10. 0s. 2d. There is still an amount of £1,015 for which borrowing powers have been acquired but not exercised. Following we give an abstract of the revenue account for the year under review.

Receipts.	£	s.	d.
Sale of current	1,413	13	7
Public lamps	480	0	0
Meter rents	85	0	3
Rents received from Low Bridge site	87	10	10
Sale of lamps and other apparatus	35	6	2
Sundries	0	11	0
	£2,102	1	10

Expenditure.			
Coal	269	19	2
Oil, waste, water, etc.	23	14	1
Wages at station	346	8	10
Repairs and maintenance (generation)	80	0	7
Repairs and maintenance (distribution)	36	8	5
Attending to public lamps	98	17	9
Interest to gas department for land	275	4	11
Rates and taxes	263	7	11
Salary of engineer	300	0	0
Salary of clerks	95	0	0
Stationery and printing	24	12	11
General establishment charges	83	3	7
Law charges	1	1	1
Insurances	20	0	0
Coronation illuminations	16	0	3
	£1,933	19	6

Thus the gross profit amounts to £168. 2s. 4d.

The net revenue account shows a total of £3,955. 1s. 8d. on the debtor side, and a total on the creditor side of £2,104. 9s., leaving a deficit on June 30, 1903, of £1,850. 12s. 8d. To ascertain the loss for the year the engineer brings down the above total of £3,955. 1s. 8d., and deducting the deficit (which is included) brought from last year's net revenue account of £1,559. 15s. 8d., and also deducting the gross profit from this year's revenue account of £168. 2s. 4d.—total, £1,727. 18s.—makes a loss for the year of £2,227. 3s. 8d. Again, the total loss from commencement of works to June 30, 1903, is £6,285. 6s. 1d. To set against this loss the sum of £4,434. 13s. 5d. has been provided in the general district rate, and the difference, amounting to £1,850. 12s. 8d., will be utilised from the sum of £3,206. 9s. 1d., provided in the present general district rate. This will leave £1,354. 16s. towards meeting the deficit of the current year.

In the following items the figures in brackets are for the year 1901-2: number of 8-c.p. lamps connected at end of year (motors, arc and incandescent lamps, equivalent in 8 c.p.), 9,446 (5,707); number of units sold—private lighting 53,196 (29,177), motors 45.147 (22,017), public lamps 39,378 (39,543), total 137,721 (90,737); maximum load on feeder cables in kilowatts, 120 (113); capacity of dynamos at end of year, 440 kw. (440 kw.); statutory maximum price per unit, 8d. (8d.); prices charged—private lighting 5d. (5d.); power 2½d. to 1¾d. (2½d. to 1¾d.); public lamps £20 per lamp per annum (£20 per lamp per annum); average price obtained per unit—private supply 3·46d. (3·39d.), public lamps 2·92d. (2·91d.); average price obtained on total revenue, 3·66d. (3·18d.); number of consumers on June 30, 133 (92); number of public lamps on June 30, 24 (24); number of motors on June 30, 37=123 h.p. (12=64 h.p.).

With regard to the revenue account, it is noticeable that there is a small gross profit of £168. 2s. 4d. this year instead of a deficit of £2461. 7s. as in 1901-2. The increase in the number of units sold is also noticeable, being equal to 51·8 per cent., and the increase in revenue is equal to 49·5 per cent., but there is only an increase of 4·75 per cent. in the working expenses. By this means a considerable reduction has been made in the works cost per unit sold. The receipts from the sale of electricity, however, are as yet much too small to pay all charges, including interest and sinking fund, and the net result for 1902-3 is a deficit of £2,227. 3s. 7d. There is no doubt, concludes Mr. Smyth, that the starting of the traction supply and an increased day load in the shape of motors will go far towards bringing the undertaking to the self-supporting stage, and it is advisable that every encouragement should be offered to motive power consumers.

SALFORD ELECTRICITY ACCOUNTS.

Below we give a full abstract of the accounts of the Salford Corporation electric lighting undertaking for the year ended March 31 last. The capital expenditure during the year amounted to £102,247.

Revenue Account.

Dr. Expenditure.	£	s.	d.
Generation of electricity—fuel, etc.	5,905	19	8
Oil, engine-room stores, etc.	1,058	7	1
Wages at generating station	2,440	5	1
Repairs and maintenance—buildings	580	10	11
Machinery, etc.	1,365	8	10
Distribution of electricity—salaries and wages	679	1	2
Commission on sales	45	1	1
Repairs of mains, transformers, meters, etc.	2,214	11	11
Change of voltage: lamps, switches, cables, wages, etc.	2,681	6	11
Repairing and trimming of public lamps	697	5	5
Rents	213	14	4
Rates and taxes, etc.	1,391	15	2
Management expenses—salaries	1,587	15	3
Printing, stationery, stamps, and advertising	581	19	6
Incidentals	260	8	2
Fees—procuration of loans	99	1	6
Travelling expenses	31	6	0
Special charges	42	15	6
	£21,876	13	6
Balance carried to credit of profit and loss account	24,044	10	2
	£45,921	3	8

Cr. Income.	£	s.	d.
Sale of current—general consumers	15,456	14	7
Tramway traction	28,086	19	0
Public lighting	1,544	0	4
Charges for lamps	1,088	3	2
Rental of meters	298	8	2
	46,474	5	3
Less discounts and allowances	1,254	6	9
	45,219	18	6
Motor hire, etc.	143	11	5
	45,363	9	11
Rent	180	0	0
Sale of scrap cable	377	13	9
	£45,921	3	8

Profit and Loss Account.

Dr. Expenditure.	£	s.	d.
Balance at debit, March 31, 1902	13,214	17	9
Interest on mortgage loans, less income tax	13,921	11	5
Interest on deposits	1	10	5
Instalment on principal—public works loan	194	0	0
Contributions to sinking fund	11,837	5	1
Bank interest (£729. 10s. 2d.), less transferred from redemption fund account (£245. 2s. 11d.)	484	7	3
	£39,653	11	11

Cr. Income.	£	s.	d.
District rate subsidy—deficiency at March 31, 1902	13,214	17	9
Surplus—gross profit for the year	24,044	10	2
Balance, March 31, 1903—deficiency to balance-sheet	2,394	4	0
	£39,653	11	11

Balance-Sheet.

Dr. Liabilities.	£	s.	d.
Mortgage loans	472,429	13	4
Sundry creditors—outstanding trade accounts	9,255	8	5
Due for interest on loans	2,834	6	6
Deposits for securing electric current	250	5	4
Balance due to the bank	12,993	1	4
Balance of assets	16,712	19	10
	£514,475	14	9

Cr. Assets.	£	s.	d.
Lands, buildings, and plant	242 054	2	1
Feeder cables and laying same, etc.	154,633	14	7
Consulting engineers' fees	3,833	7	9
Laying mains and services, etc.	63,551	11	9
Motors on hire	1,850	14	4
Transformers, etc.	2 690	16	6
Meters and ind cators; less depreciation, £1,076. 8s. 4d.	4,334	12	2
Electrical instruments, etc.	915	2	10
Stocks on hand	8,254	11	2
Sundry debtors	32,357	1	7
	£514,475	14	9

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PORTSMOUTH ELECTRIC LIGHTING ACCOUNTS.

Below we present abstracts of the above accounts for the year ending March 31 last, the capital expenditure on which date amounted to £218,446.

REVENUE ACCOUNT.

Dr. Expenditure.	£	s.	d.
Coal or other fuel	9,932	17	2
Oil, engine-room stores, etc.	1,021	16	2
Wages at generating station	1,561	9	9
Repairs and maintenance	2,378	9	11
	14,894	13	0
Less received for old material	45	18	1
	14,848	14	11
Repairs, etc., of mains	179	17	4
Repairs of transformers, meters, etc.	898	4	2
Repairs—distributing station	18	11	9
Attending and repairs of public lamps, etc.	1,532	13	4
Rents payable	13	8	0
Rates and taxes	1,059	16	7
alaries	1,737	0	5
Salary of collector	126	18	1
Stationery and printing	134	11	10
General establishment charges	416	13	9
Compensation, insurances, etc.	308	1	0
Bad debts written off (less amount provided last year)	31	13	0
New workshops account (less amount provided last year)	97	1	7
Total expenditure	21,203	5	9
Balance carried to net revenue account	14,079	2	0
	£35,282	7	9

Cr. Income.	£	s.	d.
Sale of current at 4½d., less allowances	28,128	7	10
Sale under contract	84	0	0
Public lighting	5,111	8	0
Slot meters	33	14	0
Rental of meters, etc.	1,417	10	9
Sale and repair of arc or incandescent lamps	67	2	0
Sale and repairs of other apparatus	329	4	6
Rents receivable	41	4	10
Part fees from pupils	6	5	0
Charging accumulators	13	7	2
Sale of ashes	50	3	8
	£35,282	7	9

GENERAL BALANCE-SHEET.

Dr. Liabilities.	£	s.	d.
Capital account, less amount repaid (£11,470. 17s. 1d.)	184,189	18	7
Amount advanced by treasurer, less amount repaid	22,138	6	0
Sundry creditors	2,683	16	7
Reserve fund account—balance at credit thereof	7,725	0	0
Amount due to treasurer on revenue account	3,465	16	10
Consumers' deposit account	387	14	3
Amount carried forward from revenue account	376	13	5
edemption account—mortgages repaid, etc.	12,117	16	4
	£233,085	2	0

Cr. Assets.	£	s.	d.
Capital account	218,446	0	11
Stores on hand	2,011	17	9
Motors in stock	1,781	0	8
Sundry debtors for current	10,619	18	6
Other debtors and unexpired insurances	226	4	2
	£233,085	2	0

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T. units			2,446,475
Quantity sold: Public lamps	439,876		
Quantity sold: By contract	1,580		1,998,307
Quantity sold: Private consumers by meter	1,547,851		
Quantity used on works			150,250
Quantity used for magnetising current			198,791
Quantity used for motor-generators			96,089
Total quantity accounted for			2,434,437
Quantity not accounted for			12,038
Total maximum supply demanded (kw.)			1,862

Number of public lamps: 264 arcs, 107 incandescents.

AYR CORPORATION TRAMWAYS.

Messrs. R. Craig and Fred. Coutts, the convener and manager of the Ayr Corporation tramways respectively, have presented to their committee their first annual report on the working of the tramway for the 12 months ended May 15 last. The following are some particulars of the year's running: cars miles run, 338,049; units used. 335,893; units per car mile, 1; cost per unit, 1·39d.; passengers carried, 3,201,586; average passengers per car mile, 9·52; times population carried, 100; working expenses per car mile, 5·04; total expenses per car mile, 9·01; traffic drawings per car mile, 9·83; total drawings per car mile, 10·11; average fare per passenger, 1·03; average number of miles run per car, 21,003. A large addition has, during the year, been made to the car-shed, accommodation for another eight cars having been provided, and a new store has been built, the old one being turned into a messroom for the men. The workshops have been removed into the new building, where a light overhead crane has been erected, and a large turning lathe suitable for turning the tyred wheels has also been added. During the year six cars and one combined water-car, snow-plough, and track cleaner have been added, so that there are now 16 double-decked cars—10 of the reversed staircase type, seated for 57, and six of the ordinary staircase type seated for 59, and one water-car. The paint work of all the cars was touched up and revarnished during the winter, and the whole equipment has been kept in first-class state of repair, six cars having been re-wheeled with tyred wheels, which have been found more suitable than the chilled wheels supplied with the cars. On May 19, 1902, the Burns Monument section, which measures 1 mile 5 furlongs 5 chains, was opened, giving a total mileage of 5 miles 5 furlongs 5·48 chains, of which 2 miles and 7·71 chains is double line; or in all, 7 miles 6 furlongs 3·19 chains if measured as single track. Up to the present very little has been done to the permanent way, but as several portions of the paving were showing signs of wear, three men have now been put on this work. The overhead construction has been kept in a good state of repair, and undergoes a most thorough and regular inspection, which accounts for the very few breakages in it, none of which have delayed traffic more than a few minutes or caused accident. The earliest workmen's cars to and from Prestwick are very poorly patronised in winter, but those running to the Monument have, on account of the construction of the Dunure and Maidens Light Railway, been bringing in a fair return all the year round.

Following we give an abstract of the accounts.

REVENUE ACCOUNT. Expenditure.	Per car mile.	£	s.	d.
Power expenses—electric energy	1·34	1,884	6	6
Traffic expenses—wages of motormen and conductors	1·42	1,997	4	10
Wages of inspectors	·12	170	17	0
Cleaning and oiling cars	·36	518	0	3
Lighting cars	·06	89	18	2
Cleaning, salting, and sanding track	·05	80	14	11
Fuel, power, light, and water for depôt	·07	102	15	1
Uniforms	·03	49	13	0
Miscellaneous	—	9	4	2
Tickets	·04	67	9	7
Hire of punches	·01	14	4	3
General expenses—salary	·16	229	3	4
Auditor's fees	·01	21	0	0
Chamberlain's fees	·01	25	0	0
Rent of office	·03	50	5	3
Wages of clerk's and office expenses	·08	118	2	6
Lighting public road	·03	43	8	9
Local taxes	·12	167	11	1
County taxes	·12	161	12	5
Property and income tax	·15	216	7	6
Licenses	·01	16	10	0
Printing and stationery	·05	74	3	5
Fuel and light for office	—	10	8	9
Legal expenses	—	1	6	6
Accident assurance (third party risk)	·09	125	0	2
Employers' liability assurance	—	8	13	0
Fire insurance	·01	15	17	9
Miscellaneous	·08	113	4	2
Repairs—track and roadway	·03	35	4	6
Electrical equipment of line	·05	61	13	10
Buildings	—	2	0	5
Workshops, tools, and sundry plant	·03	41	0	3
Cars—bodies	·49	148	13	5
Trucks		237	4	9
Electrical equipment		306	9	10
		£7,214	9	4
Balance carried to net revenue account		6,946	4	4
		£14,160	13	8

Revenue.	£	s.	d.
Traffic revenue—passengers	13,775	18	0
Special cars	17	19	5
Sundry revenue—parcels	31	10	11
Advertising	186	16	0
Rent of workmen's houses	36	6	10
Interest on deposit receipt uplifted	112	2	6
	£14,160	13	8

BALANCE-SHEET.

Liabilities.	£	s.	d.
Mortgage account	68,958	3	9
Reserve fund	1,781	14	10
Sinking fund	225	9	3
Surplus—contributions from revenue for instalments of mortgage debt repaid	824	12	4
	£71,790	0	2

Assets.	£	s.	d.
Capital account	70,887	0	11
Sinking fund on deposit receipt	225	9	3
Stock in hand	328	12	0
Balance due by bank on open account	348	18	0
	£71,790	0	2

The total capital expenditure to date amounts to £74,220.

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LEGAL INTELLIGENCE.

ACETYLENE GAS AND ELECTRIC SMELTING COMPANY.

In the Vacation Court last week before Mr. Justice Bucknill, Mr. Byrne moved, in the matter of the Acetylene Gas and Electric Smelting Company, Limited, on part of certain persons to rectify the register by removing their names.

Counsel said that the names of the persons on the part of whom he moved were inserted without any justification whatever. The company was carrying on business, and the applicants had been put upon the register, and, of course, responsibilities were being incurred. The company, he understood, did not now appear, but his clients had done all they could "to bring them up to the scratch."

His Lordship thought the applicants were entitled to the order.

Judgment accordingly.

THEFT OF ELECTRICITY.

On Saturday, at Marlborough-street, Léon Guerin, 36, and Louise Jones, 55, two French restaurant keepers, of 25, Frith-street, Soho, were charged with stealing electricity from the Metropolitan Electric Supply Company.

Mr. Muir stated that a man named Bonnet, the cook at the restaurant, asserted that Guerin used regularly to disconnect the wires passing through the meter and connect them outside the meter with another piece of wire, so that the electricity passed through the wires outside the meter and was not recorded. Bonnet made an appointment with the men from the prosecuting company, who saw the wire-tapping process by means of the added wire. Guerin had previously told one of their men that he had been an electrician on board a ship.

Andre Bonnet, the cook, corroborated counsel's statement.

Mr. Newton submitted on behalf of Jones that she was an uneducated woman of 55, ignorant of electricity and such modern inventions, and did not know what was being done.

Mr. Muir said there was no wish to press the charge against the woman.

Mr. Plowden thereupon discharged her, and committed the man for trial.

SPEED OF TRAMCARS.

At the West London Police Court on Friday, the third hearing of the adjourned summonses taken out by Mr. Moffat Ford against four drivers of electric tramcars in West London for exceeding the Board of Trade speed limit of 10 miles an hour, came before Mr. Rose. It was stated that the Board of Trade had now consented to nominate an independent expert, and that if the magistrate would adjourn the case until Oct. 31, the speed trials could take place before that date in time for the matter to be finally decided then.

Eventually the Court agreed to an adjournment till Oct. 31.

COMPANIES' MEETINGS AND REPORTS.

ELECTROLYTIC ALKALI.

The annual meeting of the shareholders in this Company was held at Liverpool on the 8th inst., Mr. C. C. Connor presiding.

The **Chairman** said the smallness of profit for the past year was accounted for by the conflict between foreign and English manufacturers of bleaching powder, resulting in a great depression of prices. He regretted that the results shown were not more satisfactory. The results, on the other hand, did not show any loss of capital, and on that circumstance they must be congratulated, considering the state of business. The small profit made was due to causes over which the directors had no control. From the beginning of the current year and probably during the greater part of last December they had very low prices for their bleaching powder in the market. The price which ruled now was probably below the cost of production, and therefore there were very good reasons for anticipating a rise in price. So far as the Company was concerned, the directors were taking every precaution in establishing improvements, pointing to more economy in production, and even if prices should not rise they certainly should not lose any money, and in all probability they would show a better profit next year.

The report was unanimously agreed to.

Mr. T. D. Owen moved that the vacancias on the directorate caused by the retirement of Messrs. J. A. Morice and William Thomson be not filled, and that the number of directors be reduced to six.

After discussion, the proposition was eventually carried by a large majority.

ULSTER ELECTRICAL POWER DISTRIBUTION.

A meeting of the shareholders in this Company was held at the registered office, 1, Lombard-street, when Mr. W. L. Preece, C.E., partner of Sir William Preece, K.C.B., whose firm, in conjunction with Mr. L. L. Macassey, are engineers to the scheme, was in attendance, and explained very fully as to the sites he had visited in Ulster for the proposed power and light stations at the intended distributing centres. As Mr. Preece will be engaged in Ulster on the scheme for the next week, it was decided to hold the next meeting of the Company at 8, Queen Anne's-gate, Westminster, on 21st inst., by which time it was expected Mr. Preece's preliminary survey would be completed. Progress was reported respecting the Bill to be laid before Parliament next session for the carrying out of the scheme.

KALGOORLIE ELECTRIC POWER AND LIGHTING.

The report of the directors for 1902 states that the plant was taken over from J. G. White and Co., Limited, the contractors, on Sept. 22, 1902, and the directors are pleased to state that its operation has been very satisfactory, and the reliability of the supply of power well demonstrated. Although power was supplied to the Kalgoorlie Electric Tramways, Limited, at an earlier date, the transmission lines to the mines were not in use until November, 1902. Despite the fact that only a few consumers were connected prior to Dec. 31, the difference between receipts and expenditure in Western Australia for the whole year is a debit of only £682. The units sold in October, 1902, were 62,000, while in July last 153,745 units were sold, each month between those dates, save one, showing an increase. From the many applications and enquiries received from probable consumers the directors had hoped to be in a position to state that all the power available had been contracted for, but regret that owing to the depression in the West Australian market for the past two or three years having caused many of the smaller mines, which were working at the time of the inauguration of the plant, to cease or curtail operations, and that the larger companies contend the price for power is somewhat high, less than one-half of the power available has so far been definitely sold. Negotiations are going on, and, as new contracts are constantly being made, it is expected the plant will be fully loaded within a few months. To enable an official quotation for the shares to be applied for, the Stock Exchange Committee require certain alterations to be made in the articles of association, and an extraordinary general meeting to follow the ordinary general meeting has been convened to give effect to the requirements. The directors recommend that the items charged to general expenditure during construction to Dec. 31, 1902, be carried to capital account.

NORWICH ELECTRIC TRAMWAYS.

The report of the directors for the year ended June 30 shows that the gross earnings of the Company amounted to £33,833. 8s. 7d., and the working expenses to £24,204. 14s. 1d., leaving a gross profit for the year amounting to £9,628. 14s. 6d. To this have to be added the amount brought forward from last year of £824. 3s. 5d. (after having paid 2 per cent. on Oct. 22, 1902, or £4,840 and placing to reserve account £974. 10s. 9d.) and £1,209. 16s. 7d., interest received from the Corporation in final settlement of account, making a total of £11,642. 14s. 6d. Deducting from this the sum of £2,640, being 4 per cent. interest on the Company's outstanding mortgage debentures to June 30, 1903, there remains a profit of £9,022. 14s. 6d. The directors recommend that a dividend of 2½ per cent. be paid on the Company's shares for the year ended June 30, 1903, which would absorb £6,600, and that a sum of £1,209. 16s. 7d. be placed to reserve account, the balance of £1,212. 17s. 11d. being carried forward. The reserve account will then be increased to £2,184. 7s. 4d. A comparison between the gross receipts for 11 months to June 30 and the receipts for the same period ending June 30, 1902, shows that there was an increase of £497. 15s. 4d., notwithstanding that the first months have shown a falling off of over £1,000. The working expenses for the same period show an increase of £699. 2s. 9d. The average cost per car mile was 5·43d. The average receipts per car mile were 7·76d. The number of car miles run was 1,045,901, and the number of passengers carried 7,173,420. Taking into consideration that the weather was again exceptionally bad during the spring and summer months, it is fairly satisfactory to think that the dividend can be increased, whilst the reserve is substantially increased and the balance to be carried forward is larger than last year. Both the permanent-way material and the track have been maintained in a state of satisfactory efficiency.

NEW COMPANIES REGISTERED.

Cross Electric Engineering and Manufacturing Company, Limited.—Capital, £4,000. Objects: To adopt an agreement with A. H. Sparks and W. F. Carter for the acquisition of the business carried on by them as manufacturing electricians, and to carry on the business of electricians, manufacturers of and dealers in all kinds of electrical machines, engines, instruments, and appliances. Registered office, 106, Murray-street, New North-road, Hoxton.

Hemsworth Electricity Supply Company, Limited (78,733).—Capital, £6,000. Objects: to acquire from the Rev. C. Leteux and G. Hodgson the benefit of a certain contract entered into by them (as trustees for this company) with R. J. Nicholson, and to carry on the business of electrical or mechanical engineers, etc. Registered office: 5, Bank-street, Hemsworth, near Wakefield, Yorkshire.

Blake-Morscher Electrical Ore Separator Syndicate, Limited (78,732).—Capital, £10,000. Objects: to adopt an agreement with H. C. Callahan, to investigate the validity of the patents and the efficiency of the process and mechanism therein referred to. Registered office: 20, Copthall-avenue, E.C.

APPOINTMENTS VACANT.

Cable Jointer, Erith, 45s., Oct. 24.

Shift Engineer, Reading, 36s. per week, Oct. 16.

Arc Lamp Trimmer, 30s. per week. See advertisement.

Switchboard Attendant, Fulham Borough Council, 25s., Oct. 23.

Assistant Electrical Engineer, Oldham Corporation, £100 per annum, Oct. 20.

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Clerk, Kirkcaldy Corporation Electricity Works, 30s. per week. See advertisement.

Lecturer, South-Western Polytechnic, Manresa-road, Chelsea, S.W., 12s. 6d. per night. See advertisement.

Distributing Assistant for the Poplar Borough Council. Salary, £120 per annum. Applications to Mr. L. Potts, Council's office, 117, High-street, by Oct. 17.

CONTRACTS FOR ELECTRICAL SUPPLIES.

Canterbury.—The Town Council invite tenders for electric cable.

Luton.—The Guardians invite tenders for lighting the new tramp wards by electricity.

Crewe.—The Town Council require tenders for wiring the proposed municipal buildings for electric light.

Nelson.—The Corporation invite tenders for a 400-kw. engine and dynamo, by Oct. 19. See advertisement.

Lisbon.—The Public Works Department require tenders for the public electric lighting of Macao. Tenders by Oct. 21.

Leeds.—The City Council invite tenders for one or two complete sets of steam or electrically-driven surface condensing plant. Tenders by Oct. 17.

Army Contracts.—A notice from the Secretary of State for War referring to tenders for annual supplies will be found in our advertisement columns.

Bray.—The Urban District Council invite tenders for jet condenser with steam-driven pump, to deal with 4,500lb. of exhaust steam per hour. Tender by Oct. 19.

Pietermaritzburg.—Tenders are invited by the Natal Government Railways Electrical Department for additional plant for the power station at Pietermaritzburg.

Dudley.—The Guardians invite tenders for the supply and fixing of the various appliances for the electric installation to the laundry and boiler house. See advertisement.

Swansea.—The Corporation invite tenders for the supply, delivery, fixing, and connecting of ducts, troughs, cables, wires, street boxes, etc. Tenders by Oct. 31. See advertisement.

Transvaal Colony.—The Chairman of the Tender Board, Pretoria, requires tenders for installing and working the electric lighting of Potchefstrom for about five years. Tenders by Oct. 30.

Munera.—The Municipality require tenders for installation and working of electric lighting. Particulars may be obtained from the Secretary of the Ayuntamento of Munera, province of Albacete, Spain. Tenders by Oct. 28.

London.—The Directors of the Metropolitan Railway Company invite tenders for the erection of a repairing shed and shops for electric rolling-stock at Neasden. Specifications, etc., after 5th inst. Tenders by 19th inst.

Kilmarnock.—The Electricity Committee have agreed to extend the time for receiving tenders for the bricklayer and mason's work in connection with the proposed new generating station tramcar shed at Kilmarnock until 21st inst.

Bridgend.—The Guardians invite tenders for wiring the workhouse. Specifications may be seen at the office of Mr. P. J. Thomas, architect, Bridgend. Tenders to Mr. R. Harmar Cox, clerk, Union Offices, Bridgend, before 17th inst.

Wolverhampton.—The Corporation invite tenders for the supply, delivery, and erection of surface condensing plant and oil separators, to deal with 15,000lb. of steam an hour. Tenders to Electrical Engineer, Commercial-road, by Oct. 19.

Kilmarnock.—The Corporation invite tenders for the supply, delivery, and erection of three Lancashire boilers, engines and dynamos, overhead hand travelling crane, storage battery, and switchboard, by Nov. 18. See advertisement.

Blackpool.—The Corporation invite tenders for the supply of arc lamp carbons for the ensuing year. Specification, etc., may be obtained on application to Mr. Charles Furness, borough electrical and tramway engineer, Electricity Works, Blackpool.

London, S.W.—The London County Council invite tenders for the supply, for one year from Jan. 1, of electrical fittings, etc. Forms of tender may be obtained on application to the Clerk of the Council (Stores Branch), 19, Charing Cross-road, W.C. Tenders by 26th inst.

Shanghai.—The French Colony propose to instal motor-propelled tramways. Tenders may be sent by Oct. 31, 1903, to Secrétariat de la Municipalité Française de Shanghai. Particulars may be obtained from l'Office National du Commerce Extérieur, Rue Feydeau, 3, Paris.

Devonport.—The Corporation invites tenders for the supply, delivery, and erection of a motor-driven booster. Specification may be obtained from the Borough Electrical Engineer, Newport-street, East Stonehouse, Devon. Tenders before noon on Oct. 24. See advertisement.

Russia.—The Russian Minister of the Interior has sanctioned a plan for the reconstruction of three lines of municipal tramways—namely, those in Newsky, Sadovaïa, and Wassiliostrow districts. Each car is to provide for two classes of travellers, and will accommodate 52 persons.

Todmorden.—The Corporation invite tenders for one Lancashire boiler, two steam dynamos and balancer booster, two feed pumps and one injector, economiser, surface or jet condenser, switchboard and instruments, storage battery, cable work, and overhead hand crane. See advertisement.

West Ham.—The London County Council invite tenders for the supply and erection of (a) engine, dynamo, switchboard, etc., and (b) electrical wiring, mains, and fittings required in connection with the installation of electric light at the Abbey Mills pumping station. Tenders by Nov. 3.

Leicester.—The Tramway Committee invite tenders for erection of two district car-sheds, offices, and all other buildings and works in connection therewith. Specifications, etc., may be obtained at the office of Mr. E. George Mawbey, M.I.C.E., Town Hall, Leicester. Tenders by 23rd inst.

Salford.—The Tramways Committee invite tenders for the installation of electric light at their central car depôt in Frederick-road, Pendleton. Specifications and plans may be obtained from the General Manager, Tramway Offices, 32, Blackfriars-street. Tenders by 5 p.m. on 19th inst.

Halifax.—The Tramways and Electricity Committee invite tenders for (a) 750-kw. continuous-current dynamo, driven direct by horizontal engine; (b) two 9ft. by 30ft. Lancashire boilers; (c) high-tension three-phase cable, etc. Tenders to Mr. Keighley Walton, town clerk, by Oct. 21.

East Barnet.—The Urban District Council will receive proposals for carrying out the provisions of their electric lighting order within the Council's district. Further particulars upon application to Mr. Henry York, the Council's surveyor, Council Offices, Station-road, New Barnet. See advertisement in last issue.

Johannesburg.—The Municipality require tenders for gas generating plant or for steam generating plant and for gas motors or steam motors, with electric generators and accessories. Particulars may be obtained from the Town Clerk, Johannesburg, or from Messrs Mordey and Dawbarn, 82, Victoria-street. Tenders by Oct. 19.

Aberdeen.—The City Parish Council invite tenders for electric light wiring, telephones, bells, etc., of new poorhouse to be built at Oldmill. Plans may be seen and schedule of quantities obtained at the offices of Messrs. Brown and Watt, 17, Union-terrace. Tenders to Mr. C. B. Williams, 20, Union-terrace, Aberdeen, by 12 noon on 19th inst.

Bradford.—The Guardians invite tenders for the electrical engineer's work for the erection of a hospital pavilion at the union workhouse, Horton-lane, Bradford. Specifications, etc., may be seen and bills of quantities obtained on application to Mr. Fred Holland, 11, Parkinson's-chambers, Hustlergate, Bradford. Tenders by 9 a.m. on 26th inst.

Leeds.—The Markets Committee invite tenders for an electric lift to the hotel. Specifications may be seen and bills of quantities obtained upon application to the architects, Messrs. Leeming and Leeming, FF.R.I.B.A., Victoria House, 117, Victoria-street, Westminster, S.W. Tenders to Mr. W. J. Jeeves, town clerk, Town Hall, Leeds, by 12 noon on Oct. 19.

Beckenham.—The Urban District Council invite tenders for the electric wiring of houses in their district under a free wiring scheme. Specifications, etc., may be obtained from the consulting engineer, Mr. Reginald P. Wilson, 66, Victoria-street, Westminster, or Mr. John A. Angell, surveyor, Council Offices, Beckenham. Tenders by 4 p.m. on Nov. 9. See advertisement.

Swansea.—The Corporation invite tenders for (1) laying of permanent way, including rail bonding; (2) rails and fishplates; (3) steel tiebars, bolts, and nuts; (4) points, crossings, cast-steel curved rails, and special work; (A) overhead electrical equipment; (B) ducts, troughs, cables, wires, section and other boxes, etc. Tenders by Oct. 31. See advertisement in previous issue.

Salford.—The Tramways Committee invite tenders for the supply and delivery of planing, turning, boring, drilling, grinding, milling, screwing, punching, and shearing, and wood-working machinery, power hammer, shafting motors, etc., at their central car depôt, Frederick-road, Pendleton. Specifications, etc., can be obtained from the General Manager, 32, Blackfriars-street, Salford. Tenders by Oct. 19.

Harrismith (South Africa).—The Town Council invite tenders for the following electrical machinery and accessories f.o.b. and alternatively erected in Harrismith, Orange River Colony, South Africa: two water-tube boilers and one 25-kw. and two 80-kw. steam alternators, with ejector condensers, switchboards, pipework, and other accessories. Specifications, etc., may be seen and obtained at the offices of Messrs. Mordey and Dawbarn, 82, Victoria-street, Westminster, S.W. Tenders to Messrs. Webster, Steel, and Co., 5, East-India-avenue, Leadenhall-street, London, E.C., by noon on 19th inst.

Great Western Railway.—The Directors invite tenders for the supply of telegraph instruments, telegraph apparatus, copper wire, G.P. wire, etc., telegraph ironwork and tools, telegraph drysalteries, electric light carbons, incandescent electric lamps, iron rivets, bolts and nuts, etc., fishplates, and bolts and nuts for permanent way, and telegraph poles and yellow pines, etc., from Dec. 1 next to Nov. 30, 1904. Samples, etc., may be seen from 6th to 15th inst., at the office of the Stores Superintendent, Swindon. Specifications, etc., may be obtained at the office of the Stores Superintendent. Tenders by 19th inst. to Mr. G. K. Mills, secretary, Paddington Station, London. See advertisement in last issue.

Bolivia.—The Director of Public Works to the Government of Bolivia is prepared to receive from British manufacturers, quotations, prices, catalogues, and printed matter, with discounts, shipping weights, &c., for the following materials: hydraulic power plant, piping, and turbines; alternating and direct current generators and motors; transformers and rotary converters; switchboards and measuring instruments; overhead trolley wire and fittings; third-rail insulators, plastic and copper bonds; hydraulic screw jacks and lifting tackle; contractor's plant and tools. All communications to

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Mr. T. Clive Sheppard, A.M.I.C.E., director-general of public works, general manager of the Guaqui to La Paz Railway, La Paz, Bolivia, and sent by registered post either via New York or by Royal Mail steamers (West India route) via Panama and Mollendo (Peru).

RESULTS OF TENDERS.

Gravesend.—The Council have accepted the tender of the British Westinghouse Company for a generating set at £994.

Derby.—The tender of Messrs. Newton Bros., at £307. 17s., has been accepted for electric wiring the Reginald-street baths.

Wolverhampton.—The Corporation have accepted the tender of Mr. Herbert Holloway, of Wolverhampton, for the construction of the permanent way for the proposed extensions at £33,964. 11s.

Birkenhead.—The Corporation have accepted the tender of John Parry, 92, Oxton-road, Birkenhead, for cleaning and painting the poles and bracket arms in connection with the Corporation electric tramways.

Manchester.—Royce, Limited, Hulme, Manchester, have received the contract for lighting the premises of Messrs. I. J. and G. Cooper, Limited, Dale-street, Manchester. The installation will consist of 1,139 incandescent lights and 12 arc lamps.

Horsham.—The Urban District Council have accepted the following tenders: Wheeler Condensing Company £1,095, for the erection of a condensing plant and cooling tower at the electricity works; Johnson and Phillips (approximately), £2,800, for cables for the extensions to the electric mains and laying feeders and certain distributors.

Liverpool.—The tender of the Wheeler Condensing and Engineering Company, 179, Queen Victoria-street, London, for the supply of condensing plant required for the first section of the new station at Lister-drive, for the sum of £11 975, has been recommended for acceptance, subject to the approval of final plans and specifications, and to a contract to be prepared by the town clerk.

Rochdale.—The Guardians have accepted the tender of the Henley Telegraph Company for alterations and additions to the existing switchboard and new cables in connection with the electric light at Dearnley Workhouse, subject to the consulting engineers being satisfied as to the sub-contractor for the switchboard work; also that the Local Government Board be asked to sanction a loan to meet the cost of the work.

Fulham.—The Council have accepted the following tenders: Locket and Judkins for a supply of 1,000 tons of Welsh coal (No. 1 Locket steam Navigation nuts) at 14s. 11d. per ton, and Charrington, Sells, Dale, and Co. for the supply of 2,000 tons of Shirebrook double-screened nuts at 13s. 5d. per ton; the Hardy Pick Company for the supply and erection of a clinker crushing and sifting machine for the sum of £675, subject to the work being carried out under the supervision and to the satisfaction of the borough electrical engineer; Windsor and Co. for construction of sub-stations at £520.

Aston Manor.—The Urban District Council have received the following tenders for the complete overhead equipment of about five miles of tramways in the district:

Dick, Kerr, and Co., Limited	£5,155	14	6
Brush Electrical Engineering Company, Limited, (accepted)	4,742	10	7
R. W. Blackwell and Co., Limited	5,225	0	0
G. Law (amended)	6,333	16	0
G. Trentham (amended)	5,819	4	6
F. W. Smith and Co., Limited	5,321	5	7

London, S.W.—The following tenders have been received for the wiring of the new hall of the Royal Horticultural Society in Vincent-square, S.W.:

National Electric Construction Company (accepted)	£777	17	7
G. E. Taylor and Co.	810	0	0
R. Dawson and Co.	810	0	0
Drake and Gorham	854	0	0
Strode and Co.	867	0	0
Buchannan and Curwen	1,080	0	0
D. Watson and Co.	1,106	0	0
Pearson and Co.	1,175	0	0
Marryat and Place	1,337	0	0

Engineer's estimate, £790.

Bootle.—The Corporation have received the following tenders for the extension of the boiler-house at the electric light station, Pinegrove:

Contract No. 1.

J. and G. Chappell	£1,085	16	0
J. Riddock (accepted)	1,033	0	0
W. Musker	1,175	0	0
Hughes and Stirling	1,140	0	0
S. Webster	1,301	0	0
J. Townson and Co.	1,279	7	8
Wellman Bros.	1,165	13	4
P. McKinley	1,306	8	7
P. Tyson	1,149	14	5
G. Woods and Son	1,211	6	11

Contract No. 2.

J. and G. Chappell	1,237	0	0
J. Riddock (accepted)	1,231	0	0
W. Musker	1,225	0	0
Hughes and Stirling	1,220	0	0
S. Webster	1,300	0	0
G. Woods and Son	1,350	0	0
J. Paterson and Son	1,366	0	0
S. Fowler	1,350	0	0
Holme and Green	1,404	0	0

Swindon.—The tender of Mr. A. J. Colborne, at £3,233 17s. has been accepted for the erection of the car depôt stores, shops, etc.; also that of J. G. White and Co., Limited, for the construction of the permanent way for the tramways. Rails of British manufacture are to be supplied at an additional cost of 4s. per ton, making a total additional cost of £138.

BUSINESS NOTES.

TRACTION.

Ayr.—The Corporation are raising a loan of £12,000 for tramway purposes.

Maidstone.—Plans for the proposed light railway have been approved by the Urban District Council.

Sunderland.—Plans have been accepted for the proposed new tramway offices, which are to cost £5,000.

Salford.—The construction of the remaining lines of tramways in the Eccles borough is to proceeded with at once.

Rochdale.—At their last meeting the Town Council sealed the contract for cars with the Brush Electrical Engineering Company.

Dover.—An early meeting of the Town Council is to be called to consider the question of instituting ½d. fares on the tramcars in the evenings.

Thornhill.—The tramways company have informed the District Council that they cannot see their way to institute ½d. fares on the tramcars.

Spen Valley.—The electric cars commenced running on the Gomersal and Birkenshaw section of the Spen Valley tramway system this week.

Devonport.—The Board of Trade have appointed an inspector, but a day has not yet been fixed for the inspection of the tramway extensions.

Scarborough.—The contractors for the laying down of the tramways in the town (Edmundson's Electricity Corporation) have now commenced the work.

Leicester.—The first section of the new electric tramways will be opened for traffic within a week or two. It extends between Victoria Park-road and Queen's-road.

Warrington.—At the next meeting of the Town Council it will be proposed to proceed with the construction of tramway No. 7 from the termination of tramway No. 6.

Perth.—The question of appointing an engineer to advise the Corporation on the question of the tramway reconstruction will be discussed at the next meeting of the Council.

Gosport.—The preparation of the plans for the reconstruction of the existing tramlines is proceeding, and no time will be lost when everything is ready in making a start.

Leeds.—Some 245 electric tramcars are run at present on the Corporation system. It is proposed to purchase more cars in order to meet the growing demands of the traffic.

Blackburn.—The tramway extension from Witton to Cherry Tree has been formally passed by the Board of Trade inspector, Major Druitt, R.E., and opened for public traffic.

Manchester.—The Corporation will promote a Bill in the next parliamentary session for powers to carry out extensions and other works in connection with the tramway system.

Johnstone.—Operations are to be begun next month for the construction of the tramways. Promise is made that the line will be opened about the end of May next or in June.

St. Marylebone.—The Legal and Parliamentary Committee recommend the Borough Council to adhere to their previous decision against the construction of a surface tramway in Edgware-road.

Morley.—Plans of the proposed tramways in the town, promoted by the British Electric Traction Company, are in an advanced state, and will soon be submitted to the Council for their approval.

Lastingham.—The Board of Trade have confirmed the Lastingham and Rosedale Light Railway (Extension of Time) Order, 1903, amending the Lastingham and Rosedale Light Railway Order, 1900.

Cardiff.—Application is to be made to the Board of Trade to allow increased speeds on the tramways. The question of ordering new cars for next summer's traffic has been referred to a sub-committee.

Erith.—The District Council have engaged Messrs. Hawtayne and Zeden to act as consulting electrical engineers in relation to the scheme of tramways for which parliamentary sanction has been obtained.

Walsall.—The Town Council have agreed to spend £2,345 on laying down new junction lines at Pleck Junction in order to facilitate interchange of traffic between the Corporation and the company's lines.

Bere Alston.—The Light Railway Commissioners have submitted to the Board of Trade for confirmation an order made by them amending the Bere Alston and Calstock Light Railway Order, 1900.

Railway Electrification.—The conversion of the Manchester South Junction and Altrincham Railway from steam to electric traction is under the consideration of the directors. An enquiry into the cost of such a scheme is being made.

Belfast.—The City Council have approved the scheme for the purchase and electrification of the tramway system at an expenditure of nearly £1,000,000. At a special meeting on Tuesday arrangements were made for promoting the necessary Bill in the next session.

Dartford.—The Board of Trade have confirmed the Dartford District Light Railways Order, 1903, authorising the construction of light railways in Kent, from the River Thames near Greenhithe to

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Dartford and Eynsford, with branches to Swanley Junction and to Stansted.

Lowestoft.—Reports on the working of the tramways continue to be eminently satisfactory. The Council have agreed to refer to the Tramway Committee the suggestion that arrangements should be made to enable the children of the borough to travel to school at half fare.

Torquay.—The Town Council have definitely decided in favour of tramways, but have not committed themselves to anything further than to approve in principle the Dolter surface-contact system. The company owning this system intend to apply for parliamentary powers next session.

Kirkcaldy.—In view of the extension of the tramway system, the Tramway and Electric Lighting Committee are purchasing an additional seven cars. The car-shed is to be extended and another 500-h.p. generating set put down at the generating station, costing in all £9,800.

Heckmondwike.—At the last meeting of the Chamber of Commerce a letter, in reply to a request from the last meeting for halfpenny fares, was read from the managing director of the Yorkshire (Woollen District) Tramways stating that for the present they had no intention of making any change.

Crewe.—Heads of agreement have been drawn up between the Town Council and the promoters of the light railway scheme. The ratepayers, however, have decided by an emphatic vote that if a scheme of tramways is to be provided for Crewe, the Council shall undertake it in preference to a private company.

Heywood.—At the monthly meeting of the Town Council the Tramways Committee reported that they had considered the suggested modification of the proposals for leasing the tramways to the Bury Corporation, and had decided that they could not recommend any modification of the terms originally agreed to. Negotiations have been broken off.

Leith.—The Tramways Committee of the Town Council have resolved to inspect the existing tramway system in the burgh and the routes upon which extension is proposed, with the view of incorporating in the provisional order to be promoted by the Corporation next session a clause giving the Council power to work the tramways instead of leasing them to a company.

Penarth.—A joint meeting of the Glamorgan and Cardiff County Councils and the Penarth Urban District Council has been held, at which Mr. Harpur (Cardiff borough engineer), Mr. Ellis (electrical engineer and manager), and Mr. Evans (engineer to the Penarth Council) were asked to prepare an estimate of the cost of the scheme for a tramway between Cardiff and Penarth.

Islington—The Borough Council propose to call a conference of representatives from each borough affected by the proposed reconstruction of the London County Council's northern tramways for electrical traction, together with their respective town clerks and borough engineers, to consider the question of the system of traction to be adopted with a view to united action being taken in the matter.

Worcester.—Complaint having been received of delay in laying down the lines for the electric trams, the Streets Committee have agreed to insist upon a strict observation of the law regarding the construction of the tramways and light railways, and intend to force compliance therewith, The city engineer is to be directed to see that the resolution is complied with, and to report any breaches thereof.

Greenock.—The arbitrator in the dispute between the Corporation and the tramway company with regard to the point of time from which a charge for the supply of electricity for traction purposes should be made, and also to the price to be paid for a supply above 500,000 units, has given his decision. It has not yet been made public, but it is understood to be against the Corporation on nearly every point.

Musselburgh—It was intimated to the Town Council at this week's meeting that the engineers of the electric tramway scheme had nearly completed the details and estimates had been prepared. There was a remote chance of a start being made this month. The promoters were to fix upon a power-station site within a day or two, and there was to be a considerably greater extent of double lines than was proposed under the old agreement.

Plymouth.—Application is to be made for power to construct a light railway to Crownhill, also for a tramway through Garden-street from Ebrington-street to Tavistock-road and a tramway from the Caprera Hotel to the boundary of the borough near North-road Station. An application will soon be made for sanction to borrow £1,300 for the alteration of the tramways in Old Town-street, consequent upon the street improvements.

Derby.—In connection with the electrification of the tramways, the committee have arranged for Messrs. J. and G. White, Limited, to fix bonds of rails at 9d. each instead of the work being done by the Corporation themselves. With reference to the contract which has been placed for foreign rails, it was stated at the last meeting of the Town Council that they would have had to pay £1,200 more for English rails, and the committee felt they would not be justified in doing so.

Aberdeen.—A further extension of the electric tramway system was inaugurated on Saturday with the opening of a line to Torry, which has now become a thickly-populated suburb of the city. The new line passes along South Market-street from Guild-street, and crosses Victoria Bridge, which spans the River Dee. The extension has not yet been passed by the Board of Trade, but the members of the Town Council went over the route on Saturday, and the service of cars was afterwards started.

Yarmouth.—The statement of accounts for the year ended June 30, 1903, shows that the traffic revenue has been £7,584; advertising, £152; total receipts, £7,736; traffic expenses, £2,286; power, £1,244; general, £923; repairs, £607; total working expenses, £5,760; interest and sinking fund, £1,960; total expenditure, £7,720; balance on the year's working, £16. The by-laws are to be so amended as to enable cars to take up additional passengers in wet weather and on exceptional occasions.

Newcastle.—The Tramways Committee recommend the Council to apply to Parliament in the next session for the necessary power to enable them to construct a tramway on Benton Bank-road, and to purchase the land for widening the road, as recommended by the city engineer. The estimated cost of the work is £9,010. On Wednesday a special meeting of the Town Council agreed to apply for powers to extend their tramway service on the outskirts of the city, and also to Blaydon, which is two miles distant. The estimated cost is £296,000.

Ashton.—Lieut.-Colonel von Donop has inspected the tramways in the town. According to the present arrangements the Ashton Corporation cars will not be run for some time on the Manchester-road length, as the city cars will be sufficiently numerous. Ashton will take the receipts within the borough, and pay the working expenses. In connection with the settlement with Stalybridge, the cost per car mile has been worked out at 8d. The length of track from the boundary at Cockbrook to the Stalybridge Town Hall is threequarters of a mile.

Middlesbrough.—Another conference has been held of representatives of the Middlesbrough Corporation, the Urban District Council of Ormesby, and the Urban District Council of Normanby, at which Mr. Robert Hammond attended, and, as requested, reported on a scheme for the authorities concerned undertaking themselves the proposed very considerable tramway extensions. The conference decided that, having fully considered the scheme set forth in the report, it was a practicable one, and recommended the Councils represented to adopt the same.

Carlisle.—The tramways company propose to institute a parcels delivery service in connection with the tramways. The company are prepared to accept the offer of the Corporation to supply electrical energy for traction purposes at a uniform charge of 1·6d. per unit in consideration of the company running a 10 minutes' service of cars throughout the year, provided the Corporation reduce the minimum of units to be taken from 350,000 to 300,000 per annum. The General Purposes Committee, however, will recommend the Council not to amend the terms as suggested.

Additional Traffic Returns.—Anglo-Argentine, £2,564 increase; Barcelona Ensanche y Gracia, £137 increase; Barcelona, unchanged; Brisbane, £74 increase (month of August, £11,736, increase £294); British Columbia Electric (month of March), gross earnings £10,352, net income £2,659; Buenos Ayres and Belgrano Electric, £634 increase (month of September, £13,793, increase £1,317); Calcutta, £428 increase; Cape Town (month of September) receipts £15,174, expenditure £8,503; Isle of Thanet Electric, £25 decrease; Mexico Electric (month of August), receipts £48,600, expenses £27,900; Perth Electric, £169 increase; Port Elizabeth (month of September), receipts £3,730, expenditure £2,767.

Pemberton.—With reference to the tramway reconstruction, the electrical engineer reported at the last meeting of the District Council that during the month good progress had been made with the electrical equipment in Ormskirk-road, the whole of the poles having been planted, all span wires erected, and the trolley run out and finished off as far as the section box at Union Bridge. Fairly good progress has also been made with the track work in Warrington-road, but the wet weather had been very much against this work. The new engines had not yet been under steam, owing to non-delivery of branch pipes from main ring to engines, but as there was no immediate hurry for this he was not pushing the makers.

Edinburgh.—At a meeting of the Tramway Committee of the Town Council last week a report was submitted by Provost Mackie and Mr. James More, C.E., the Council's expert, on the system in operation on the London County Council's tramways at Kennington, by which electrically-equipped cars are taken over the cable lines. This, it was said, would be a feasible arrangement between Edinburgh and Leith. Probably the above report was made out in ignorance of the decision which the London County Council have arrived at to abandon the present practice of taking the electric cars over the cable system for the reasons explained in our last issue. In view of the great trouble and inconvenience the arrangement has resulted in in London, we should not advise Edinburgh to try the experiment.

Jarrow.—At the last meeting of the Town Council the Town Clerk read a letter from Dr. Spence Watson, stating that if the Tyneside Tramways Company failed to come to terms for an exchange of traffic with the Newcastle Corporation, they would be prepared to go to Parliament for running powers. A letter was also read from the Board of Trade, in answer to one from the Council, drawing attention to the danger to the public at level crossings in connection with the electrification of the North-Eastern Railway Company's branch line, to the effect that the responsibility lay with the North-Eastern Railway Company, and they had no doubt that the company would acknowledge its liability. The railway company, in a letter upon the same subject, promised to do all that was necessary to protect the public.

Tramway Contracts.—We are informed that Edgar Allen and Co., Limited, of the Imperial Steelworks and Yorkshire Steel and Engineering Works, Sheffield, have secured, through the contractor (Mr. George Law, of Kidderminster), the contract for the supply of the whole of the cast-steel points and crossings and special work required in the reconstruction of the Gloucester Corporation tramways. They have also secured, through the contractors (Messrs. William Griffiths and Co., Limited), the contract for points and crossings and special work for the Worcester Corporation tramways, and from the British Electric Traction Company, Limited, the contract for points and crossings and special work for the reconstruction of the Birming-

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ham and Midland Tramways. All the Worcester and Birmingham and Midland points are fitted with Allen's Imperial manganese steel tongues.

Yorkshire Electric Tramways.—The *Financial News* says the prospectus is in private circulation in connection with the arrangements for the placing of the capital of the Yorkshire Electric Tramways Construction Syndicate, Limited, formed to acquire certain orders of the Light Railway Commissioners and tramway orders of the Board of Trade for the construction of light railways and tramways in Yorkshire. The capital of the company is £280,000, consisting of 10,000 ordinary shares of £10 each and 180 preference shares of the rather unusual denomination of £1,000 each. The directors are Mr. H. S. Leon, of 5, Throgmorton-street, and the Stock Exchange, Mr. Albert G. Kitching, and Mr. Ernest Schenk. The bankers are Messrs. Glyn, Mills, Currie, and Co. in London, and Messrs. Beckett and Co. in Yorkshire; and the solicitors are Messrs. Ashurst, Morris, Crisp and Co.

North Wales.—A large gathering of Flintshire gentlemen was held at Chester on Wednesday to confer with regard to the application to Parliament during the coming session for powers to construct an electric tramway connecting the districts of Bagillt, Greenfield, Holywell, Halkyn, Northop, Mold, Buckley, Sandicroft, Queensferry, Shotton, and Connahs Quay The tramways will be worked on the overhead trolley system, and the route, which extends about 30 miles, and serves a district with a population of about 34,000, is circular. The cost of the scheme is estimated at £9,600 per mile. It is proposed to erect a generating station in the area, but not if electrical power can be obtained from a generating station which is to be erected by the North-Western Electricity and Power Gas Company, which was incorporated by Act of Parliament during last session. It was decided to issue a prospectus.

Camberwell.—At this week's meeting of the Borough Council the Works Committee reported that the trenches made by the London County Council during the work of reconstruction of the tramways for electrical traction in Camberwell New-road, Church-street, Peckham-road, High-street, Queen's-road, and Old Kent-road have been repaired in a very unsatisfactory manner, and that the condition of the roadways in many places is a serious source of danger to the traffic. The borough engineer has made several representations to the engineers of the London County Council without effect. Plaster casts of some of the worst portions of the roadways have been prepared and submitted by the borough engineer. The committee, being of opinion that the matter was of an urgent nature, have written to the London County Council requesting that immediate steps be taken to reinstate these roadways to the satisfaction of the borough engineer.

Portsmouth.—At a meeting of the Tramways Committee on Tuesday, the provision of covered cars was again discussed, but no decision was arrived at. It was felt that something should be done to obviate the nuisance caused by the flooding of the lines, and consequent dislocation of the traffic, and the chairman and vice-chairman were appointed to call on the borough surveyor with regard to the matter. The committee had also before it the introduction of automatic points, which would do away with the point boys, but no decision was arrived at. It was felt that the sinking of a well at the power station would effect a considerable saving. The water company's charges last year amounted to £77. The matter was referred to a sub-committee to consider and report. It is stated that the Tramways Committee have refused to arrange through fares with the Horndean Light Railway, and that in consequence an interesting innovation will take place. The joint railway companies are arranging to run motor trains from Portsmouth to Cosham, branching off thence to the Horndean light railway. This will ensure a speedy through service from between Horndean and Portsmouth entirely independent of the borough tramways system.

Motor Omnibuses in London.—Speculation has for some time been rife as to the non-appearance on the London streets of the service of electric omnibuses which was promised by the London General Omnibus Company some time ago. The reason for the delay appears to be a conflict with both the police authorities and the Local Government Board—the former because the new vehicles are said to exceed the prescribed height and width, and the latter on account of the regulation that locomotives on the highways weighing over two tons must not exceed a speed of five miles an hour. The first difficulty could probably have been amicably and satisfactorily settled but for the intervention of the Whitehall authority on the score of weight. To this suggestion the company urge several strong objections, one being that it is impossible to build a motor omnibus of less than two tons that would be remunerative to the shareholders. The vehicle with which experiments have been made weighs nearly five tons. Another obstacle is the speed question. The limitation to five miles an hour is looked upon as altogether unreasonable, and one likely to lead to police interference for obstruction sooner or later. There at present the whole question rests, and we shall be interested to hear the sequel.

Bolton.—At the last meeting of the Tramways Committee applications for the position of assistant general inspector were received and considered, and the following were reserved for further consideration: Messrs. G. M. Atkinson, W. B. Ball, J. Burney, T. Edwards, C. Fowler, J. Hindle, F. Hartshorne, R. Salkeld, Wm. Smith, and W. Smith, all of Bolton. The committee then resolved that the services of Mr. C. C. Howard as traffic manager and otherwise under the department be determined on Nov. 11 next. It was resolved that the report submitted of the special sub-committee as to the general management of the tramways be approved and adopted. This stated that subject to the control and directions from time to time of the Tramways Committee and the Council the chief care and management of the premises, rolling-stock, electrical equipment, etc., should be entrusted to an officer to be termed the general manager, who should have the chief conduct, charge, and responsibility of all arrangements for the proper working of the tramways and traffic and control all officers and servants. For the performance of these duties the general manager is to have, and be subject to, such advice and services as might be reasonably requisite from the electrical engineer and the borough engineer. The commencing salary of the general manager is placed at £500. The borough electrical engineer will act as consulting engineer and general adviser to the tramways department.

Huddersfield.—Below we are able to give some interesting particulars of the revenue from the tramways undertaking for the six months ended Sept. 30 last, compared with the corresponding period of last year. The capital outlay to date amounts to £410,953. The total receipts for the period under review amounted to £34,672, or 9·97d. per car mile, compared with 11·00d. last year. The miles run were 834,160, as against 626,031 in the corresponding six months. In giving the following items of expenditure, the figures in brackets show the cost in pence per car mile last year: Maintenance and repairs—rolling-stock, £3,067. 4s. 4d., or ·88 per car mile (·91); engines and boilers, £302. 8s. 8d., ·09 (·11); overhead equipment, £325. 8s. 9d., ·09 (·09); generation of electricity, £1,598. 19s. 8d., ·46 (·46)—total, £5,294. 1s. 5d., 1·52 (1·57). Traffic—motormen, conductors, etc., £8,096. 3s., 2·33 (2·42); oil, sand, etc., £573. 11s. 9d., ·17 (·16); uniforms, £385. 3s. 1d., ·11 (·06)—total, £9,054. 17s. 10d., 2·61 (2·64). Maintenance of works—total, £88. 19s. 3d., ·02 (·03). Maintenance of ways—total, £1,240. 5s. 9d., ·35 (·25). Management—total, £727. 4s., ·21 (·28). Rents and taxes—total, £950, ·28 (·36). Miscellaneous—£501. 15s. 1d., ·15 (·24); insurance (proportion), £567. 18s. 4d., ·16 (·17)—total working expenditure, £18,425. 1s. 8d., 5·30 (5·54); gross surplus, £16,247. 11s. 4d., 4·67 (5·46). Interest on debt, £7,772. 7s. 6d., 2·24 (2·44); redemption of debt, £5,561, 1·60 (1·71)—total, £13,333. 7s. 6d., 3·84 (4·15); surplus, £2,914. 3s. 10d., ·83 (1·31). Following we give a comparison of the working costs per car mile of the tramways undertakings in several of the large towns: Huddersfield, 5·30d.; Blackpool and Fleetwood Company, 7·34d.; Coventry, 6 53d.; Dublin, 5·45d.; Isle of Thanet Company, 6·85d.; Aberdeen, 6·14d.; Blackpool, 8·94d.; Bolton, 7·06d.; Burnley, 8·72d.; Dundee, 7·00d.; East Ham, 7·20d.; Halifax, 9·68d.; Liverpool, 7·13d.; Nottingham, 6·90d.; Rochdale, 7·67d.; Sheffield, 7·24d.; Southampton, 7·90d.; Southport, 6·44d.; Sunderland, 6·49d.

Paris Metropolitan.—The Paris correspondent of the *Financial Times* says: "According to all reports, the issue of £1,000,000 fresh stock in the Paris Metropolitan Railway Company has not proceeded so satisfactorily as might have been expected. So far as can be gathered, the shareholders have taken full advantage of their privilege to subscribe the new issue, but, on the other hand, there has been no rush on the part of the investing public to purchase 'Metro' shares on the Bourse for the purpose of being able to subscribe to the new issue, which, be it recollected, was entirely reserved for existing shareholders in the company. Now, as the 'Metro' shares are quoted at a considerable premium, it naturally follows that those who have been able to subscribe to the new issue will have made a very profitable deal, seeing that the new shares are offered at par. The absence of any rush to purchase stock on the part of the investing public who are not already shareholders in the company must evidently be a source of considerable disappointment to the promoters of the company, at the head of whom is the well-known Belgian financier, M. Empain. The fact is that the issue, following as it does on the recent disaster, and on the mass of criticism to which the company has been subjected in the Press, could not have taken place at a more unfavourable period. . . . It is fully anticipated that the total cost of the Metropolitan system, when completed, . . . will reach in round figures £20,000,000. The full mileage of the system when complete will be 46¼ miles. Of this mileage about 12 miles were open to traffic in 1902, over which 62,122,000 passengers were carried. Calculating at this rate, the total number of passengers to be carried over the entire system, when complete, would be 328,000,000 per annum. M. Felix Roussel, who was entrusted with the preparation of the municipal report on the Metropolitan Railway scheme, calculated that when complete not less than 352,000,000 passengers would be carried over the system annually. At the lower figure, however, the proportion of the receipts accruing to the city would be £740,000 per annum, or considerably more than sufficient to cover the interest on the loans contracted."

Bournemouth.—The manager has presented to his committee his report on the working of the tramways undertaking for the year ended July 22 last. During the period under review, the total working expenses have amounted to £17,336. 7s. 11d., equivalent to 6·58d. per car mile run. This sum is exclusive of income tax and repayment of loan and interest on same. The receipts from traffic have amounted to £34,232. 0s. 7d., equivalent to 13·00d. per car mile, while receipts from other sources have brought the total up to £35,096. 10s. 11d., equivalent to 13·33d. per car mile. The balance—namely, £17,760. 3s.—equivalent to 6·75d. per car mile, remains to meet income tax, repayment of loan and interest thereon, and to be set aside as reserve and depreciation fund, or for such other purpose as may be decided upon. The above working expenses are equivalent to about 49·39 per cent. of the income. This is a very low figure, which the manager is afraid will not be touched again, since renewals have, in some cases, been carried out at the contractors' expense. The total number of passengers carried has been 5,969,418, the average receipts per passenger being 1·37d., and the total number of car miles run has been 631,885. During the year there has been a freedom from serious accidents. The total number of accidents of all kinds has amounted to 239, being made up of collisions with other vehicles, 145; accidents to persons, 81; miscellaneous, 13. This means that for 2,644 car miles one accident has occurred, while for each 1,000,000 passengers 13 persons have met with accidents, many of which were of a very trifling nature. Following are some of the principal items of income

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and expenditure: generation—salaries and wages, £1,033. 1s.; coal and other fuel, £2,932. 6s. 8d.; gas and water, £253. 0s. 6d.; running—salaries and wages, £7,004. 1s. 11½d.; cleaning, £964. 17s. 7d.; oiling, £230. 19s. 7d.; gas, £108. 8s. 3d.; stationery, printing, etc., £1,031. 19s. 6d.; rates (not yet proportioned); maintenance and repairs—general, £1,116. 8s. 5d.; overhead system, £365. 11s. 7d.; conduit system, £589. 15s. 1½d. Total traffic receipts, £34,232. 0s. 7d.; miles run, overhead system, 518,319·99; conduit system, 113,565·72—total, 631,885·71; average receipts from traffic per car mile, 13·00d.; passengers carried, 5,969,418; average receipts per passenger carried, 1·37d.; units generated for traction, 760,300; street-lighting, 64 961; station and shed, 12,227—total, 837,488; average units used per car mile run, 1·20.

Darlington.—Prof. A. B. W. Kennedy has presented to the Tramways Committee a report on the alleged defective cement packing in the construction of the tramway track. The report reads as follows: "In company with your sub-committee, my own engineers, and Mr. Connett, the engineer of Messrs. J. G. White and Co., I examined three portions of the work, one which has been laid for 10 weeks, one for five weeks, and one for 10 days. In each case we had a rail moved so that we could examine the material below it and at the side of it. The packing below the rails was in every case satisfactory, and in the 10 weeks' old work it was thoroughly hard. In the five weeks' old work it had fairly begun to set, but was not hard; in the new work it had excellent surface, but was still quite soft. The concrete in the margins, which I also examined, had hardly begun to set in the 10 days' work, and even in the 10 weeks' work it was still very little set, so that large pieces could easily be broken by hand. From various indications which I mentioned to your committee, I have come to the conclusion that the cement used (which I may say had been repeatedly tested, and had been up to the specified quality) was of an exceptionally slow-setting kind, but there is every indication that the setting will be complete before the time when the tramways are opened, and in that case the work will be none the worse for the setting having been slow. At the same time the extreme slowness of setting is a distinct inconvenience, and I have given instructions that another make of cement, which will set more quickly, is to be used, and this is being done. Since I met your committee I have received from the steelworks manager to Messrs. Bolckow, Vaughan, and Co. a letter about Casebourne's cement, which is extensively used at Bolckow, Vaughan, and Co.'s works, which I am glad to say corroborates my view of the matter. Mr. Richards gives various particulars, but the whole matter is summed up in his words, 'Very slow setting, but sets hard enough if given plenty of time.' In any case, as I explained to your committee, the contractors have full responsibility for the nature of the work, and have to maintain it for a year after it is taken over, and if any defects show themselves, either due to the slowness of setting or any other cause, the contractors are responsible and will have to make them good at whatever cost." Current is to be supplied to the tramways at 1½d. per unit.

London County Council.—At Tuesday's meeting of the London County Council the Highways Committee reported that the reconstruction of the New Cross and Greenwich, etc., sections of the London County Council tramways was approaching completion, and so soon as the working of these lines by electrical power was commenced it would be possible to clear the remainder of the site at Greenwich required for the erection of the second portion of the generating station, as the use of the stabling premises now on the site could then be discontinued. The Council on July 20, 1902, approved an estimate to cover the cost of the first portion of the station, and contracts had been let for a part of this work. It was important that the erection of the remainder of the station should not be unnecessarily delayed, as the second portion of the building would be required in connection with the electrical working of some of the tramway extensions in the south as well as of a portion of the Council's (northern) tramways. They suggested, therefore, that they should be authorised to arrange for trial holes to be dug on the site, and for the drawings, specifications, estimates, etc., of the second portion of the station to be prepared. The necessary expenditure for this purpose would not, it was estimated, exceed £2,000. They recommended that the estimate of £2,000 be approved. The same committee presented the following report with reference to the northern trams: "The Council on July 7 last authorised us to prepare plans, specifications, and estimates of cost for the reconstruction for the underground system of electrical traction of various sections of its northern tramways, and the construction of certain authorised lines in connection therewith, the total length of the old and lines referred to being about 52 miles of single track. It appears to us to be desirable that the reconstruction of those sections which can be worked independently with through services of cars should be put in hand with as little delay as possible. We are advised that the following lines can be most conveniently dealt with in the first instance—namely: (*a*) Theobald's-road terminus, *via* Clerkenwell-road, Old-street, Great Eastern-street, Commercial-street, and Leman-street, to near the London Docks; (*b*) Norton Folgate terminus, *via* Shoreditch, Kingsland-road, High street, and Stoke Newington-road, to Stamford Hill; (*c*) Aldgate terminus, *via* Commercial-road, Commercial-road East, and East India Dock-road, to Poplar; (*d*) Moorgate-street terminus, *via* Finsbury-pavement and City-road, to junction with Old-street; (*e*) Holborn terminus, *via* Gray's-inn-road, to junction with Theobald's-road; and (*f*) along Old-street between Great Eastern-street and Shoreditch. The first three of the routes above indicated are of considerable length, and in conjunction with the others form several main tramway routes on which through services can be run. Should our proposal be adopted by the Council, the first effective steps will be taken towards the establishment of through services of electrical cars on the Council's (northern) tramways. The length of the tramways which we propose shall be first dealt with is about 22 miles of single line, and it will be practicable for the whole of these to be worked from the Greenwich electricity generating station. If the reconstruction of these lines be proceeded with at once, it will, probably, be possible to work them by electrical power immediately the generating station is ready, and this is a consideration of great importance in view of the advantage which will accrue from the introduction of electrical in place of horse traction in the crowded thoroughfares affected. We are not yet in a position to present estimates of the cost of the work, as trial holes will have to be made at certain points along the routes, in order to determine the depth available for the tramway conduits over railway and canal bridges, and the position of pipes, wires, and other obstructions under the carriageway; but so soon as the necessary preliminary investigations shall have been completed, we will report fully on the matter. The cost of making the borings referred to is estimated at £600, and we have to ask the Council to sanction this expenditure, for which we have requested the Finance Committee to submit an estimate. We recommend that the estimate of £600, submitted by the Finance Committee be approved; and that expenditure on capital account of that amount be sanctioned for carrying out the necessary preliminary investigations in connection with the reconstruction, for electrical traction, of the first portions of the Council's (northern) tramways." An interesting report was brought up showing the results of recent proceedings taken against drivers of vehicles for wilfully obstructing the tramcars. From June 4 to Sept. 3 no less than 18 proceedings of this character were taken, and it may be judged that the Council are justified in their action from the fact that convictions were obtained in every case but one. The Highways Committee intend to bring up reports on the subject from time to time. In a further report the Highways Committee asked for authority to spend £30,500 on the construction, for the conduit system of electric traction, of the tramway authorised by the 1900 Act, along St. John-street and St. John-street-road, to join the existing tramways in High-street, Islington.

Wolverhampton.—At this week's meeting of the Town Council a long discussion took place on the Tramways Committee's recommendation that the remaining tramway routes in the town should be equipped on the Lorain surface-contact system, and eventually this was agreed to. The committee presented a long report on the subject, from which we take the following extracts: "The committee, as a whole, met and fully considered the question of communication with the outlying districts, with a view to thoroughly and definitely settling the matter. The routes to be dealt with are (*a*) Dudley-road; (*b*) Willenhall-road; (*c*) Wednesfield-road; (*d*) Waterloo-road. . . . With respect to these routes your committee instructed the borough electrical engineer to present figures which would show the comparative costs of equipping the lines, either on the Lorain surface-contact or the overhead system. . . . In addition to these figures, your committee had to consider, when coming to a decision as to which system to recommend to the Council, the following points: (1) the fact that the Council had already decided on the Lorain system for the Tettenhall, New Hampton-road, and Bilston-road lines; (2) the question of a break of communication at the borough boundaries should the Lorain system be generally adopted; (3) the difficulties of operating a dual system within one area; (4) in case the overhead system should be adopted, the necessity of equipping either Piper's-row and Bilston-street with the overhead system, in addition to the existing Lorain system, or else the expense of fitting all overhead cars with skate attachment; and also (5) (though common to both systems) the question of whether single or double track should be laid down along the routes to be constructed. After thoroughly considering all these questions your committee came to the conclusion, with but three dissentients, that the system to be adopted on the routes *a*, *b*, *c*, and *d* must be the Lorain system, and accordingly recommendations to this effect appear later on in this report. But your committee felt that they should also give in this report reasons for the conclusion at which they had arrived, and also make specific recommendations with regard to the question of double or single track and as to the order in which the work of construction should be carried out. The most important objections to the Lorain system hitherto urged have been (1) the cost, and (2) the break in communication at the borough boundaries. First, with regard to the cost, reference should be made to the detailed comparative statement of the borough electrical engineer, which shows the difference in capital cost and annual expenditure between the two systems, but this system, although it received due consideration from the committee, was largely overweighted by the fact that the Council had decided upon the Lorain system upon the Tettenhall, New Hampton-road, and Bilston-road routes, and consequently new factors had been introduced into the situation which would materially affect this monetary difference. [The comparative statement referred to shows the following figures: Dudley-road double line, cost of construction £19,812, or £2,691 in excess of the overhead system, and annual maintenance £1,773, or £296 in excess of overhead; Waterloo-road double, cost £15,378, or £1,684 in excess of overhead, and annual maintenance £1,397, more than overhead £126; Wednesfield-road to Heath Town, single, cost £12,882, or £956 in excess of overhead, and annual maintenance £1,421, or £102 in excess of overhead; Willenhall-road, single, cost £19,214, or £665 in excess of overhead, and annual maintenance £2,062, or £165 more than overhead. The total capital expenditure on the extensions is estimated at £60,000.] The decision of the Council operated adversely to the overhead system being introduced into the borough, inasmuch as the borough electrical engineer advises that should that system be adopted on any route within the town, it would entail the necessity of either equipping Piper's-row and Bilston-street with the overhead system, in addition to the existing Lorain system, or else the expense of fitting overhead cars with skate attachment. For, unless the cars were made interchangeable, additional spare cars would have to be kept in the sheds to meet an emergency, in excess of what would be necessary if the undertaking were worked on one system. Besides this, there would be the many and important objections to the working of a dual system within one area of

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control, and which are dealt with more fully in the borough tramways manager's report, which is also appended hereto. Again, preferential treatment would be accorded to the better-class roads and streets of the town to the detriment of the inhabitants living in the poorer districts, were the overhead system to be laid down in any part of the borough after the Lorain system had been adopted for the Tettenhall, New Hampton, and Bilston roads. On the other hand, should the Lorain system be adopted throughout, the necessity for the cars carrying two equipments, which would add materially to the amount of electric energy required to drive them, and the unsightliness and danger of the poles in some of the most important and crowded streets in the borough would be disposed of. Taking all these facts into consideration, your committee came to the conclusion that the difference in capital cost and annual expenditure between the two systems would be outweighed by the advantages to be gained by the maintenance of one, and only one, system, and that the only possible policy is to extend the Lorain system throughout the borough. Secondly, with respect to the question of break in communication at the borough boundaries, your committee had to consider whether the inconvenience of changing cars was such a serious drawback as to involve laying down the overhead system, especially considering the fact that the Corporation have no power to run outside the lines specified in the Wolverhampton Corporation Act, 1899. This question could only apply to the Dudley-road and Willenhall-road routes. In settling the point, your committee had to guide them the fact that on the Bilston-road the break in through communication has had no serious effects, as has been practically tested by the traffic returns, which have steadily increased. For instance, the increase of passengers carried during the month of August this year was 26,849 (equivalent to £192. 14s. 7d.), as compared with the same month last year, during the existence of the exhibition, as is shown in the following table:

	Car miles run.	Receipts. £ s. d.	Receipts per car mile.	No. of passengers carried.
August, 1903.....	9,799	485 8 6	11·89	97,096
August, 1902.....	6,487	292 13 11	10 83	70,247
Increase	3,312	192 14 7	1·06	26,849

To this argument should be added the important fact that it lies with the outside districts alone to determine that there shall always be an overhead car to meet a Wolverhampton car at the boundary, so as to minimise to the greatest extent possible the inconvenience consequent upon a change from one car to another. It is equally open to the outlying districts to bring pressure on the British Electric Traction Company to run through cars into Wolverhampton from Dudley, Bilston, and Willenhall. This would be quite possible in view of the fact that the Corporation some time ago made an offer to the company which would permit them to run through cars into Wolverhampton (by affixing skate attachments) upon terms to be agreed upon, and, failing agreement, by reference to the Board of Trade, such terms acknowledging two broad principles—viz., that the Corporation must absolutely control its own traffic; and, secondly, that they should take all earnings within the borough. Any other arrangement, by which a competitive system would exist, would be prejudicial to the financial interests of the undertaking. It may be mentioned that shelters will be provided at the termini of the respective boundaries. Should the Council adopt the resolutions contained in this report, your committee would then be open to receive proposals from the company under the offer before alluded to, and to make such arrangements as might be found practicable and suitable. But, even if the company do not avail themselves of their power in this direction, your committee feel that the inconvenience of changing from car to car is not so great, especially if the two systems run in conjunction with one another, as to involve the adoption of the overhead system, and the consequent extra expense and innumerable difficulties. Therefore, your committee decided that, from this point of view also, they must advise the Council in favour of the Lorain system. There only remains the question of single or double track to be dealt with. Here your committee have deemed it rather a question of engineering possibilities rather than from the point of view of policy. For instance, in the Waterloo-road and Stafford-road, although your committee would rather have recommended that a double line of track should be laid down the whole distance, and although a double line was scheduled in the Wolverhampton Corporation Act, 1899, they were confronted with the initial difficulty that, under part of the route over which a double track was projected, the gas company's 24in. and 16in. mains are laid side by side, and the company's rights are protected under Section 38 of the Tramways Act, 1870. Again, on the Dudley-road and Willenhall-road routes the thoroughfare is so narrow in places that much cost would be involved in buying property for widening, or failing such widening, great risk of danger and inconvenience would be incurred, and more delay would arise on double than on single lines. It should be pointed out that any alterations in track from the plans deposited to the Corporation Act, 1899, require the approval of the Board of Trade, and where there is a less distance than 9ft. 6in. between the kerb of the footway and the edge of the outer rail, the consent of the frontagers. It may be mentioned that when the routes *a*, *b*, *c*, and *d* are ready for traffic the additional cars required to work them can be housed—and this whether they be on the Lorain or overhead system—by building an additional bay, as and when required, on to the existing car-shed at a cost of about £4,000. Your committee, therefore, have to make the following recommendations: (1) That the Lorain surface-contact system be adopted on the following tramway routes—viz., Dudley-road, Willenhall-road, Wednesfield-road, and Waterloo-road. [Memo.: Your committee are very anxious that the Wednesfield-road line should be extended to Wednesfield. It appears, however, that while such extension would only be a mile in extent, it would be necessary to obtain statutory powers. If the Council are of opinion that this step should be taken, your committee are willing to act in that direction. It appears that the Board of Trade do not grant provisional orders to local authorities for the extension of tramways outside their area, but the Corporation would have to proceed by way of a private Bill.] (2) That the tenders of Mr. Herbert Holloway, of Wolverhampton, for the construction of the permanent way on the above routes at the following sums be accepted—viz.: Dudley-road, £11,582. 10s.; Willenhall-road, £8,700; Wednesfield-road, £7,482. 1s.; Waterloo-road, £6,200. (3) That the plans now submitted by the borough engineer showing the above routes, and where it is intended to have single and double tracks respectively, be approved. (4) That the consent of the Board of Trade be obtained where necessary to any alterations made under the authority of Section 28 of the Wolverhampton Corporation Act, 1899, and that the town clerk be empowered to apply for such consent, and to give all necessary notices to frontagers if required, and to obtain their consents if and when necessary. (5) That the routes above mentioned be equipped with the said system in accordance with the prices scheduled, to and the terms contained in the contract between the Corporation and the Lorain Steel Company dated July 26, 1901, subject, however, to such variation and modification as may be agreed upon between the Corporation and the company; and that the said routes be constructed and equipped in the following order—namely, (*a*) Dudley-road, (*b*) Willenhall-road, (*c*) Wednesfield-road, (*d*) Waterloo-road. (6) That the Finance Committee be requested to raise all requisite moneys in such manner as they deem most advisable, and, if necessary, to raise Wolverhampton Corporation stock, for the purpose of defraying the costs, charges, and expenses of the works referred to in the foregoing recommendations. (7) That the town clerk be, and he is hereby, authorised to prepare the necessary contracts with the contractors of the permanent way and electrical equipment respectively, and also with Callender's Cable and Construction Company, Limited (so far as the Waterloo-road track is concerned), and that the corporate seal be affixed as and when required." The following is a report prepared by Mr. W. A. Luntley, the tramways manager. It runs: "In my opinion, the introduction of a dual system of tramways in a town the size of Wolverhampton would lead to many difficulties, as, unless we kept a good number of spare cars for each system, we could not properly cope with the traffic on holidays or special times, such as bank holidays, race meetings, football matches, flower shows, etc. As an example, take a race meeting (of which I understand six, occupying 13 days, are now held annually), when we should require the greatest possible number of cars, we could not take one car (or perhaps two) off all the other roads during the rush in order to deal with the traffic, which could be done if one system only were in operation, and consequently it would mean either robbing one or two roads of nearly all the cars for a time (which would certainly be unwise), or let the traffic go by default. Again, take a bank holiday. It is almost impossible to tell in what direction the majority of the people will travel; consequently, if the cars were not interchangeable, it may be that we could not do justice to the heaviest traffic, on account of the cars we could spare on a certain route not being suited to the system of another road where they would be required. Also, on such days as these, there would be a big through traffic, say from Willenhall-road, or Wednesfield, to Tettenhall, or maybe the racecourse, and, if a dual system is in operation, passengers would have to change cars in town. Of course, in the foregoing remarks I have only taken special days, but it must be remembered that such times will materially assist the tramway receipts here if properly looked after. On ordinary days, when traffic is normal, such inconveniences of working might not occur with a usual allowance of spare cars for each system." A ratepayers' meeting has passed a resolution strongly condemning the extension of the Lorain system to other parts of the town.

LIGHTING AND GENERAL.

Kingswinford.—The electric lighting has been started.

Buckfastleigh.—The electric lighting was started on the 1st inst.

Elland.—It is expected that the electric current will be turned on by Oct. 17.

Sale of Plant.—Particulars of a sale of complete electric lighting plant appear in another column.

Southport.—The Electricity Committee have decided to discontinue the practice of supplying fittings.

Hereford.—The Town Council intend to apply for sanction to borrow £1,000 for electric lighting extensions.

Wolverhampton.—The Council propose to undertake the electric lighting of private houses on the free wiring system.

Pemberton.—The total units generated during the month of August were 15,001, and the total sold 11,250—a percentage of 75.

West Bromwich.—An enquiry is to be held into the Town Council's sanction to borrow £12,217 for electric lighting purposes.

Llandilo.—An enquiry has been held into the District Council's application for sanction to borrow £1,508 for additional electric plant.

Pontypridd.—The Reading Town Council are lending the Urban District Council £2,000 for purposes of electricity and tramway undertakings.

Carrickfergus.—The Urban District Council are in communication with the Belfast and North-East Ireland Electricity and Power Gas Company.

Leeds.—The Corporation electric works have increased their outpu of current during the past 12 months to an extent equivalent to 40,000 8-c.p. lamps.

Grantham.—The Mayor (Mr. William Hornsby, J.P., D.L.), i the presence of a large company, last week formally opened the electricity works.

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Farnham.—The Sir Hiram Maxim Electrical and Engineering Company have withdrawn their intention to apply for powers to supply the district.

Indo-European Telegraph Co.—The directors have declared an interim dividend for the half-year ended June 30 last at the rate of 5 per cent. per annum.

North Shields.—A failure, now rectified, we understand, of the electric light has caused much inconvenience at North Shields and Tynemouth during the past few days.

Chesterton.—The Cambridge Electric Supply Company have informed the Council that a cable will be laid in a month. The standard pressure had been fixed at 200 volts.

Stourbridge.—The Council on Wednesday decided to adopt Mr. J. B. Clarke's electric lighting scheme. Application is to be made for sanction to borrow £16,000, and Mr. Clarke is to act as engineer.

Weybridge.—The rector and churchwardens have issued a circular letter inviting subscriptions to meet the estimated expenditure of £170 for carrying out a system of electric lighting in the parish church.

Woodhouse.—The Council have decided to apply on or before Dec. 21 for a provisional order to authorise the Council to supply electricity for public and private purposes within the urban district.

Bootle.—With regard to the loan of £40,000 for electric lighting purposes, the Local Government Board have sanctioned the borrowing of £38,750, but have requested further particulars with reference to the balance.

Antony.—The town clerk of Devonport has informed the Parish Council that the Corporation would consider any proposal for the supply of electricity for lighting when they had obtained the necessary power to supply it.

Manchester.—Owing to the failure of the electric power many hotels and other buildings were in darkness in Manchester for about half an hour late on Saturday night, and the tramcar service was temporarily suspended.

East Barnet.—Several special meetings of the Council have been held, at which the subject of electric lighting was discussed. Letters from Finchley District Council are before the Electric Lighting Committee for consideration.

Tonbridge.—The resident engineer in his last report states that 13 applications for light (570 lights) had been received since the last meeting. The total number of applications to date was 85, with a demand of 2,965 8-c.p. lamps.

Bridgend.—The amended specifications of the architect for the lighting of the workhouse with electricity provide for six 32-c.p., 69 16-c.p., and 50 8-c.p. lights, with 112 switches. Tenders for the installation of the light will be advertised for.

Consett.—At the last meeting of the Urban District Council the Chairman said he expected to be able to make a definite statement respecting electric lighting next month, and he fully believed that by next season the district would be lit up by electricity.

Gravesend.—Sanction has been received to borrow £9,102 for electricity works and £53 for dust destructor. These figures include the cost of the new generating set necessary to supply current for the workmen's trams, and for which such trams are waiting.

Kensington.—Notices have been received relative to proposed extension of mains from the Kensington and Knightsbridge Electric Lighting Company, the Notting Hill Electric Lighting Company, and the Brompton and Kensington Electricity Supply Company.

Fulham.—The Council have adopted, on the recommendation of the borough electrical engineer, a scheme for replacing the electrical fittings in the town hall, as follows: large hall, £70; corridors and cloakrooms, £67. 10s.; small hall, £56. 4s. 4d.; offices, £20.

Cardiff.—The instruction given to the electrical engineer to proceed with the electric lighting of Woodville-road and Splott-road as far as Walker-road as soon as possible has been referred back to committee, pending the receipt of the engineer's report on the whole scheme.

Lowestoft.—Sanction has been received to a loan of £2,000 for purposes of electric lighting, repayable, with reference to the £1,000 for the provision of the cables, in 30 years; and with reference to the £1,000 for the provision of meters, indicators, etc., in 10 years.

Cheltenham.—The Lighting Committee are on the first six months £150 below half of the estimated expenditure for the year. Most of the items included in the proposed additional loan of £4,000 for electric lighting extensions have already been approved by the Council.

Sheffield.—The proposed electric street-lighting in the neighbourhood of the Penistone-road destructor is not to be proceeded with. The spare steam from the destructor was to be utilised for this purpose. The superintendent has been instructed to report in what other way the steam should be utilised.

Middlesbrough.—The revenue derived from the Corporation's electrical undertaking during the last month was £645, against £571 in the corresponding month last year, and the cost £369 against £248. The electrical engineer, Mr. Taylor, has been instructed to prepare specifications for extending the plant at the electric lighting station.

Crook.—The Urban District Council have accepted an offer from Messrs. Pease and Partners to provide eight additional lights, with wires, poles, and lamps, all complete, and fix the same in such positions as the Council may direct, and to supply current for lighting at the rate of 35s. per year for each 16-c.p. lamp in operation, and 45s. per year for each 32-c.p. lamp.

Camberwell.—The County of London and Brush Provincial Electric Lighting Company, Limited, are about to commence the execution of the following works: laying electrical conduits along the side of Tyrrell-road from Barry-road to the end of Tyrrell-road, also across Tyrrell-road at end of road, in each case one 2in. low-tension pipe, and construction of a transformer box in Burbage-road.

Barton.—At the last meeting of the Guardians it was stated that, comparing the cost of gas lighting with the cost of the electric light installed a year ago, a saving was effected of about £40 per annum. By extending the electric lighting to the old infirmary a further sum of £30 per annum would be saved. The Electric Lighting Sub-Committee were instructed to report on the matter.

Dublin.—Mr. P. C. Cowan, chief engineering inspector of the Local Government Board, is holding a protracted enquiry into an application of the Corporation for loans of £48,000 and £8,238. 17s. for the purpose of defraying extra expenditure in connection with the electric lighting scheme for the city. This amount includes expenditure for carrying out wood paving, asphalting, and concreting works. There is a further application for £28,500 for electrical works in the Clontarf district.

Stafford.—The electricity output for August shows a decrease of 36·8 per cent., and for September a decrease of 27·9 per cent. But if the supply which one firm took last year, and which has now ceased, is left out of the reckoning, it will be seen that the private consumers show an increase of about 30·17 per cent., which must be considered satisfactory. With regard to the provisional order an enquiry is to be held, after which the advisability of extending the cables will be considered.

Ballymoney.—Messrs. Rowcliffe and Co., Westminster, have informed the Council that it is their intention to apply on behalf of a syndicate for powers to erect electricity and power gas generating stations and lay mains for the supply of electricity and power gas through the manufacturing portions of the counties of Antrim, Down, Armagh, and Londonderry, and asking the help and co-operation of the Council. It was decided not to oppose the syndicate in their undertaking.

Epsom.—The Rural District Council have agreed to favourably consider the application of the Surrey Electrical Power Distribution Company for consent to the granting of a provisional order to supply electrical energy in the parishes of Cheam, Cuddington, and Ewell on the basis of the Wallington order, the company undertaking to make the same terms as regarded the price of electrical energy supplied to private consumers and for public lighting as they had made with the Sutton Council.

Bermondsey.—The Borough Council have resolved to issue a standing order that the electrical engineer make such conversions of gas lamps to electrical lamps in the side streets as the extension of the distributing mains will allow. The following new charges have been adopted for power supply: 2d. per unit up to 10,000 units per annum, 1¾d. per unit between 10,000 and 20,000, 1½d. per unit between 20,000 and 30,000, and for quantities over 30,000 units a special rate would be quoted on application.

Aberdeen Poorhouse.—Mr. J. E. Marr, 29, Union-street, Aberdeen, has been recommended as the consulting engineer in connection with the installation of the electric light at the new poorhouse. It has been decided to place four groups of three 16-c.p. lamps in the main approach to the poorhouse; two of three 16-c.p. lamps in the north entrance; three of three 16-c.p. lamps in the east avenue around the children's block; and three of three 16-c.p. lamps in the avenue leading from the main approach to the hospital.

Spalding.—At the last meeting of the Urban District Council the question of electric lighting was discussed. A private company intend to apply for an electricity supply provisional order, and the Council were advised they could not successfully resist the application unless they applied for a provisional order themselves. The Council, however, as the owner of the gasworks did not wish to do this, and they also objected to a private company installing the electric light. Eventually the whole matter was referred to the Gas Committee.

Malton.—The Urban District Council are in trouble with the Northern Counties Electricity Supply Company, with whom they have practically an agreement for the lighting of the district. The latest grievance is that the company propose to place their generating station outside the area, and the Council object probably because they might later on have difficulty in buying the same. The Council endeavoured to induce the Board of Trade to force the company to place the works within the area, but could get no redress from that quarter.

Stock Exchange Settlements.—The Stock Exchange Committee have appointed Oct. 21 special settling day for Oriental Telephone and Electric Company, Limited, 50,000 6 per cent. cumulative preference shares of £1 each, fully paid, Nos. 1 to 50,000, and have ordered the said securities to be quoted in the official list. Application has been made to the committee to appoint a special settling day in and to grant a quotation to Charing Cross and Strand Electricity Supply Corporation, Limited, 40,000 "City Undertaking" 4½ per cent. cumulative preference shares (1903) of £5 each, fully paid.

Gloucester Electrical Exhibition.—An electrical exhibition will be held on Nov. 16, 17, 18, and 19 in the Guildhall. We learn that the exhibition will include primarily: (1) any device which can be used for the purpose of consuming or carrying current, or any fitting connected with such a device; (2) any other electrical apparatus, such as telephones, etc.; (3) any machine or other apparatus showing some application of electricity. No motor over 8 kw. will be allowed in the building. Motors up to 5 kw. will be supplied at 220 volts, motors over 5 kw. at 440 volts. Current at a pressure of 220 and 440 volts will be supplied to each stall if required. Exhibitors will be charged 1½d. per unit for current, and the amount will be measured by meter, or by arrangement covered by payment of a lump sum.

Newry.—Messrs. Rowcliffe and Co., Westminster, intend to apply on behalf of a syndicate for parliamentary powers to erect electricity and power gas generating stations and laying mains for the supply of electricity and power gas throughout the district, comprising about 1,600 square miles in the manufacturing portions of the counties of

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Down, Antrim, Armagh, and Londonderry. This is the old electric scheme for Newry revived in another name, which was talked of about a year ago. The matter is before the Gas Committee of the Urban District Council.

Coventry.—An enquiry has been held into the Town Council's application for sanction to borrow £5,000 for the purchase of electric motors to be let out on hire. The sum of £2,000 has already been spent in this way, and the results have proved satisfactory. Consumers of energy for lighting are to be allowed to pay for their energy either 6d. per unit for the first hour, 3d. per unit for the second hour, and 1d. per unit for the third and all subsequent hours, or at a uniform rate of 4½d. per unit, provided that either system be adopted for a period of at least 12 months.

Tiverton.—The Town Council have decided to accept, subject to the Board of Trade and the Local Government Board's approval, the offer of Frank Suter Company, London, to instal electric light for £9,990, and for an additional £500 to work the undertaking for three years, being responsible for the maintenance, sinking fund, and interest, but taking all the receipts earned. The maximum price per unit chargeable to private consumers is to be 6d., and the minimum 4d. The firm have promised to use all materials of British manufacture, except the dynamos, which were to be made by the Helios Company.

Worthing.—At the last meeting of the Town Council it was stated that the electric lighting account was exceedingly satisfactory. For the first time since the electric light was established the committee suggested that there would be no need to apply for a grant in aid. The light was being taken very well, and they found that £186 more had been received this half-year than had been anticipated. The estimated income was put at an exceedingly moderate figure, while on the other side all expenditure had been allowed for, and £300 had been put aside this half-year for interest that did not really become due in this half-year.

Rugby.—The Urban District Council have completed the laying of the electric light cables. An arrangement has been made to erect engines of the Willans type of dynamos on the premises of the British Thomson-Houston Company, who undertake to run them and supply the expert supervision at a certain price per unit. As, however, this machinery is not quite ready, the company have arranged to supply the current from their own generating plant, and it was switched on for the first time last week for a limited time. For the present consumers will be allowed to use the current free of charge. The price will eventually be 5½d. per unit.

Ealing.—The number of electric lamps applied for during the vacation this year amounts to 2,896, and represents 117 new consumers, the number connected during the recess being 112 for 2,497 lamps. These figures, compared with the applications during the recess last year, show a very decided advance, the figures then being 48 new consumers with 1,854 lamps. The number of consumers who made application during this recess was nearly 2½ times as many as last. There are now on the books 1,615 consumers, the number having doubled in a little over two years. The committee have authorised main extensions for connecting 47 houses in various streets.

Battersea.—Mr. S. A. Lovick, of Walsall, has been appointed canvasser to the Lighting Committee at a salary of £2 per week and commission. Messrs. Potter and Co. have been asked to continue the boring of the artesian well at the central electric generating station from 400ft. to 450ft. previous to testing, having regard to the fact that they have only just reached the best water-bearing strata at 379ft. The price is 17s. 6d. per foot inclusive, provided hard chalk is not struck. The charge for the supply of electrical energy for motive purposes is to be altered, after the Christmas quarter's readings of the meters have been taken, from 2d. per Board of Trade unit with rebates to 1½d. per unit without rebates.

Macclesfield.—The Town Council have agreed to the following notice of motion for the quarterly meeting of the Council on Nov. 9: "That a committee be appointed as a standing committee of the Council and be designated the Electricity Committee, and that the duties of such committee to be dealt with (1) all questions respecting the installation of electricity in the borough for lighting and power purposes; (2) applications for the consent of the Council to Bills or provisional orders for the construction of tramways within the borough; (3) applications for the consent of the Council to Bills providing for the distribution of power gas and electricity in the borough, and that the acts and proceedings of such committee be subject to confirmation by the Council."

Erith.—The Electric Lighting and Tramways Committee have instructed the surveyor to erect a temporary structure showing the design and size of the proposed kiosk for a transformer station in Erith-road, Belvedere, and the committee will inspect this temporary structure before deciding upon the erection of a permanent building. The committee have come to the conclusion, with regard to the breakdowns in the transformers supplied to the sub-station at Messrs. Callender's works, that the British Electric Transformer Company were responsible for the delivery of the transformers and for the delay in the completion of the switchgear. They have recommended that the Council to not admit the claim, amounting to £39, made by the British Electric Transformer Company for repairs to the transformers.

Ayr.—The last report by the burgh electrical engineer (Mr. Roland Marshall) states that during the past month the various departments of the works have run satisfactorily. Some Nernst lamps are on order, and they will be erected in different parts of the town immediately on their arrival. The erection of a small sub-station in Blackburn-road is in hand. The maximum load for the year so far was reached on the Friday of the race week between 8 p.m. and 9 p.m., and amounted to 443 kw., as against 373 kw. last year. In connection with this it is interesting to note that the tramway load reached its maximum at the same time—viz., between 8 p.m. and 9 p.m. The units generated during the race week, from 14th to the 20th inclusive, amounted to 22,996 units, as against 22,098 last year, being an increase of 898 units.

Liskeard.—The Rural District Council have referred to their solicitor an application of the St. Neot China Clay Company for permission to erect an electric cable and telephone wire across the highway in the parishes of St. Neot, St. Cleer, and Liskeard, to connect the clay beds at Parson's Park with the works at Moorswater, for which concession they would pay an annual rent of 6s. Permission is asked for a term of 40 years. The General Purposes Committee are considering an application from Messrs. Thompson Bros. and Co., Plymouth, for consent to run overhead wires for the transmission of current for electric lighting in the main streets of Liskeard, and this permission was sought for about three or five years, as the firm are desirous of considering the question of putting down a medium-sized plant for lighting a few of the principal shops.

Bradford.—The special sub-committee of the Finance and General Purposes Committee have reported that it would not be in the interests of the efficient conduct of public business if the Electricity and Tramways Committees were amalgamated, and they have recommended that full reports be exchanged between the committees in future in case of difficulty arising as to methods of working or financial adjustments. The total number of units sold for all purposes during the past 12 months was 9,124,223, an increase of 4,223,051 on the previous year. The total number of consumers for the half-year was 1,740, an increase of 180. The price of electricity for lighting has been reduced from 4½d. per unit to 4d., with a discount of 2½ per cent. and a free supply of incandescent lamps. The total working costs have been reduced during the past year from 1d. to ¾d. per unit.

Poplar.—Some time ago the electrical engineer reported that the Borough Council's plant was being worked to its fullest extent, and brought forward an extensive scheme to cost about £150,000. The Council, however, declined to adopt the scheme. At the last meeting of the Council the Electrical Committee reported that they had again been warned by the engineer that the Council would be running a serious risk during the winter in coupling up new consumers, and having regard to this view the committee were now of opinion that under present circumstances only proposed consumers whose premises were not in the Isle of Dogs area should be accepted, and then only subject to the condition that current is not to be taken between the hours of 4 and 10 p.m. for six weeks on each side of the shortest day of the year. In consequence of this report several large applications for current have been refused.

Kingswear.—Owing to the absence of facilities at Kingswear for shifting the heavy drums the laying of the electric light cables under the River Dart has been somewhat retarded, but early on Saturday morning last it was successfully accomplished. The three drums of cable, weighing about 12 tons, were mounted on specially constructed stands, placed on a lighter, and made fast to the lower side of the floating bridge, at the Kingswear side of the river, at low water. The bridge was brought slowly across, the cables being gradually unwound and dropped to the bottom. The actual time of crossing did not exceed 10 minutes, and was accompanied without a single stop. The cable is of the bitumen submarine type, protected by steel-wire armouring, the sectional sizes being ·125, ·075, ·125 respectively. On either side of the river it will be joined to the feeder cable by means of specially constructed boxes, which allow either section to be disconnected in case of accident.

Colliery Plant.—The British Thomson-Houston Company, Limited, have obtained a contract of the Bolsover Colliery consisting in the supply of two steam generators, each comprising one compound, two-crank, C/16 engine by Belliss and Morcom, complete with usual fittings, and capable of developing 375 b.h.p. with 140lb steam pressure, and working non-condensing at 375 revolutions per minute, direct-coupled to one British Thomson-Houston Company's 250-kw., 375 revolutions per minute, 550-volt, 50-cycle, three-phase, alternating-current generator; the above mounted on combination baseplate. Each set to be also furnished with a direct-coupled exciter and field rheostat for the three-phase generator and exciter. The engines for the above sets will be capable of carrying an overload of 15 per cent. continuously. One switchboard, comprising two generator panels and two feeder panels, with oil-break switches, instruments, etc.

Bury.—From the last report of the engineer, Mr. L. P. Greig, it appears that the new engine and dynamo passed the final test at the works on Sept. 26, and since that date have, with the condensing plant, worked very satisfactorily. The other dynamo has been running fully loaded up every night. During the past month four new services of a total of 54 8-c.p. lamps have been connected. The engineer suggests that five new street lamps be erected there at a capital cost of about £50, and a charge of £8. 15s. per annum. That number would place the lamps 138ft. apart. During the past quarter 17,000 units have been consumed by private consumers alone, as against 10,000 for the same period in the previous year, being an advance of 70 per cent. The Electric Lighting Committee have inspected the works, including the new dynamo and engine and the condensing plant, and were pleased to report "everything to be satisfactory."

London Gazette.—An application for discharge has been made in the estate of Frederick King, electrical engineer, the Stone Bridge, Bristol; day for hearing Nov. 20, at 11 a.m. at the Guildhall, Bristol. A first and final dividend of 2s. 4½d. in the £ has been declared in the estate of William Scholes, residing at 49, Main-street, Failsworth, Lancaster, and carrying on business at 85, Corporation-street, Manchester, and 10, Rochdale-road, Middleton, electrical engineer and contractor; payable Oct. 16 at the Official Receiver's Office, Byrom-street, Manchester. By an order made by Mr. Justice Bucknill dated Sept. 30, 1903, on the petition of William Bratby, of Alton Lodge,

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Hale, Bowdon, Cheshire, a creditor of the company, it was ordered that the voluntary winding-up of the Electric Tramways Trust, Limited, be continued, but subject to the supervision of the Court. The partnership subsisting between Thomas Richard Carpenter and Ernest Francis Carpenter, carrying on business as chandelier, gas, and electric fittings manufacturers and brassfounders, at 171 to 179, Bishop-street, Birmingham, under the style or firm of Carpenter Bros., was on June 30, 1903, dissolved by effluxion of time. A final meeting of the members of the British Blahnik Arc Light Company, Limited, will be held at 57, Moorgate-street, London, E.C., on Nov. 19, 1903, at 12 noon, for the purpose of having an account laid before them showing the manner in which the winding-up has been conducted.

Hove.—The Town Council have adopted the following report of the Lighting Committee in reference to the application of the Hove Electric Lighting Company, Limited, to compel certain consumers to change the voltage of their supply. The committee detailed the various steps which had led to the company's application to allow a change of voltage from 110 to 220 without the customers' consent, and its refusal by the Board of Trade; and, in conclusion, said the committee had thus succeeded in maintaining, on behalf of the Council and of objecting consumers, the position they took up and so had secured the result for which they contended—viz., that the Hove Electric Lighting Company could not be empowered to compel consumers to change over against their desire, nor without the consent of the Corporation, a consent which the Lighting Committee felt they could not advise the Corporation to give, unless and until the Hove Electric Lighting Company had agreed on their part to give to the consumers a benefit commensurate with that which the company were seeking to obtain for themselves. The agreement between the Brighton Corporation and the Council has now been exchanged, also the working contract between the Corporation and Messrs. Henley and Co. with reference to laying ducts has been approved by both parties. The laying of ducts has been commenced in George-street, and six ducts are to be laid in Church-road.

London County Council.—The Council on Tuesday agreed to lend the Battersea Borough Council £10,500 further on account of the installation of the electric light within the borough on condition that the loan be taken up at once, interest being charged thereon, from the date of the advance, at the rate of £3. 15s. per cent. per annum, payable quarterly, and the principal being repaid by such equal annual instalments on each Aug. 28 as will repay the amount borrowed, as to £6,794 within a period of 50 years, and as to £2,720 within 20 years, in each case from Aug. 28, 1903. This completes the loan of £61,794 to the Council. The following notices under Electric Lighting Acts and Orders of intention to lay mains were agreed to: Blackheath and Greenwich District Electric Light Company, across Burnt Ash-road and along Dorville-road, and to construct a transformer box at the junction of Dorville-road and Cambridge-road; Brompton and Kensington Electricity Supply Company, along a portion of Bolton-gardens South; Metropolitan Electric Supply Company, along a portion of Maida-vale; from County of London and Brush Provincial Electric Lighting Company, along a portion of Cooper's Arms-lane, Putney; Lewisham and District Electric Supply Company, across Silverdale-road and along Bishopsthorpe-road, to lay low-tension mains along Queensthorpe-road, Kingsthorpe-road, Princesthorpe-road, Dukesthorpe-road, Earlsthorpe-road, Mayow-road, and Sydenham-road, and to construct a transformer box at the junction of Bishopsthorpe-road and Mayow-road; and the St. Pancras Borough Council along a portion of South-grove. The receipt of a notice from the Stepney Borough Council under the Limehouse District Order, 1900, of intention to lay mains along London-street was also reported.

Islington.—In our last issue we noted that the Islington Council were recommended by the Electric Lighting Committee to reduce the charge for electrical energy used for motive power between midnight and 6 p.m. We have since had an opportunity of seeing a report presented to the committee by Mr. Albert Gay, in consequence of which the proposed reductions have gone forward to the Council. In this report Mr. Gay, in the first place, gives instances in other towns of the successful use of single-phase motors, of which 1,400 aggregate horse-power are in use at the present time at Sheffield. At Derby these motors aggregate about 1,000 h.p., whereas at Islington they have only connected to the system 61 motors with a total output of 260 h.p. The engineer shows that in order to compete with gas-engines the charge ought not to be higher than 1½d. per unit with gas at 3s. per 1,000 cubic feet. He then gives an analysis of the electric lighting accounts for the last three quarters in 1902 and the first quarter in 1903, in order to ascertain the actual cost per unit for coal and oil. The figures are as follows: for the quarter ending June, 1902, 1·78d.; that ending September, 1902, 1·7d.; that ending December, 1902, 1·47d.; and for the quarter ending March, 1903, 1·29d. This shows that the cost increases in the summer as is to be expected, but the next step taken clearly shows how much extra coal and oil is required for producing the large number of units in the winter quarter. To arrive at this figure Mr. Gay abstracts the number of units and the gross cost of coal and oil respectively for the June quarter from the figures for the March quarter, and arrives at the conclusion that to produce 382,584 extra units in March it requires £1,261 to be expended upon coal and oil, or 0·79d. per unit. Proceeding in the same way for the September quarter the extra cost comes out at 0·85d. These figures are only about half of the average cost per unit of coal and oil for the whole year—*i.e.*, 1·58d. Mr. Gay then gives load curves to show how the present machinery could be used to supply power through the day without overlapping the peak load, at a cost well within the limit mentioned above. Such a motor load is looked for in the Belle Isle district, where there are a number of factories. Assuming that some 300 h.p. or 400 h.p. of motors could be obtained there, the output from the station could be increased nearly 1,000,000 units, or about 40 per cent. Mr. Gay concludes that it would appear desirable (*a*) that the rate per unit should be 1½d., on the condition that not less than 2,000 units were taken annually (equal to, say, a 1-h.p. motor running eight or nine hours daily for five or six days weekly, and 50 weeks yearly); (*b*) that for smaller consumption the rate be as at present, 2d. per unit; (*c*) that any less than 2d. per unit apply only to the period midnight to 6 p.m. (or sunset if this be later than 6 p.m.), and that motors so supplied be then entirely disconnected from the supply; (*d*) that a rebate of $\frac{1}{12}$d. be allowed on each 10,000 units taken over the first 10,000 per annum to a minimum price of 1¼d. per unit; (*e*) that motors driving machinery only (not motor-generators) be supplied at reduced rates; (*f*) that the present day light rate for lighting purposes be not extended unless the consumption at 2d. be guaranteed to equal at least 1,000 units per annum (or 30 units per 30 watts of demand, if less than 1,000 units); (*g*) that all cooking and heating appliances be supplied at a uniform rate of 2d. per unit (this also to apply to motors of less than 1 h.p., or consuming under 2,000 units per annum). It will be seen that these recommendations are practically contained in a report of the Lighting Committee now before the Council—*i.e.*, that to encourage an increased day load the uniform flat rate of 2d. per unit be modified for all electricity for power purposes consumed between the hours of midnight and 6 p.m. by the following sliding scale: for all units up to 2,000 per annum, 2d. per unit; from 2,000 to 20,000 units per annum, 1½d. per unit; from 20,000 and over per annum, 1¼d. per unit.

PROVISIONAL PATENTS, 1903.

Oct. 5.

21315. Improvements in steps for electric and other tramway cars, vehicles, and the like. William Edward Cable, 18, Ebor-street, Heaton, Newcastle-on-Tyne.

21318. Improvements in or relating to electric switch holders or key switches. Charles Henry Davies, 104, Colmore-row, Birmingham.

21320. Improvements in apparatus for electric signalling. Carl Fridolf Brodin and Hermann Axel Schepeler, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

21324. Improvements in magnetic separators for ores or the like. John Thomas Dawes, 4, Clayton-square, Liverpool.

21344. Improvements in and connected with storage batteries. Edward John Wade, "Perugia," Sidney-road, Staines.

21359. Improvements in arc lamps for dark lanterns, cinematographs and similar apparatuses. Nikolaus Köhler, 81, High Holborn, London.

21363. Improvements in electric accumulators. Jean Emmanuel Georges Méran, 11, Southampton-buildings, Chancery-lane, London.

21386. Improvements in or connected with electric fuses or cut-outs. Julien Henri Mercadier, 4, South-street, Finsbury, London.

21404. Electricity meter for alternating currents. Siemens Bros. and Co., Limited, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Siemens und Halske Actien-Gesellschaft, Germany.) (Complete specification.)

21405. Improvements in electricity meters for motors. Siemens Bros. and Co., Limited, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Siemens und Halske Actien-Gesellschaft, Germany.) (Complete specification.)

Oct. 6.

21466. Improvements relating to electric arc lamps. Felix Jeannot and François de Zea Bermudez, 45, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents Act, 1901, Sept. 12, 1903, being date of application in France.) (Complete specification.)

21491. Improvements in electromotors of the induction type. Frank Michael Lewis, Norfolk House, Norfolk-street, Strand, London.

21493. Apparatus for perforating the type bands for automatic telegraph transmitting apparatus and the like. Siemens Bros. and Co., Limited, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Siemens und Halske Aktien-Gesellschaft, Germany.) (Complete specification.)

21504. Improvements in electric meters. Société Anonyme des Ateliers de Mécanique de Précision de Territet, 45, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents Act, 1901, Oct. 15, 1902, being date of application in Switzerland.) (Complete specification.)

Oct. 7.

21511. Improved means of temporary holding electric light lamps by magnet. Loftus Brook Mollan and Adam Millin, 59, Victoria-street, Belfast.

21529. Improvements in telegraphic apparatus for transmitting cable messages. Thomas D. Taylor, Dalton Dene, Minnaye-road, Penzance.

21551. Improvements in switches for use for electric lighting and power. Kyran Quaney and William Cecil Kirwan, 11, Brookfield-terrace, Anglesea-road, Donnybrook, co. Dublin.

21582. Improvements in primary electric batteries. George Schauli, 47, Lincoln's-inn-fields, London.

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21592. Improved electromagnetic signalling apparatus. Siemens Bros. and Co., Limited, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Siemens und Halske Aktien-Gesellschaft, Germany.) (Complete specification.)

Oct. 8.

21598. Improvements in self-replacement intercommunication telephones. Franz Petmeky, 4, Vernon-street, Camp-street, Broughton, Manchester.

21623. Improvements in accident-preventing or life-saving apparatus for electric tramcars and like vehicles. William Henry Taylor, 3, Brown-street, Market-street, Manchester.

21632. Improvements for electric igniting devices for petards. Friedrich Hülsmann, 112, Potsdamerstrasse, Berlin.

21636. Improvements in electric safety and alarm devices for doors. Kilian Josef Lender and Franz Brod, 112, Potsdamerstrasse, Berlin.

21637. Improved electrical alarm-clock. Heinrich Peters, 112, Potsdamerstrasse, Berlin. (Complete specification.)

21652. An improved form of electric accumulator or secondary battery. Jacques Marie de la Croix, 52, Chancery-lane, London.

21653. Improvements in coherers for wireless signalling. Thomas Edward Clark and the Thos. E. Clark Wireless Telegraph-Telephone Company, 52, Chancery-lane, London. (Complete specification.)

21700. Improvements in electrical measuring instruments. Carl Beez, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

Oct. 9.

21717. Improvements in apparatus to be used in connection with trolley lines for electric traction. John Isaac Hall, 82, Durlston-road, Kingston-on-Thames.

21728. Improvements in magnetic separators for ores or like materials. Joseph Mansell Moss, 4, Clayton-square, Liverpool.

21759. Improvements in telephones, metallic circuit automatic secret intercommunication instruments. Ernest George Bradnam, 139, Antill-road, South Tottenham, London.

21779. Improvements in and relating to electric cells. Thomas Heffernam, 18, Southampton-buildings, Chancery-lane, London.

21791. Improvements in the manufacture of filaments for incandescing electric lamps. Jack Randall Crawford, Clun House, Surrey-street, Strand, London.

21793. Improvements in valve and brake controlling mechanism for steam or electric winding or hoisting engines. Thomas Campbell Futers, 18, Buckingham-street, Strand, London.

21801. Improvements in simultaneous telegraphy and telephony. Josiah Sayers and Frank Bartholomew Holt, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

Oct. 10.

21830. Improvements in or relating to electric ignition apparatus for internal-combustion motors and the like. Edmund Woodward Lewis, 18, Hertford-street, Coventry.

21846. Improvements in trolleys for electric tramways. James Newall Dauncey, 24, Southampton-buildings, Chancery-lane, London.

21851. Improvements in telephone attachments. William Stanley Haddock, 45, Southampton-buildings, Chancery-lane, London.

COMPLETE SPECIFICATIONS ACCEPTED.

To be published Oct. 29, 1903.

1902.

15218. Electric safety apparatus for controlling the traffic upon railways. Prochaska.

21706. Telegraphic recording apparatus. Armstrong and Orling.

22032. Mariner's compass. Baron Kelvin, Clark, and Kelvin, and James White, Limited.

22106. Safety fuses for electric leads. Siemens Bros. and Co., Limited. (Siemens und Halske Aktien-Gesellschaft.)

22107. Sockets for safety fuses for electric leads, partly applicable also to sockets for glow lamps. Siemens Bros. and Co., Limited. (Siemens und Halske Aktien-Gesellschaft.)

22108. Electrical safety fuses. Siemens Bros. and Co., Limited. Siemens und Halske Aktien-Gesellschaft.)

22346. Apparatus for indicating the presence of leaks on electric circuits. Bott.

23797. Apparatus for composite systems of simultaneous telegraphy and telephony. Fell.

24710. Electrical measuring instruments. Carolan. (General Electric Company.)

25578. Electric frequency and speed indicators. Heap.

25658. Apparatus used for wireless telegraphy. Marconi's Wireless Telegraph Company, Limited, and Franklin.

26048. Electric transformers. Carolan. (General Electric Company.)

26050. Magnetic clutches. Carolan. (General Electric Company.)

26331. Electric controllers. Carolan. (General Electric Company.)

26448. Secondary or storage electric batteries. McKinnon.

26414. Regulation of electric motors. Vickers, Sons, and Maxim, Limited, and Williamson.

26943. Electrical measuring instruments. Appleyard.

1903.

162. Electric railway system. Mismahl.

2483. Electrically controlled lifts. Richmond and Carey.

6116. Electric safety fuses. Salmony.

16258. Rotors for dynamo-electric machines. Brooks. (Elektricitäts-Gesellschaft Alioth.)

16456. Manufacture of incandescence electric lamps. Hogge and Barrollier. (Date applied for under International Convention, April 8, 1903.)

16939. Trolleys for electric traction. Lake. (Trolley Supply Company.)

17057. Steering gear for motor road vehicles, electric or steam launches, and the like. Mathewson and Fielding.

17184. Clamps or couplings for wires, especially applicable for use in overhead electric conductors. Krückl.

18453. Dynamo-electric machines. Macku.

18485. Secondary or storage batteries. Wade. (Rodman.)

18953. Check or indicator applicable to the electric controllers of electrically-driven vehicles. Wille.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.	Last price
Commercial and Industrial.—	£	£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1 ..	½-⅝
Aron Electricity Meter, 5 p.c. Cum. Pref. Shares, 1-125,000	1 ..	½-⅝
British Insulated and Helsby Cables, Ord., 1-100,000	5 ..	6¼-6⅜
—— 5 per cent. Cum. Pref., 1-100,000	5 ..	5¼-5⅜
—— 4½ per cent. Mortgage Debentures	100 ..	103-106
British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red.	100 ..	104-106
British Westinghouse Elec. and Manuf., 6 per cent. Pref., 275,001-375,000	5 ..	5⅛-5⅜
—— 4 per cent. Mortgage Debenture Stock	100 ..	100-102
Brush Electrical Engineering, Ordinary, Nos. 1-105,731	2 ..	¾-1¼
—— Non. Cum., 6 per cent. Pref.	2 ..	1-1¼
—— 4½ per cent. 1st Debenture Stock	100 ..	97-100
—— 4½ per cent. 2nd Debenture Stock	100 ..	85-90
Callender's Cable, Debentures	100 ..	106-110
—— Ordinary	5 ..	11¼-12¼
—— 5 per cent. Pref.	5 ..	5¼-5⅜
Crompton and Co.	5 ..	2-2¼
—— 5 per cent. Debentures	100 ..	100-104
Edison and Swan United, "A" Shares, 1-98,261	3 ..	¼
—— "A" Shares, 01-017,139	5 ..	1¼-2¼
—— 5 per cent. Debentures	100 ..	76-81
—— 4 per cent. Deb. Stock, Red.	100 ..	72-77
Electric Construction, Limited, Nos. 1 to 112,100	2 ..	1¼-1⅜
—— 7 per cent. Cumulative Pref.	2 ..	2¼-3
—— 4 per cent. Perp. 1st Mort. Deb.	100 ..	97-100
Ferranti Limited, 5 per cent. 1st Mort. Deb. Stock, Red.	100 ..	90-95
General Electric Company (1900), 5 per cent. Cum. Pref.	10 ..	9¼-10
—— 4 per cent. 1st Mort. Deb. Stock	100 ..	97-100
W. T. Henley's Telegraph Works, Ordinary	5 ..	14-15
—— 4½ per cent. Preference	5 ..	5-5¼
—— 4½ per cent. Debentures	100 ..	108-112
India Rubber, Gutta Percha, and Telegraph Works	10 ..	18¼-19¼
—— 4 per cent. Debentures	100 ..	100-103
Parker, Thos., Limited, Ordinary	10 ..	14¼-15¼
Telegraph Construction and Maintenance	12 ..	34-37
—— 5 per cent. Bonds	100 ..	100-103
Electric Lighting and Supply.—		
Blackheath & Greenwich District Ordinary 1,201-101,200	1 ..	⅝-¾
—— 4½ per cent. Deb. Stk. Certs., Red. and Conv.	100 ..	116-119
Bournemouth and Poole, Ordinary	10 ..	12¼-13¼
—— 4½ per cent. Cum. Pref., 7,501-15,000	10 ..	10-11
—— 6 per cent. Cum. Second Pref., 15,001-22,500	10 ..	11-12
—— 4½ per cent. Debenture Stock, Red.	100 ..	103-106
Bromley (Kent) Electric Light and Power Co., 4½ per cent. 1st Debenture Stock, Red.	100 ..	102-105
Brompton and Kensington, Ordinary	5 ..	10¼-11
—— 7 per cent. Preference	5 ..	10¼-10⅝
Calcutta Electric Supply Corp., Ordinary, Nos. 1-40,000	5 ..	7-7¼
—— Nos. 20,001-30,000	5 ..	7-8
Cambridge Electric Supply Company, Ltd., £10 Ord.	8 ..	14¼
—— " " £10 Ord.	6 ..	10⅜
Central Electric Supply, Ld., 4 per cent. Guar Deb. Stock	100 ..	107-110
Charing Cross and Strand, Nos. 1-70,000	5 ..	9-9¼
—— 4½ per cent. Cum. Pref.	5 ..	5¼-5⅜
—— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000	5 ..	4⅜-5
—— 4 per cent. Debenture Stock, Red. (Prov. Certs.)	100 ..	104-106
Chelsea Electricity Supply	5 ..	5¼-5
—— 4½ per cent. Debentures	100 ..	108-111
City of London, Ordinary	10 ..	10¼-10⅜
—— 6 per cent. Cumulative Pref.	10 ..	13-14
—— 5 per cent. Debenture Stock	100 ..	122-127
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100 ..	102-105
County of London and Brush Provincial, Ordinary	10 ..	7¼-8¼
—— 6 per cent. Cum. Pref.	10 ..	11¼-12¼
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	100 ..	107-110
Edmundsons' Electricity Corporation, Ordinary, 1-50,000	5 ..	6¼-7
—— 6 per cent. Cum. Pref.	5 ..	6¼-6⅜
—— 4½ per cent. First Mort. Deb.	100 ..	105-108
Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-30,000	5 ..	3¼-4⅛
—— 5 per cent. Debenture Stock, Red.	100 ..	85-95
Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000	5 ..	6-6¼
—— 4½ per cent. First Deb. Stock, Red.	100 ..	100-103
Hove Electric Lighting, Limited, Ord., 1-13,000	5 ..	7¼-8¼
Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000	5 ..	10¼-11¼
—— per cent. Debenture Stock Red.	100 ..	103-106

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Name.	Amount paid. £	Last price. £
Kensington and Knightsbridge and Notting Hill	100 ..	101-104
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10 ..	9½-10½
London Electric, Ordinary	3 ..	1⅞-2⅛
—— 5 per cent. Pref.	5 ..	5⅛-5⅜
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100 ..	100-102
Metropolitan, Ordinary	10 ..	17½-18½
—— 4½ per cent. First Mortgage Debenture Stock	100 ..	110-114
—— 4½ per cent. Mortgage Debenture, Red.	100 ..	97-100
Newcastle-upon-Tyne Electric Supply, Ordinary	5 ..	98-101
—— Preference	4 ..	100-103
Notting Hill Electric Lighting	10 ..	13-14
—— 4 per cent. First Mort. Debs., Nos. 1-500 (Reg.)	100 ..	98-101
Oxford Electric, Ordinary, 1-96 and 407-14,310	5	5⅛-5⅜
—— 4 per cent. Debenture Stock	100	98-101
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100 ..	98-100
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5 ..	3-3½
—— 4 per cent. Debenture Stock	100 ..	85-90
South London, Ordinary	5 ..	3½-4⅜
St. James's and Pall Mall, Ordinary, 101-20,080	5 ..	14½-15½
—— 7 per cent. Pref.	5 ..	8-9
—— 3½ per cent. Deb.	100 ..	98-101
Urban Electric Supply Co., Ordinary, 8-30,007	5 ..	4⅞-5⅛
—— 5 per cent. Cumulative Preference, 50,001-80,000	5 ..	4⅜-5
Westminster, Ordinary	5 ..	12½-13½
—— 5 per cent. Cum. Pref., 110,101-138,251	5 ..	6-6½

Electric Railways.—

Central London, Ordinary	100	..	94-97
—— 4 per cent. Pref.	100	..	99-102
—— ,, deferred	100	..	99-102
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100	..	115-118
City and South London, Consolidated Ordinary	100	..	54-56
—— 4 per cent. Debenture Stock	100	..	116-119
—— 5 per cent. Pref. Stock '91	100	..	127-130
—— ,, ,, ,, '96	100	..	126-129
—— ,, ,, ,, '01	100	..	125-128
Liverpool Overhead, 5 per cent. Pref.	—	—	13-13½
—— Ordinary, 1-50,000	—	—	7⅞-8
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	—	—	102-104
Waterloo and City, Ordinary	100	—	93-96

Electric Tramways.—

Anglo-Argentine, 1-250,007	5	..	4⅜-4⅝
—— Permanent 6 per cent. Debenture Stock, 1888	100	..	125-130
Blackpool and Fleetwood Tramroad	10	..	13½-14½
Brisbane Tramway Invest., Lim., Ord., 1-75,000	5	..	2-3
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5	..	4-4½
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100	..	98-102
British Columbia Electric Railway Co., Ord., Nos. 1-20,000	100	..	83-86
—— Non-Cum. 5 per cent. Pref., Nos. 25,001-38,600	100	..	92-95
—— 4½ per cent. 1st Mt. Debs., Nos. 1-6,250, of £40 each	40	..	104-106 p.c.

Name.	Amount paid. £	Last price £
British Electric Traction, Ord. 1-300,000 & 60,001-90,000	10 —	12¼-12⅝
—— 6 per cent. Cm. Pf., 30,001-60,000	10 —	11½-11⅞
—— 5 per cent. Perpetual Debenture Stock	100 ..	120-123
Buenos Ayres and Belgrano Tram., Ord., 1-100,000	5 —	2⅜-2⅝
—— "A" 6 per cent. Cm. Pf., 1-40,000	5 —	5-5⅛
—— "B" 6 per cent. Cm. Pf., 1-27,500	5 —	4½-5
—— 5 per cent. Deb. Stock, Red.	100 ..	107-110
—— Prov. Cert., all paid	100 ..	99-102
Cape Electric Tramways, Nos. 1-480,000	1 —	2⅛-2⅜
City of Birmingham Tramways, 5 per cent. Cum. Pref.	10 ..	5-5⅛
—— 4 per cent. 1st Mortgage Deb., 1-3,000 (1917)	100 ..	99-102
Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red.	100 ..	102-105
Cork Electric Tramways and Lighting Co., Ordinary	10 ..	13-14
—— 5 per cent. Cum. Pref.	10 ..	11-12
—— Debentures	100 ..	96-99
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10 ..	12-13
—— 6 per cent. Pref., Nos. within 1-60,000	10 ..	15-16
—— 3½ per cent. Mort. Debs., 1-3,000, Red.	100 ..	94-97
Imperial Tramways Ordinary	all ..	22-22½
—— 6 per cent. Cum. Pref.	all ..	14½-15½
—— 4½ per cent. Deb Stock	100 ..	112-114
Isle of Thanet Electric Tramways and Lighting, 5 per cent. Cum. Pref., Nos. 30,001-60,000	5 ..	3⅜-4⅛
—— 4 per cent. Debenture Stock	100 ..	92-95
Kidderminster and District Lighting and Traction, Pref.	5 ..	3⅛-4
London United Trys. (1901), 5 per cent. Cum. Pref.	10 ..	11½-12
—— 4 per cent. 1st Mt. Db. Stock, Red.	100 ..	104-106
Metropolitan Electric Trams., Deferred, 1,000 001-1,314,016	1 ..	3/16-5/16
—— 5 per cent. Cum. Pref., 500,001-814,016	1 ..	⅛-1⅛
New General Traction, Ordinary	5 ..	⅛-⅜
—— 6 per cent. Cum. Pref.	5 —	2-3
—— 5 per cent. Mortgage Debentures, 1-1,713 (Regd.)	100 ..	88-93
Oldham, Aston, and Hyde Tramway, Ordinary	10 ..	10¼-10⅝
—— 5 per cent. Cum. Pref.	10 ..	11½-12½
Perth Elec. Tramways (W.A.) 5 per cent. 1 Mort. Deb. Stk.	100 ..	99-102
Potteries Electric Traction, Ordinary, 20,001-40,000	10 —	9-10
—— 5 per cent. Cum. Pref., 1-20,000	10 —	8½-9½
—— 4½ per cent. Debenture Stock	100 —	103-106
South Lancashire Electric Traction and Power Company—		
—— £250,000 Ordinary	1 —	1
—— £101,132 6 per cent. Preference	1 —	1
—— £528,093 4½ per cent. Debenture Stock	100 p.c.	100 p.c.

Telephones.—

National Telephone, Preferred	100	—	99-101
—— Deferred Stock	100	..	72-74
—— 6 per cent. Cum. First Pref.	10	—	13-14
—— 6 per cent. Cum. Second Pref.	10	—	13-14
—— 5 per cent. Non-Cum. Third Pref.	5	—	4⅛-4⅜
—— 3½ per cent. Deb. Stock, Red.	100	—	93-96
—— 4 per cent. Deb. Stock, Red.	100	—	101-103
Oriental Telephone and Electric Company	1	—	⅛-1

TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line	Traffic Returns for week: Ending	1903. £	1902. £	Increase or decrease: Week. £	Current year. £	Miles of single track open: 1903.	1902.	Accounts for past year: Ending	Total receipts £	Passengers carried.	Car miles run.	Receipts per: Pass'nger d.	Car mile. d.	Mile of track. £	Cost per car mile. d.
Aberdeen Corporation	Oct. 10	1,140	872	+ 267	+ 3,540	19¼	17¼	May 31	37,531	9,099,715	794,641	0·98	13·02	1,970	6·14
Ayr Corporation	,, 3	323	314	+ 9	—	8	6	Sept. 25	12,503	2,979,276	290,099	1·00	10·34	1,560	4·7
Birmingham Tramways	,, 10	5,314	5,152	+ 162	+ 9,192	6½	6½	—	—	—	—	—	—	—	—
Blackburn Corporation	,, 9	797	760	+ 37	+ 689	24	24	March 25*a*	40,964	7,234,106	826,558	1·36	11·87	1,705	7·44
Blackpool Corporation	,, 8	677	772	− 95	− 245	17½	16½	,, 31	211,163	6,169,121	784,443	1·52	10·8	—	—
Blackpool-Fleetwood Tramways	,, 10	629	458	− 29	− 152	16½	16½	Dec. 31	30,923	2,049,677	584,989	3·62	12·68	1,932	6·99
Bolton Corporation	,, 11	1,764	1,635	+ 133	—	38	25	March 31	85,704	17,761,605	1,896,247	1·15	10·75	3,430	5·87
Bournemouth Corporation	,, 7	974	—	—	—	10½	—	—	—	—	—	—	—	—	—
Bradford Corporation	,, 11	3,943	3,388	+ 555	+13,176	41	—	—	—	—	—	—	—	—	—
Brighton Corporation	,, 11	857	858	− 1	—	6½	—	,, 31	—	10,432,508	1,031,928	1·00	10·10	—	—
Bristol Tramways Company	,, 9	5,013	4,541	+ 472	—	51½	51½	Dec. 31	223,480	41,192,899	5,724,114	1·30	9·38	4,348	—
Burnley Corporation	,, 10	826	682	+ 144	—	—	—	—	—	—	—	—	—	—	—
Burton Corporation	,, 11	415	—	—	—	—	—	—	—	—	—	—	—	—	—
Cardiff Corporation	,, 10	2,015	1,531	+ 490	+16,746	—	—	—	—	—	—	—	—	—	—
Carlisle Tramways Company	,, 10	211	183	+ 28	+ 566	—	—	,, 31	—	2,216,583	320,129*h*	—	—	—	—
Central London Railway	,, 10	6 504	6,858	− 354	− 4,555*h*	6	—	,, 31	367,225	45,305,110	1,276,971*a*	1·87	66·6 *a*	59,076	35·6 *a*
City and South London Railway	,, 11	2,749	3,349	− 600	− 5,302	6⅝	—	,, 31	165,003*a*	19,069,319*a*	—	—	—	—	—
Cork E. T. and L. Company	,, 8	559	741	− 182	− 2,681	—	—	—	—	—	—	—	—	—	—
Darwen Corporation	,, 9	227	222	+ 5	− 103	7·23	—	March 31*g*	12,341	2,360,735	254,279	1·25	11·65	1,707	9·36
Dover Corporation	,, 10	224	213	+ 11	+ 103	3	—	—	—	—	—	—	—	—	—
Dublin & Lucan Electric Railway	,, 11	121	112	+ 9	+ 1604	—	—	Dec. 31	5,796	364,796	102,087	3·81	13·62	859	7·68
Dublin U. T., electric cars	,, 9	4,043	3,778	+ 265	} —	46	46	March 31	126,121	24,553,133	3,429,356	1·23	8·82	2,741	5·06*h*
Dublin S. District, Electric	,, 9	934	746	+ 188											
Dundee City Tramways	,, 7	922	811	+ 111	—	22	22	May 15	35,874	9,084,522	752,814	0·93	11·276	1,630	—
East Ham Corporation	,, 10	667	477	+ 190	+ 5,932	10·75	7·52	March 31	25,341	9,971,337	650,224	0·61	9·35	2,357	—
Farnworth U.D.C.	,, 7	139	125	+ 14	—	—	—	—	—	—	—	—	—	—	—
Glasgow Corporation	,, 10	14,090	12,402	+1,688	+29,019	124	101	May 31*g*	656,572	177,179,549	14,008,750	0·88	11·25	5,489 *b*	7·40*d*
Halifax Corporation	,, 7	1,340	1,105	+ 235	+ 4,425	30¼	27½	—	—	—	—	—	—	—	—
Huddersfield Corporation	,, 10	1,282	1,080	+ 202	—	34	35	March 31	56,631*h*	9,738,213	1,218,539	1·4	11·14	1,618	6·38
Hull Corporation, E. S.	,, 10	2,217	2,132	+ 84	+ 2,580	19	19	,, 31	87,707*h*	21,065,999	2,218,696	1·00	9·49	5,004	5·07
Ilkeston Corporation	,, 7	172	—	—	—	—	—	—	—	—	—	—	—	—	—
Kirkcaldy Corporation	,, 7	180	—	—	—	—	—	—	—	—	—	—	—	—	—
Leeds Corporation	,, 10	5,422	4,827	+ 595	+10,000	77	—	March 25	262,656	67,239,779	5,773,651	1·11	10·91	3,283	—
Liverpool Corporation	,, 3	10,784	10,171	+ 613	+13 156	101	95	Dec. 31	504,304	108,906,472	11,705,425	1·11	10·34	5,000	6·88
Liverpool Overhead Railway	,, 11	1,562	1,470	+ 92	+ 1,739	15½	15½	June 30	79,252	10,466,726	986,185*a*	1·82	19·30*a*	5,110	— *a*
Lowestoft Corporation	,, 10	206	—	—	—	—	—	—	—	—	—	—	—	—	—
Nelson Corporation	,, 10	98	—	—	—	3	—	—	—	—	—	—	—	—	—
Newcastle-on-Tyne Corporation	,, 10	3,736	3,019	+ 717	—	38½	36	March 25*g*	150,334	33,474,122	3,379,119	1·08	10·93	4,175	6·17
Portsmouth Corporation	,, 10	1,703	1,439	+ 264	—	29	29	Sept. 30	47,651	9,158,137	868,157	1·24	13·17	1,643	—
Rochdale Corporation	,, 12	111	126	− 15	—	4½	—	March 31	5,416	925,281	127,456	1·38	10·27	—	7·66
Rotherham Corporation	,, 1	521	—	—	—	—	—	—	—	—	—	—	—	—	—
Salford Corporation	,, 12	3,842	2,896	+ 946	+33,039	—	—	—	—	—	—	—	—	—	—
Sheffield Corporation	,, 11	4,392	—	—	—	53½	46¼	Mar. 25*g*	216,309	56,812,019	4,926,083	0·904	10·428	7,510	7·0
Southampton Corporation	,, 8	1,061	947	+ 114	—	11	11	,, 31	35,874	9,084,522	752,814	0·946	11·436	3,760	—
Sunderland Corporation	,, 11	1,139	1,110	+ 29	+ 1,864	18·48	17·18	,, 31	59,930	13,987,121	1,270,957	1·03	11·3	3,243	6·43
Wallasey U.D.C.	,, 10	676	561	+ 114	+ 2,659	10·5	10·5	,, 31*g*	31,307	5,690,378	654,550	1·32	11·47	2,981	6·97

* Includes maintenance of permanent way and proportion of profits paid to the tramway companies for term of unexpired lease. *a* Train mile.
b Per mile of single track. *c* Include rail and tram. *d* including depreciation. *f* Including one section of horse traction. *g* 1903. *h* Half-year's figures.

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NOTES.

Birmingham Local Section.—This local section of the Institution of Electrical Engineers will open its winter session on Nov. 18, when the chairman, Mr. J. C. Vaudrey, will deliver an address. Subsequent meetings will be held on Dec. 9, Jan. 20, Feb. 17, March 16, and April 27. The annual general meeting is fixed for May 18.

I.M.E.A.—The official report of the eighth annual convention of the Incorporated Municipal Electrical Association, which was held at Sunderland in July last, is now to hand. It forms a bulky and valuable record of the proceedings at that meeting, and includes, besides the presidential address of Mr. J. F. C. Snell, all the individual papers, together with the discussions thereon.

Wireless Telegraphy in China. — The Italian Legation at Pekin has just established a radio-telegraphic station, enabling it to maintain communication with the Italian ships stationed at Taku, Tien-Tsin, and on the coast. A correspondent says the first messages were transmitted from the Legation at Pekin to the admiral's vessel, "Vettor Pisani," in the Gulf of Pe-chili, 130 miles distant.

The Nobel Prizes.—The prophets are already at work assigning the Nobel prizes which are to be distributed by the committee at Copenhagen in a short time. According to their prophecies, Signor Marconi is to receive the prize for scientific inventions, while the chances for the medical prize are said to be divided between the Danish professor Finsen, whose name is associated with the treatment of lupus by light rays, and a foreign medical man. The English competitor for the literary prize is Swinburne.

London Traffic Enquiry.—The members of the Royal Commission appointed to enquire into the conditions of locomotion in London generally have now been in the States nearly three weeks. Besides making personal inspection of the various methods of transport adopted in the American cities, the Commission are hearing evidence by leading experts, and while in New York Messrs. H. H. Vreeland, Wm. Barclay Parsons, and B. J. Arnold, whose names are so well known both in the States and on this side, were among those whose testimony was presented. The Commission has also been in Boston, and will probably visit Philadelphia, and possibly Chicago, before returning to this country.

Proposed Moving Platform.—It is stated that the Rapid Transit Commission of New York has decided to construct a moving platform in tunnel between Brooklyn and the Manhattan borough, at a cost approaching a million and a half sterling. If, it is added, the moving platform scheme should be found impracticable or inadequate, an electric railway will be built. We remember the scheme being mooted some months ago, but apparently the commission has only now arrived at a definite decision. The platform will be after the style of those which proved so successful at the Paris and Chicago Exhibitions. A company is to carry out the work, and the bidding for the contract will be open.

Trafford Park Development.—The Trafford Park Estates, Limited, have issued a new plan showing the development which has taken place in Trafford Park under their administration. The plan indicates the locality of the numerous large engineering and other works on the estate, including those of the British Westinghouse Company, W. T. Glover and Co., the Lancashire Dynamo and Motor Company, etc. One attraction to manufacturers to establish works on the estate undoubtedly is that electric power and light, also fuel gas, are available at cheap rates, as well as an electric car service and full telegraph and telephone facilities. Apart from this, the transport facilities on the estate are exceptional.

Natural Gas Supply.—A discovery of a source of a natural gas supply in the Sussex village of Heathfield is now being turned to account by the Natural Gas Fields of England Company. It was during boring operations for water that the discovery was made, and it is said that its development in the near future may reveal a gas field larger in area than any known to exist in America. The company has one borehole at present, reaching to a depth of 400ft., where there is a pressure of 200lb. to the square inch, and a possible output of 15,000,000 cubic feet a day. This is about one-eighth of the total daily sale of gas in the Metropolis. The gas comes from the Kimmeridge clays, and it is calculated that with 10 boreholes 50 million thousands of cubic feet of gas could be produced a year. Perhaps this natural gas will resuscitate the old iron industry of Sussex.

Canadian Patent Law.—A further amendment is announced of the Canadian patent laws which is expected to result in immense benefit to patentees. A large number of Canadian patents were invalidated a short time ago by legal decisions, which stated that patents which had not been practically worked within the specified time, or of which a corresponding foreign patent had lapsed, were void. A new Act has just been passed revalidating these patents under certain conditions, and providing for the future that a Canadian patent shall not expire merely on account of the lapsing of a foreign patent, and also giving an alternative to working by rendering the patent subject to a compulsory granting of licenses. Both these alterations are calculated to greatly encourage patentees in the Dominion, for whom the former arrangement formed a grievance. Other alterations in the Canadian patent laws were dealt with in a recent issue of this journal.

Platinum in Incandescent Lamps.—A French company claims to have got over the necessity for using platinum in the manufacture of incandescent lamps. The reasons for the use of platinum are that its coefficient of expansion is the same as that of glass, and, therefore, changes of temperature do not cause cracking. A further reason is that when platinum is fused into the glass, the latter adheres to the platinum as though cemented. While other metals, particularly some alloys, such as nickel steel, have been found which have a coefficient of expansion equal to that of glass, none of them has the property of forming a tight joint when fused in. To get over this difficulty a French company, which manufactures incandescent lamps, has discovered a cement which enables it to secure a tight joint around the leading-in wires without it being necessary to use platinum. This cement is said to be unaffected by air or ordinary temperatures.

Guttapercha Supply.—There is always a fear in the electrical as well as other trades that there may one day be a shortage of guttapercha, and it is therefore a matter of general importance to find a substitute or an addition to the sources of supply. This, the Colonial Economic Committee of Berlin announces, is now in propect of being discovered. The utility of the guttapercha discovered by the expedition which was undertaken to New Guinea under the leadership of Herr Schlechter has so far been established that it may be regarded as suitable for cable purposes as an admixture, and, if carefully obtained, to be suited for cables in a pure condition. Large quantities of guttapercha have been obtained from New Guinea, and are at present being tested. The Secretary of State for the German Post Office, it is further stated, has identified

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himself with this movement, and has granted a large sum of money to cover the preliminary expenses.

Post Office Telephone Extension.—Everything considered, the extension of the Post Office telephone system in the Metropolis is going on very satisfactorily. Considerable delay has occurred in the completion of the Mayfair exchange, for which, however, the Post Office were in no way responsible, and Tuesday this week saw the successful inauguration of the exchange. It is situate in Bird-street, off Oxford-street, and is intended to serve an area bounded by Regents Park on the north, Knightsbridge and Pall Mall on the south, Regent-street on the east, and Bayswater on the west. The district is only second in importance to that covered by the Central exchange, including as it does Oxford-street, Regent street, Piccadilly, and the residential district of Mayfair. The new exchange has more subscribers connected up at the start than any exchange that has yet been opened by the Post Office in London, and when the switch was released on Tuesday 500 instruments were brought into use.

Subways for Service Pipes.—Our readers will remember that some time ago we announced a competition which was instituted by the Paviors' Company for the best essays sent in on the subject of "Subways or other Means of Placing and Maintaining, without Interference with the Surface, the Main Pipes and Services of Gas, Water, and other Undertakings below the Carriageways or Footways of Cities, Boroughs, and Towns." We understand that essays, drawings, and models were submitted by 26 competitors, and were considered by the judges—the Master of the Company (Major L. H. Isaacs) and Messrs. D. J. Ross, J. W. Bradley, and W. Weaver, the engineers of the city of London, city of Westminster, and borough of Kensington respectively. The awards which have now been made public are as follows: first premium (£105) to Mr. R. M. Parkinson, Peterborough; second premium (£31. 10s.) to a competitor whose name has not yet been ascertained; and third premium (£21) to Mr. F. N. Royle, of Nottingham.

Lead Salts by Electrolysis.—A German contemporary gives the results of the work of Messrs. Elbo and Nuebling on the production of various lead salts by electrolysis. They succeeded best in obtaining lead tetrachloride. The vessel used for this purpose consisted of a receptacle of glass with a porous cell arranged therein. In the cell there was suspended a lead plate, serving as cathode; on both sides of the cell strips of lead were fixed which served as anodes, and on the bottom of the glass vessel there rested a carbon plate, serving as auxiliary anode. The liquid in the cathode cell was dilute hydrochloric acid of about 1·1 specific gravity, while a 1·8 specific gravity acid was used in the anode compartment. The temperature must be below 10deg. C. The idea of using different anodes is that dichloride of lead is formed at the regular anodes, while free chlorine is generated at the carbon anode, which chlorine then effects the conversion of the dichloride of lead into the tetrachloride. The authors isolated various double salts of this substance. They also worked with hydrobromic, hydroiodic, chromic, phosphoric, and hydrofluosilic acid as electrolytes.

Loss of Light due to Globes.—Some figures have been published showing the loss of illuminating power of lamps due to globes. The results given below relate to a series of trials made with a Nernst lamp, which was first placed, by way of comparison, in a thin frosted glass globe. The illuminating power was determined by a Weber photometer. The lamp unenclosed by any globe or chimney gave the light of 81·8 English candles, and the loss resulting from surrounding it with different materials will be seen from the following figures: Concerning globes first, the illuminating power measured horizontally with "Holophane" was 70·30, a loss of light equal to 14·1 per cent.; with prismatic glass the figures were 65·80 and 19·6 respectively; with rose "Holophane," 64·30, 20·8; white opal, 38·30, 53·2; yellow opal, 33·00, 59·7; ruby opal, 28·50, 65·2; rose opal (grooved), 22·90, 72 2; rose opal (light), 19·90, 75·6; and with green opal (light), 18·30 and 77·8. For coloured chimneys the figures given are as follows: with amber glass the illuminating power is 71·30, the loss being 12·8 per cent.; with white opal, 51·80, 36 7; and with light blue the figures are 37·50 and 54·2 respectively.

Rural Telephony.—We note that in America a scheme has been proposed by means of which mail delivery in the rural districts will be considerably expedited through the intervention of the telephone. The experiment is proposed to be carried out on an extensive network of rural telephones, which incidentally calls attention to the large development that rural telephony has enjoyed in the States of late years. It would appear that the general idea underlying the plan is to organise such a system that when the envelope is properly designated and adequately stamped, the postmaster at any rural mail centre may utilise the telephone circuits to call up the person out in the country to whom the letter is addressed and communicate the contents. It is conceivable that much time and labour would be saved in this way, and an extension of the scheme can be imagined by which the person receiving the contents of a letter could dictate to the postmaster a telephonic reply if necessary, of course paying a small fee for the privilege. In the aggregate no doubt a great deal of time might be saved and much new business created corresponding to the express delivery of letters already existing in many English and foreign cities.

Electrolytic Estimation of Metals—In order to avoid the irregularities due to the evolution of hydrogen in the electrolytic deposition of metals, the use of a rotating cathode has been tried by Messrs. F. A. Gooch and H. E. Medway, and found to be satisfactory. According to the *Journal* of the Chemical Society, as cathode, a platinum crucible is used, and it is fixed to the vertical spindle of a motor. The solution to be electrolysed is contained in a glass vessel on a rising table. A strip of platinum is used as anode. At first, the cathode is immersed in the solution to only about two-thirds of its depth, and it is rotated (600-800 revolutions per minute) until most of the metal is deposited. Water is then added, so that the whole crucible becomes immersed, and the electrolysis is carried to completion. The deposit is washed and dried in the ordinary way. Results are given in the paper showing that the method is satisfactory for the deposition of copper (from copper sulphate solution containing free sulphuric acid or even nitric acid), silver (from potassium cyanide solution), and nickel (from an ammoniacal solution). As a comparatively high current strength may be used, the electrolysis can be carried out much more quickly than by the ordinary process.

South African Telephones.—In contra-distinction to this country, the Government of British South Africa holds a monopoly of the telephone, and is particularly busy providing telephone facilities in some of the more important South African towns. This is especially true in the case of Johannesburg. There exists in that town what is known as a "domestic" telephone service, and the Government is taking every precaution to see that in this connection its rights are not infringed. A "domestic" service means a system of communication from room to room within a building, and the Cape Postmaster-General has found it

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necessary to issue a warning against work of this kind being carried out privately. Owners of buildings are cautioned against entering into contracts with private firms for wiring their buildings for telephonic purposes without reference to the Postmaster-General, who, it seems, is anxious to carry out such work departmentally. Apart from the legal aspect of the question, it is obvious that serious inconvenience would be caused to the owners and occupiers of buildings if, after the installation of a "domestic" service, it were found that it could not be connected with the public telephone service owing to a different system having been provided.

Efficiency of the Nickel-Plating Tank.—Prof. Oliver W. Brown presented a paper before the Niagara Falls meeting of the American Electro-Chemical Society last month, in which he discussed the efficiency of the nickel-plating tank. To study the problem the author has determined the signal potentials of anode and cathode separately by means of a standard electrode. His results show that electrolytic nickel anodes corrode very poorly as compared with cast nickel anodes; pure rolled anodes are no better than electrolytic. The cathode efficiency is affected to a marked degree by the anode efficiency. The satisfactory operation of a nickel-plating solution depends to a large extent on the character of the anode employed. The purest anode material is not the best; presence of copper is advantageous to a certain extent, and it is quite likely that certain other impurities which are usually present in cast nickel may be equally advantageous. The reason that cast nickel anodes show a superiority may be due to the impurities or to a different physical structure which gives rise to a great porosity and roughness of the surface, and thereby a greater actual surface area. The electroplater can obtain an efficiency of 90 per cent. or more if cast anodes are used, with an anode density of about five amperes per square foot.

Yorkshire College Engineering Society.—On the occasion of the opening meeting of the above society last week Mr. E. J. Silcock, the president, delivered an address which was devoted to the subject of municipal engineering. He pointed out the numerous and responsible duties of the municipal engineer, and commented on the fact that it was only of late years that the corporations of this country had realised that in order to secure the services of first-class engineers, they must appoint men who had been specially trained, and must pay them adequate salaries. Only men who possessed a thorough knowledge of engineering principles, coupled with some judgment and the capacity to take a broad view of the development of a city, could be trusted to deal with interests of the magnitude which every day confronted the municipal engineer. As an example of municipal progress Mr. Silcock referred to electric tramway development in this country under the corporations, and particularly to the Leeds tramways and waterworks, both of which gigantic undertakings were designed and executed by the municipal engineer. All things considered, he was of opinion that, in spite of drawbacks in connection with the periodical changing of public bodies, municipal engineering offered good openings to those well up in their profession.

Wireless Telegraph Experiments.—Prof. Alexandro Artom, of the Royal Industrial Museum of Turin, is reported to have been successful in carrying on a wireless telegraphic communication simultaneously between two pairs of stations in the same locality. The experiments were made over a distance of 35 miles near Rome, and the intervening country was of a woody undulating nature. Messages intended for one station are stated to have been received without interception, although communication was going on at the same time between another pair of stations practically over the same ground. Prof. Artom is said to have employed a special instrument of his own invention in the experiments. It will be remembered that Signor Marconi has achieved a similar success in this country, when he demonstrated that it is possible under certain conditions to carry on communication between two stations without being intercepted by other stations working in the same vicinity and at the same time. Mr. Marconi has accepted an invitation from the Admiralty to give on board one of his Majesty's battleships an illustration of the results of his experiments in the transmission of messages to ships by wireless telegraphy over long distances. For this purpose he has arranged to embark on H.M.S. "Duncan," which sails from Portsmouth for Gibraltar in the course of a day or two.

Contact Potentials.—Mr. Heschus has contributed to *L'Eclairage Electrique* an article giving the results of an investigation into the influence which the degree of polish and the superficial density of bodies have on the difference of electric potential produced by their contact. The author arrived at the following conclusions: In all cases, that one of the two surfaces of a particular metal which is most polished, becomes positive. If two different dielectrics are brought into contact, the hardest one ordinarily becomes positive; the contrary takes place with the metals; the numerous exceptions can be easily explained. A body of hard material, but which presents on account of its structure few points where contact is possible, behaves like a soft substance. Glass wool, for instance, becomes negative in contact with cloth, ordinary absorbent cotton, porcelain, and glass. Hygroscopic surfaces, poorly dried, become positive like the water itself. A body which easily crumbles into dust, or a glue-like body, which leaves traces on the surface with which it was in contact, always becomes negative. This fact explains numerous variations in the sense of electrification of the same pair of bodies, through contact or by rubbing them against each other. Ebonite, for instance, becomes negative when in contact with emery paper, but it is positively electrified when it is rubbed with the paper in order to polish it. Two pieces of quartz, of sugar or of pyrite, which give a phosphorescent light when knocked against each other, are both positively electrified. The particles produced by the knocking, however, if allowed to fall on an electrometer, charge the latter negatively.

Wind-Driven Electric Plants.—Before the recent Copenhagen Technical Congress Prof. P. La Tour read a paper in which he gave the results of his investigations on this subject. The professor has for many years been engaged on behalf of the Danish Government in experiments on the use of wind-motors in connection with the operation of electric generating plants, and the results are stated to be fairly satisfactory. The main drawback has been the difficulty in obtaining approximately constant speeds, irrespective of the strength of the wind. It is reported that this difficulty has been overcome by the use of an intermediate shaft placed on a sort of balance, the transmission belt from the windmill leading horizontally down to the pulley of this shaft, and the pressure of the belt against it being regulated by means of the balance provided with convenient counterweights. From the intermediate shaft another belt leads to the dynamo, it being found practicable by this arrangement to make the transmission belt from the mill slip on the pulley as soon as the load exceeds a given value, enabling the mill to run at any speed without carrying the speed of the dynamo

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above a certain limit. By means of this arrangement in connection with a maximum and minimum interrupter, inserting the machine automatically as soon as conditions are favourable, and switching it off again as the wind becomes too weak, the author claims to have obtained excellent results, the plant having proven satisfactory even during the strongest storms. As a matter of course, storage batteries are always used in connection with such plants. A small station equipped according to this plan is said to have been in operation at Askoo, Denmark, ever since October, 1902, about 450 incandescent lamps being lighted with excellent results; a petroleum motor is provided as a reserve in case of several days' calm weather.

Spark Discharges through Gases.—The chemical effects due to spark discharges through gases are gaining steadily greater importance, and while ozonising apparatus is already in commercial use in Europe for the sterilisation of water, the best-known process of this type in America is that of Bradley and Lovejoy for the fixation of atmospheric nitrogen. The mechanical problem to be solved in all such processes is to bring every particle of gas into the most intimate contact with the spark. The *Electrical World* describes two patents granted to Mr. H. Pauling, of Brandau, Austria, for two different devices for this purpose. In the one the positive electrode is of pointed shape, and the negative is of disc shape, whereby the discharge sparks are conical with the base directed towards the disc and its apex at the discharge point. The blowing-in of the gas is effected through this point in the direction of the spark cone in such a manner that the greater part of the gas current coincides with the spark path. The outlet of the gases after treatment preferably takes place through openings in the disc electrode. In the other device the sparking surface is drawn out in band shape, and the gases are blown or sucked through the spark-gap so formed. A band-shaped sparking surface can be produced, for instance, by allowing the points between which the spark has to pass to make a rapid lateral displacement. Around a cylinder of insulating material a conducting wire is wound in form of a helix, the ends of this wire being connected to the shaft. At a suitable distance from the cylinder a metal strip is arranged parallel to the shaft. This metal strip is connected to one pole of an induction coil, while the other pole is connected with the shaft of the cylinder. A set of nozzles, supplied by a common pipe, is arranged between the metal strip and the cylinder. By revolving the cylinder at a sufficiently high speed a continuous spark band between the metal strip and cylinder is produced, so that every part of the gas passing from the nozzles comes into contact with the sparks.

Magnetic Manganese Alloys. — The German Physical Society recently considered an interesting communication from Mr. F. Hensler on magnetic manganese alloys. Both pure manganese and copper-manganese are known to be quite non-magnetic, but the author has found certain other alloys of the metal to exhibit strong magnetic properties. The following metals and metalloids will thus give more or less magnetisable manganese alloys free from iron: tin, aluminium, arsenic, antimonium, bismuth, and boron. The most interesting results are derived from a thorough investigation into the behaviour of manganese-copper-aluminium alloys. As commercial copper-manganese always includes small quantities of iron, it was first ascertained that even a copper-manganese to which material amounts of iron were added was not magnetisable. It was next shown that, with equal percentages of manganese, the susceptibility will increase for increasing percentages of aluminium up to a maximum corresponding to equal atomic amounts of both metals. This fact is the more noteworthy as the researches of Wiedemann, Quisicke, Du Bois, and others have shown aqueous manganese salt solutions to possess a magnetic susceptibility somewhat higher than the corresponding ferric salt solutions. There is a striking analogy in both the salts and certain alloys of the non-magnetic manganese metal showing strongly ferro-magnetic properties. This suggests a possible comparison of the manganese-aluminium bronzes with a salt solution where the copper would play the part of solvent; the above combination of equal atomic amounts of manganese and aluminium having to be considered as solved salt. Keeping manganese-aluminium-copper alloys for some time at a temperature of 110deg. C. will reduce them to a state of stable equilibrium, corresponding with a maximum susceptibility. The transition points beyond which these alloys become non-magnetic are relatively low, a gradual rise being, however, noted with increasing amounts of either manganese or aluminium.

Water Power from Glaciers.—A unique case of water-power development in the States is illustrated in the Chicago *Western Electrician*, from which we are able to give some interesting details. The chief feature of the scheme is the fact that the water power is to be obtained from mountain glaciers which yield a continuous flow the year round. The plant is now in course of construction at Electron, and the water is to be taken from a stream 35 miles from Tacoma, and 1,900ft. above sea-level, and within nine miles of the first glacier. In all five glaciers feed the stream. A large dam will be constructed and the water will be diverted through an 8ft. square flume, cut through solid rock, and suspended across canyons, a distance of more than 10 miles, to an elevated and precipitous bank of the stream, where a large reservoir is to be constructed. The water will be conducted at a decline of 7ft. to the mile, and at the end will be dropped at an angle of 45deg. through steel pipes 1,700ft. in length down the slope to the river bank, a fall of 888ft. and a pressure of 400lb. to the square inch being secured. The reservoir is to be provided in order to cope with fluctuations in the stream, and as a reserve power in case of accidents to the flume. With a fall of 888ft. the water will rush down through penstocks of steel and strike the buckets of the waterwheels, of which there will be nine, at a velocity of 240ft. a second. From 3,000 h.p. to 4,000 h.p. will be developed. The work is being hurried on as much as possible, and a temporary electric lighting plant has been installed, so that operations may be continued night and day. A great part of the electric power developed will be used in the operation of about 70 miles of electric tramways, but the company will have a surplus of from 10,000 h.p to 20,000 h.p. above the requirements of its own lines, which will be sold for industrial purposes. Experience with harnessing glacier-fed rivers on the continent has proved that there is want of water during hard winters.

Electricity and Shade Trees —A most interesting report has been issued by the Hatch Experiment Station of the Massachusetts Agricultural College in America on the injury to shade trees from electricity. We do not know that the subject has been specially enquired into before, and the report is, therefore, all the more acceptable. The document discusses the subject from various aspects, and illustrates damage due to current from tramway and lighting circuits. Summarising the results, the adverse conditions with which shade trees have to contend in cities and towns constitute a serious drawback to their development. A considerable amount of damage occurs to shade trees by wires, causing abrasions, destruction of limbs and leaders, burnings, and necessitating much injudicious pruning. The greatest amount of damage caused to trees

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by alternating and direct currents is by local burnings. The higher the E.M.F., the more injury is likely to occur to trees. There is practically little or no leakage from wires during dry weather. In wet weather, however, when a film of water is formed on the bark, more or less leakage is likely to occur, and if the insulation is insufficient and contact with the tree exists, grounding takes place, and burning due to arcing results. The high resistance offered by trees and plants in general serves as a protection against death from an electrical contact. The least resistance in trees occurs in the vital layer (cambium), and those tissues adjacent to it. Electric currents of whatever nature, when applied to plants of a certain intensity, act as stimulus. The physiological effect of the direct current on vegetable life differs from that of the alternating: the latter current acts more as a stimulus to the plant than the former. There is evidence to support the idea that a current, of not sufficient strength to cause burning, may over-stimulate the plant and cause a retardation of its activities which will subsequently result in death.

Train-Lighting by Electricity.—It will be generally conceded that electricity has many advantages for train-lighting, but much discussion has arisen over the best method of securing the current, whether from storage batteries, axle-driven dynamos, dynamos driven by engines supplied with steam from the locomotive boiler, or from various combinations of these systems. The last issue of the *Journal* of the Institute of American Engineers we have received contains several papers which have an interesting bearing on the subject. Many plans have been tried in Europe as well as in the United States, but the authors seem to agree that the most feasible method is to make the system on each car a unit in itself. We quote a practical example. In Austria a Viennese electrical company has fitted up a number of railway coaches with what is known as the Dick system of lighting. The apparatus of this system includes a dynamo, storage battery, and circuit wires. Each car is supplied with a small dynamo, which is attached to the axle of the car wheels by a journaled bearing carrying projecting arms on which the dynamo is mounted, it being held in a horizontal position by a spring attached to the truck. A belt drives the dynamo from a wheel on the car axle. The dynamo produces the current for lighting the lamps while the train is in motion, and simultaneously a small battery is charged from the same dynamo. This battery serves the purpose of keeping up the current while the train is at rest at stations. Generally speaking, however, the lamps should be fed as long as possible directly from the dynamo in order that the battery may be spared. The weight of the dynamo is about 440lb., and an output of 45 amperes is obtained when running at normal speed. There are two batteries which will supply 22 8-c.p. lamps during a period of five hours without being recharged. The batteries are protected by safes, which may be placed in any convenient part of a railway carriage. On the door of each safe are posted exact instructions for the benefit of the attendants whose duty is to look after the apparatus.

Electrical Enterprise in New Zealand.—We have had occasion lately to call attention to the great many electrical schemes which are going forward in New Zealand at the present time, and the interesting progress which the colony is making in all matters electrical, including the development of water power and transmission over long distances, electric tramways, and supply of electricity both for lighting and power purposes. It would be difficult to say which is the most go-ahead city in this development, although there are two or three which stand out from the others as the pioneer cities in the introduction of electricity into the colony. This may be truly said in the case of Christchurch, which has recently inaugurated a combined dust destructor and electric lighting works—the only example of its kind in the Australasian Colonies. The electrical plant has been installed by Messrs. Noyes Bros., who are the New Zealand agents for the British Westinghouse Company. The destructor, as originally erected, was fitted with two Babcock and Wilcox water-tube boilers, of a total steam-raising capacity of 500 h.p., and a working pressure of 150lb. In the new plant which has been laid down the engines are of the high-speed enclosed pattern, running at 450 revolutions per minute, with an 8in. stroke; they are of the triple-tandem, compound type, and were supplied by Davey, Paxman, and Co. Coupled direct to each engine is a British Westinghouse 100-kw. multipolar dynamo generating current at 220 volts. In order to provide power for the all-night load, a storage battery has been installed. This battery is the largest in the Colonies, having a capacity of 1,000 ampere-hours. It is equivalent in output to one of the dynamos running at about half-load for five hours. The construction of the battery is unique, as all the plates are assembled on the work and burned up by oxyhydrogen blow-pipe. Each cell is insulated separately, and the whole battery is insulated by glass from the floor. There are 124 cells in the battery, 14 of which are used as regulating cells. Each cell contains 13 positive plates, 12 negative plates, and 22 gallons of acid. Specially-distilled sulphuric acid has to be made for this battery, as the manufacturers, the Accumulatoren Fabrik Actiengesellschaft, of Hagen, insist on pure acid and distilled water. The charging of this battery requires 20 hours continuous running of one dynamo at nearly full load, and a test of its capacity, made after charging, showed that the results were much better even than the guarantee. The regulating cells and battery are controlled by a switch and minimum cut-out, mounted on the partition separating the battery-room from the engine-room. In order to charge the battery without interfering with the supply to consumers, two motor-boosters are provided. These are of Westinghouse manufacture, and each consists of a 50-h.p. motor, working at 220 volts, coupled to a 37½-kw. generator at 125 volts, both mounted on the same bedplate. The motor is controlled by a starting switch and resistance fixed near it, and also by switches on the main switchboard. The main switchboard consists of five panels of white marble, and is about 7ft. 6in. high. Each dynamo has a controlling panel fitted with necessary switches, circuit breaker, ammeter, and field rheostat. The battery and booster dynamo are controlled by switches and instruments on a separate panel, and also the booster motors. Provision has been made in the power-house for a third engine, and everything has been carried out with a view to extension at an early date. As regards the commercial side of the scheme, it is expected it will prove a success, and a clear profit of just on £1,000 is hoped to be realised the first year. This is allowing 15 per cent. for interest, depreciation, wages, and maintenance, and a sum of £1,122 for operating costs. In the first instance, electricity for lighting is being supplied at an average price of 6d. a unit, and the estimated revenue is based on this figure. It will be interesting to see, when the plant has been long enough at work, how successful the combination of the dust destructor and electric lighting works will prove. The estimate places the average supply of steam from the destructor at 2,000lb. per hour from a ton of refuse with a consumption of 25 tons of refuse per day. It is on this basis that the capacity of the electric plant now installed has been gauged, and it is hoped it will return a fair revenue.

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ELECTRIC POWER IN TEXTILE MILLS.

The limited adoption of electric motors for textile machinery is probably due rather to the conservatism of British millowners than to any fault of the power agent. Undoubtedly trade depression has also done much to retard progress in this direction. Were the electrical engineer asked to specify the most suitable time for putting in an electric plant, he would choose a moment when the mill was working at low output and numerous machines were idle, so that any delays incident to the change would be of little importance. But, on the other hand, when business is poor, the management are seldom inclined to incur the considerable expense entailed. Further, the insufficiency of antiquated methods of power distribution is less keenly felt than when the plant is working at its maximum capacity, when a brief cessation of the power supply would greatly disorganise the work. With orders pouring in and the plant working day and night, the owners feel justified in greater outlay on improvements, and in consequence this time is generally chosen for the electrification of a mill. The wisdom of the policy is open to doubt, but the facts are obvious. Much credit is due to the engineer for the ingenious manner in which delays in changing over have been avoided; in numerous cases the electrical plant has been put in without in the slightest degree affecting the continuous operation of the mill. But probably the advantages of electric power would have been better exemplified had it been possible in these cases to modify the transmission system further than by simply substituting motors for the various steam-engines employed to drive the shafting. While the driving of the majority of machines by individual electric motors is not considered the best practice from either a technical or an economical point of view, the grouping of machines driven from one source of power can often be improved upon to a great extent in changing over, resulting in improved working conditions and decreased expenses.

The plant illustrated is an example of an electrical installation grafted on to an existing mechanical system. The twisting shed, shown in Fig. 1, forms part of Sir Titus Salt's extensive works at Saltaire. These mills are for the most part driven by small steam plants laid down at several different points. The twisting shed is, however, located about 500 yards from any part of the main shafting, and it was therefore decided to drive it by electric power, rather than incur the great friction loss of mechanical transmission over such a distance. Fig. 2 shows the Westinghouse alternator put in to generate the electric power. This machine is of 100 h.p., on the three-phase system, and runs at 440 volts and 720 revolutions per minute. It is driven by eight cotton ropes from a pulley 4ft. in diameter on the main shaft, running at 340 revolutions per minute. The other small dynamo shown is auxiliary to the larger machine, supplying the current required for excitation. The electric plant has been running regularly for 18 months 10 hours a day, and has required practically no attention. Starting and stopping are very simple, and no skilled supervision is required at any time.

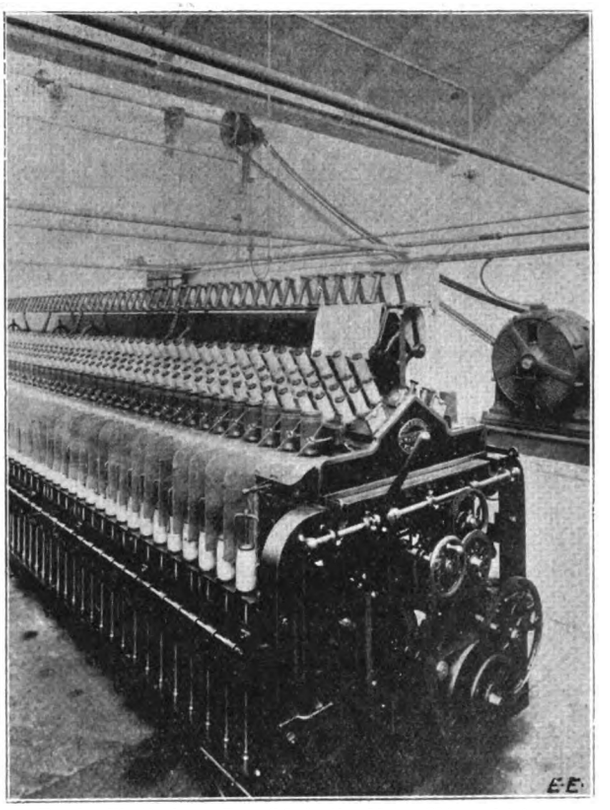

FIG. 1.—Westinghouse Type C Induction Motor, 75 h.p., driving Twenty Twisting Frames.

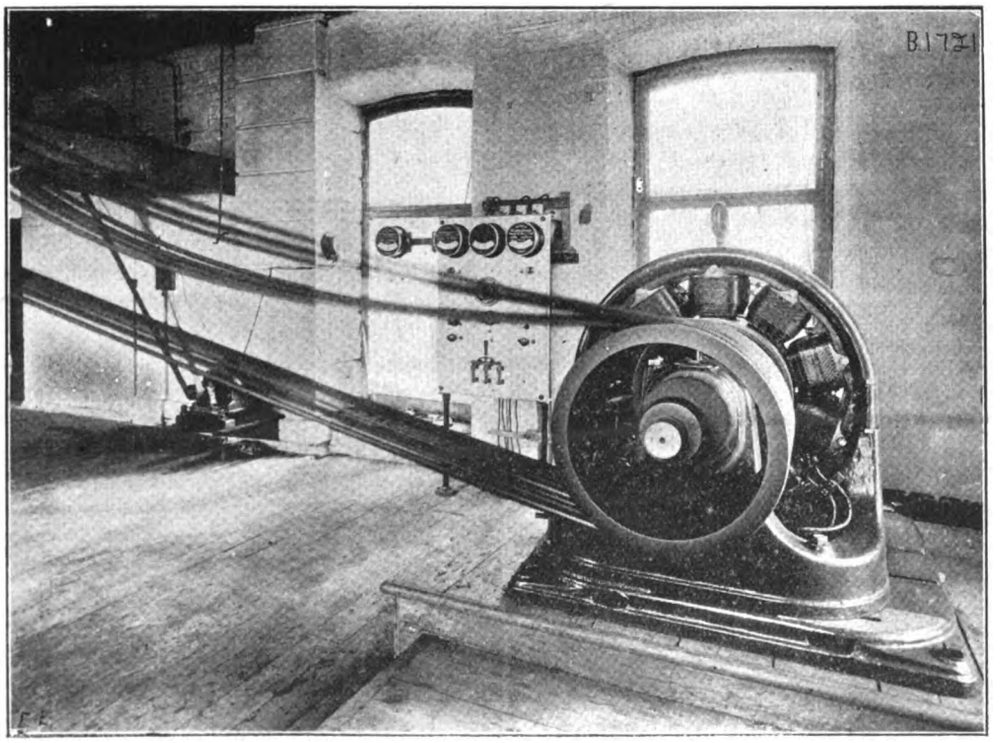

FIG. 2.—The Electric Power Plant, Westinghouse 75-kw. Alternator, with Switchboard and Exciter in background.

The Westinghouse induction motor, located at one end of the twisting shed, is of 75 h.p., and drives the line

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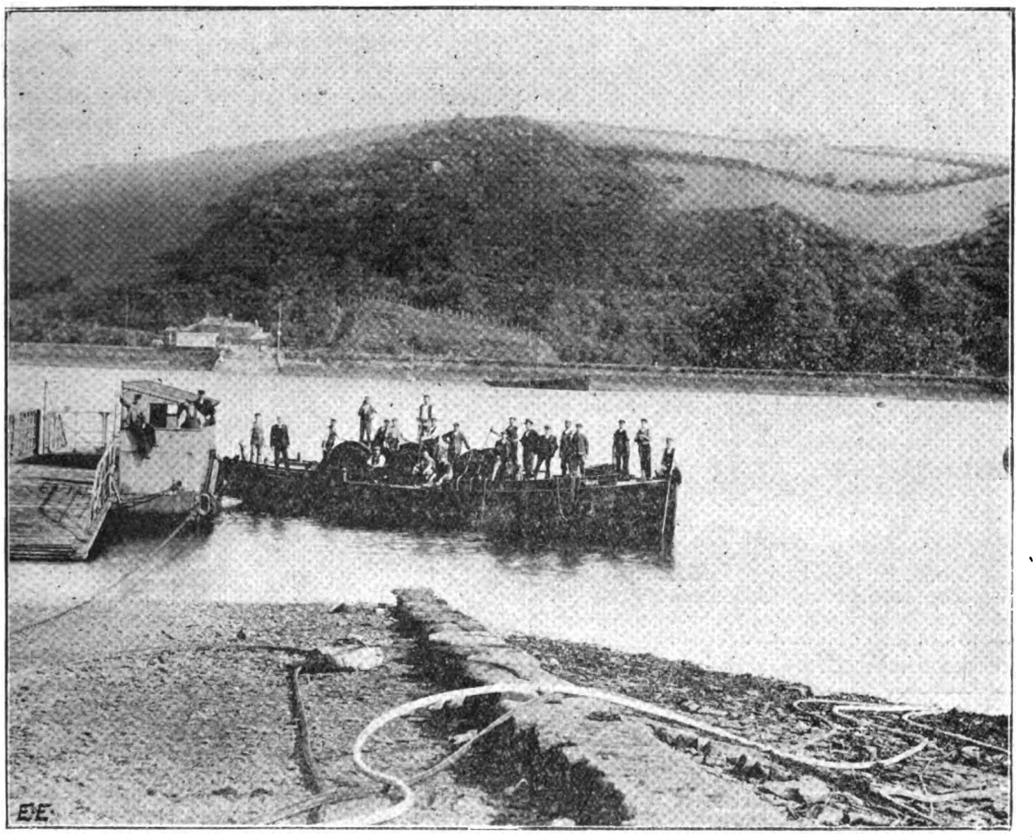
shafting by six cotton ropes running on grooved pulleys. Twenty twisting frames are at present driven by the motor, each having 180 spindles running at 2,500 revolutions per minute. The frames are driven by belts from the line shafting, and any of them can be isolated when required by the use of loose pulleys.

The polyphase induction type of motor, as here exemplified, is without a doubt superior to any other electrical machine for such work. It is simple and efficient, it can stand treatment that would inevitably ruin a direct-current machine, and it abolishes the bugbear of sparking. The rotating member, or armature, of this motor contrasts strongly with the equivalent part of the more familiar direct-current motor, consisting simply of solid copper bars laid in slots in a laminated core, these bars being bolted at their extremities to heavy copper end rings. There is no insulation, no small conductors liable to injury, no thin "band wires," and no commutator. These advantages are unquestionable, and demonstrate clearly the superiority of the alternating-current system for electric power distribution in cotton mills.



Laying Callender Cables across the River Dart to Light Kingswear.

The above plant, though but of small size, is interesting not only as an example of the polyphase transmission system, but little known in this country, but also on account of its complete success, having given every satisfaction from the start. The general neatness and compactness of arrangement made possible by the motor drive are well shown in the illustration.

DARTMOUTH AND KINGSWEAR ELECTRIC LIGHTING.

Through the courtesy of Mr. G. E. Smith, the engineer of the Dartmouth electricity works, we are able to reproduce the accompanying interesting photograph of the laying of electric lighting cables across the estuary of the River Dart. The Kingswear Council have entered into an agreement with the Urban Electric Supply Company, of Dartmouth, by which the company agrees to lay mains both for street and house lighting in the district. In order that this might be done, connections had to be made across the river. For this purpose three Callender single-core cables were used, insulated with vulcanised bitumen, and heavily armoured. These were laid in the bed of the river at a point close to where the floating bridge crosses from Dartmouth to Kingswear. The actual distance is about 550 yards, and we are pleased to state that the work was successfully carried out by the electric lighting company's own staff, under the superintendence of Mr. G. E. Smith.

INDEPENDENT TELEPHONY IN GREAT BRITAIN.

BY GARDNER AND HOLME.

(Continued from page 575.)

The method of renting telephones in England until recent years was by an annual payment to cover an unlimited number of local calls, this system now being known as the flat rate. When subscribers, however, have an unlimited use of the telephone, it tends to burden the traffic with a large number of useless calls which would be eliminated on the introduction of a toll. On the other hand, the flat rate is an exceedingly popular one in England, and large firms would oppose a compulsory toll system; at the same time it must be admitted that the toll system theoretically is the correct one, in so far as the more use a firm makes of the telephone on the toll system, the more he pays.

In practice the toll system involves a large amount of account keeping, which increases the office charges nearly in the ratio of decrease in operating. Taking all these facts into consideration, it would seem that a low flat rate combined with a toll rate should be adapted for an exchange system. It is also the practice in England to give free service to flat-rate subscribers all over the local area, although in some cases long expensive junction lines have to be erected to connect the various exchanges together. Thus in the Portsmouth local area some of the junction lines are 18 miles long. Of course, it may be argued that unless the villages were telephoned the central exchange would not be so large or important, as the shops in the villages are placed in communication with the supply stores in the town; yet theoretically a charge should be made for the use of a junction to another town or village.

The trunk lines joining the various telephone areas into which Great Britain is divided are under the direct control of the Postmaster-General, and a charge of about 3d. for

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every 25 miles for a three-minute conversation is made. Under the licenses granted by the Postmaster-General for the establishment of exchanges a toll system is obligatory, and we will now consider the method of working same from a financial point of view. One method is to demand a deposit from the subscribers in prepayment of calls, and forward the account whenever the deposit is exhausted, and refuse further calls until another deposit is made. This, however, leads to considerable friction with subscribers, and, therefore, should not be adopted by progressive exchanges; and it would not have been mentioned at all had it not been an adopted system.

Another method is to fix recording meters which automatically register the calls from the switchboard at the exchange. Although these meters work well and have been adopted in the large Post Office London central exchange, a subscriber needs convincing that the meter will not register calls which he does not have, and this is the great drawback of the meter being at the exchange end.

Another, and the last method we shall consider, is for the operator to book the calls on a pad at the switchboard, these entries afterwards being transferred to accounts which can be rendered periodically to the subscriber. This system, we believe, is adopted in the Post Office London branch exchanges and also the various Corporation exchanges. From these accounts the subscriber can see the various subscribers he has rung up during the quarter, and is satisfied that the account is in order. A sample of the form in use at Portsmouth, which automatically adds itself up, is given in Fig. 7. This last method proves very satisfactory to subscribers, and although it is an increase in clerical labour compared with the deposit or meter systems, the fact must not be lost sight of that to please subscribers is of more importance than a slight reduction in maintenance charges.

Another method of popularising the toll system is to charge the rental half-yearly or quarterly instead of yearly, forwarding the account at the same time as the preceding quarter's tolls.

No. 2 TARIFF £3. 10s. AND ½d. PER CALL. No.....

Telephone Department,

Messrs..... Town Hall.

Account of local calls originated by you for quarter ending..... £ s. d.

Arrears .....

Total .....

This account must be paid within 28 days.

	1s.		2s.		3s.		4s.	
	Date	Call to	Date	Call to	Date	Call to	Date	Call to
1d.								
2d.								
3d.								
4d.								
5d.								
6d.								
7d.								
8d.								
9d.								
10d.								
11d.								
1s.								

FIG. 7.

To arrive at the amount to charge for the rental of a toll telephone in addition to the fees for the calls is a very difficult problem, as it is affected by the proportion of flat-rate to toll-rate subscribers. The first fact necessary to base an estimate on is the maintenance charge of a direct exchange line. In the chapter on maintenance it was found that the upkeep per station, including interest, sinking fund, and special reserve account, amounts to approximately £4. 3s. 6d., and consequently the tariffs should be arranged to give an average income per station of £4. 3s. 6d. But this includes inside extension lines. It is therefore necessary to eliminate these inside extensions so as to arrive at the cost of maintaining direct exchange lines and outside extensions, as obviously an inside extension should not cost as much to maintain as an outside one, or a direct line. From actual practice it is found that the cost of maintaining exchange lines and outside extensions is £2. 7s. 1d. at Portsmouth, and £2. 9s. 2d. at Glasgow. Adding to this the interest, sinking, and reserve fund charges on the cost of £25 per line, we get £4. 8s. 8d. as the full maintenance charge on direct lines. Consequently £4. 8s. to £4. 9s. should be the average receipt per direct line in order to ensure the commercial success of the exchange, or, in other words, about 20 per cent. on the capital cost should invariably be charged in telephone practice.

A safe tariff would, of course, be £4 per annum with a toll of 1d. per call, but as the more important firms prefer a flat rate it would be necessary to introduce one. This, of course, is a concession to the large firms, and the toll rate should be reduced accordingly as a concession to the small users. A flat rate of £6 combined with a toll rate of £3 and 1d. per call are very good rates to commence with, as the tolls may be counted upon to yield at least 15s. per toll subscriber per annum. It will thus be seen that 80 per cent. of the subscribers would have to be toll subscribers before the average receipt would fall below £4. 8s.:

20 per cent. flat-rate lines at £6	=	£120
80 per cent. toll-rate lines at £3	=	240
Tolls, 80 at 15s.	=	60
		£420

Or an average receipt per direct line of £4. 4s. If the cost of the direct lines works out at £20, as at Portsmouth, instead of £25, the maintenance per direct line will, of course, fall by 8⅓ per cent. on £5, or 8s. 1⅓d., and the average receipt necessary would fall to £4. It would then be possible to reduce one, or both tariffs. The best practice would be to reduce the flat rate, as this would slightly diminish maintenance charges, and the more important toll subscribers would transfer to the flat rate, as it is the most popular one.

A reduction of the tariffs could be made as follows:

20 per cent. flat-rate lines at £5	=	£100
80 " " " £3	=	240
Tolls, 80 at 15s.	=	60
		£400

Or an average receipt of £4 per direct line. Even this would be improved on, as with a low flat rate of £5, 60 per cent. would adopt it, but the above figures are given as being an absolutely safe basis of working. Tariffs for inside extensions can now be deduced, being 20 per cent. of the capital cost. The average cost works out about £5, and £1 per annum, being 20 per cent. of £5, is the usual rental charged. Similarly with outside extensions, the tariffs should be fixed to give an average receipt of £4 to £4. 4s. The usual method of charging is if the line is under one mile in extent, but over three-quarters mile, £5; under three-quarters, but over half mile, £4. 10s.; under half mile, but over quarter mile, £3. 15s.; under quarter mile, £3.

It is often thought that call offices stem the growth of a system, but the contrary is found in practice, a good call office system being the means of inducing firms to adopt the telephone. Call offices should yield 7s. per month, otherwise they are not bringing in 20 per cent. on the capital expenditure.

Another method of catering to the small users is by establishing party lines, whereby from two to ten, or even twenty, instruments are bridged across the one line. This, however, does not meet with success in England, owing to conversations not being private and the liability of faults. A two-party line costs the extra spur into the subscriber's office, and the instrument, in addition to the first subscriber's line, so that the combined rentals should equal the

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average receipt plus 20 per cent. on the cost of the spur and instrument. The average cost of a spur and instrument is £6, and if the average receipt was £4. 8s., the combined rentals should total to £5. 12s., or a two-party line rate of £3 per annum, but as the maintenance becomes greater, owing to the complications for selective ringing, the rental should be £3. 10s. per annum to prove remunerative.

In carrying out private installations a quotation at 20 per cent. on the cost price should be given on a five years' agreement, so that even if the firm does not rent the installation at the end of the five years, little or no loss will occur. In the opening of small exchanges the 20 per cent. rule cannot be rigidly observed. For instance, if a village is one mile from an existing route, and five subscribers are obtained, an exchange could be established for £150, but the rental of the exchange would be comparatively large to the income, and so on opening small exchanges it is necessary to make up a careful estimate of capital cost, revenue, and expenditure to see that it will be commercially successful before commencing the work. To summarise, the tariffs are governed by the cost per line, and the proportion of toll subscribers to flat-rate ones. It will be found, however, that as a general rule a flat rate of £6, and a toll rate of £3 and 1d. per outward call, will prove very successful.

(To be continued.)

A METHOD OF MILKING FAULTY CELLS.

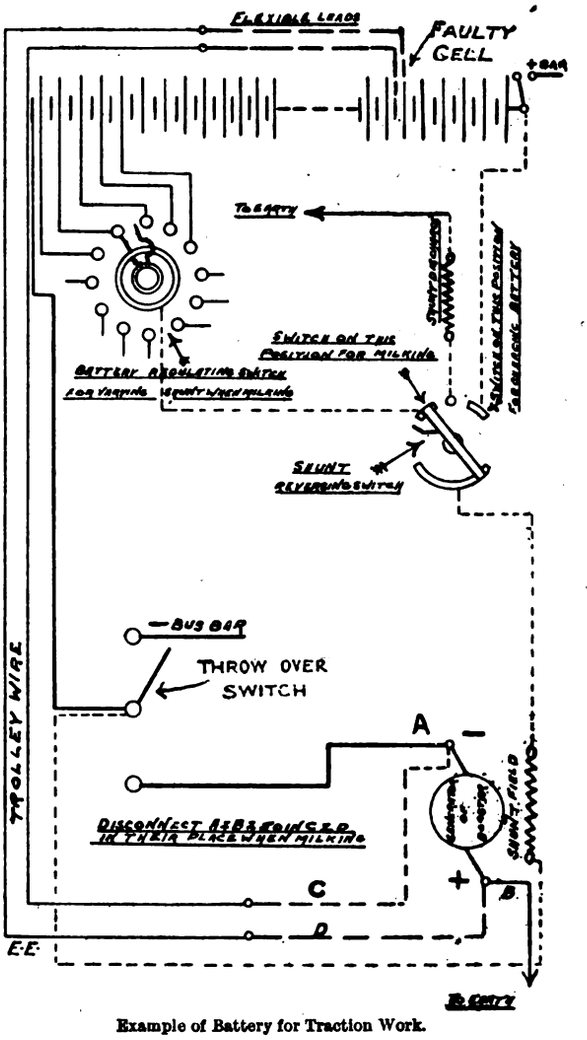
BY W. DALTON.

As a battery is at the best a very inefficient part of a station equipment and, moreover, its maintenance is also a heavy item to contend with, the following method of milking faulty cells without having to resort to the expense of a special machine may commend itself to those who have batteries under their care. It is very often found that sooner or later certain cells in a battery persistently go dead after a normal discharge, and an extra charge is invariably a cure, providing the fault is not caused by shorts between the plates.

It is assumed that an ordinary booster is used in connection with the station equipment, arranged in series with the battery when charging, connected either on the positive or negative side. Assuming there are, say, two adjacent cells which are faulty and require milking, the question to solve is how to adapt the booster (which is probably designed to give about 100 volts normally) to charge the two cells with, say, 150 amperes at a voltage only sufficient to force this current through the low resistance of the cells. The voltage required to do this may only be about six or seven volts. To get this the excitation must be brought down very low, and it is done by exciting the booster field from a few of the good cells in the battery. It may only require, say, 10 or 15 cells in series, and if there is a battery regulating switch fitted up these can be varied to suit circumstances. The ordinary connections at the booster terminals are temporarily disconnected and a pair of flexible leads joined up in their place, the other two ends being clamped across the faulty cell, care being taken to see that they are connected up with their polarity right. A switch is put in the circuit, the booster motor is run up to speed, and the generator field switched on. The main switch is now closed, but before doing so the volts of the generator should be tried, otherwise if the generator was giving no back E.M.F., the cell would be short-circuited through the armature. The battery regulating switch is now regulated until the right amount of current is passing into the faulty cell. If the battery is situated any great distance from the booster, a good method of connecting up the faulty cell is to erect two lengths of trolley wire on porcelain insulators between the booster and battery, and then at the end of this line flexible leads can be clamped on the trolley wire and taken to the faulty cell.

The advantages of the above method are: (1) no expense incurred for a special milking booster; (2) it is not necessary to break the joints and cut the faulty cell out of circuit.

Another point worth noting is that the extra amount of work put upon those cells which are used for excitation purposes is infinitesimal, therefore negligible. This is obvious when taking into account that the shunt of the machine may be some hundreds of ohms, and this divided by the voltage of the cells results in a very small fraction of an ampere. When this method was first tried, it was expected that the machine would spark, due to it giving out a heavy current in a very weak field, but it has been used on more than one make of booster with perfectly satisfactory results. The accompanying diagram shows the connections.



Example of Battery for Traction Work.

THE NEW GAIETY.

The sacred lamp of burlesque lies smouldering at the foot of pedestal, as depicted on the curtain raiser, and the figure representing the new Gaiety raises aloft an electric light. This characterises the modernising of John Hollingshead's house which has just been carried out by George Edwardes. The decorations and fittings and the architectural features do not lie within our sphere: an idea of the comfort obtained may be gathered from the single fact that each chair in the stalls and dress circle did actually cost £4.

The electrical installation is most complete, and has cost close on £7,000, £1,500 of which is represented in the switchroom. It provides for 3,500 lights or an equivalent of 9,406 8-c.p. lamps, 30 arcs, and several motors. All these lights are on the two-circuit system, the supply coming from two stations of the Charing Cross and Strand and from two stations of the Metropolitan Supply Companies. The latter company provide the main supply from their Willesden station, and their stand-by from Sardinia-street. There are 14 sets of mains coming in, divided over three different points of entry. The boards at the various points of supply are, of course, all arranged so as to change any circuit over from one station to the other of the same company. A separate switchboard and service is

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installed for arc lamps. This is on the three-wire system, with a two-way change-over switch; as there is no separate 100-volt supply, the Metropolitan Company will use for this purpose a motor-transformer to reduce the supply voltage. A separate supply board controls the "police" lights. These are on a separate main from the Charing Cross and Strand Company, so that if all the regular lights on the two separate supplies in the theatre should give out, there will remain alight 136 16-c.p. lamps connected with this third independent supply, enough to provide a slight illumination to all parts of the house, and especially the exits. Another board controls the supply to the motors. There is a 12½-h.p. for the 7ft. ventilating fan on the roof, two of 3½-h.p. for the fan on the stage and the vacuum cleaner respectively, and a 5-h.p. motor for the Waygood's lift on the ladies' side for the dressing-rooms. A separate service supplies the offices and the dressing-rooms on the Aldwych side, another those on the Strand side, and so forth.

The whole of the lamps in the auditorium, passages, etc., are controlled from two points only, the two large switch-boards, having a total of about 70 switches, being fitted in fireproof chambers with metal sliding doors near the stalls saloon, where they will be under the control of a responsible official. All the lamps in the auditorium in view from the stage will be controlled from switchboards by the fire-resisting pass door to the stage. These are fitted with arrangements for lowering the illuminating power of the lamps whilst the play is in progress, and are under the control of the electrician in charge of the stage. Most of the lights are 32-c.p. incandescent lamps. There are 74 25-c.p. lamps on the centre chandelier, an inverted 30-ampere arc lamp under the dome, and 24 12 to 15 ampere projectors on the stage, and six other arc lamps in other parts of the building.

Seven miles of steel tubing and 25 miles of wire were used on the job. The switchboard was made by Messrs. E. F. Moy and Co. In connection with it a new mechanical 57-lever regulator is used for the three-colour gamut. About one-third of these levers are connected with 21 Lyon's liquid resistances in the basement, to be used for slowly varying the lights. In other circuits metal resistances which work on sliding contacts are used, and are placed overhead. The regulator, which is of a type in common use on the Continent, is entirely new in England, and was supplied by the Electrical Company. It cost between £500 and £600, and is an ingenious contrivance for coupling up the different circuits as may be desired for simultaneous control. One regulator shaft is used for each colour, and the circuits can be coupled to the shafting or independently controlled as desired. The wiring to this switch and fuse board has been most neatly carried out, and the usual bunching of conductors near it has been avoided. Each wire can hence be got at easily if required.

The switchboard is bolted to the proscenium wall, and the regulating gear is fixed on the up-stage edge of the platform, thus enabling the person manipulating it to face the stage, instead of having his back to the lamps he is regulating. The resistances themselves are fixed in fire-resisting chambers built above the stage switchboard, extending to the underside of the fly floor, the multiple switches, which are bolted to the resistance frames, being connected to the regulating gear by means of steel-wire ropes. A complete system of electric lamp signalling has been installed to the principal points in the stage cellar, on the stage, and to the flies, the whole being placed under the control of the stage-manager in the prompt corner. As already inferred, the wiring is arranged so that in the event of any portion of the light supply breaking down the whole of the lighting of that system can be changed over to another supply, thus making the chance of a breakdown for more than a few moments impossible at any time.

The whole of the work has been carried out by Roger Dawson, Limited, Berners-street, to the specification of the consulting engineer, Mr. Thomas J. Digby. Every objection of the most exacting London County Council inspector has been anticipated, and the contractors have evidently not stinted money or pains to carry out to a successful issue what must be regarded as the most modern electrical theatre installation in the way of safety, comfort, and stage improvement. Mr. G. Poynton Applebee has been for some years the electrical engineer of the theatre, and upon him will now devolve the care and working of this complete installation.

QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any questions should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

629. Describe what you consider to be the best lifeguard for electric tramcars at present on the market.—MICA.

630. Describe the action of the sight-feed lubricator for cylinder lubrication. Give sketch.—C. W. S.

ANSWERS.

Question No. 621.—Resonance occurs when the natural period of discharge of a circuit is equal to the generator frequency, and is complete when the self-induction and capacity of the line exactly neutralise each other. Explain this clearly.

Best Answer to No. 621 (*awarded* 10*s.*).—It can be shown that the period of oscillation of a circuit consisting of an inductance and capacity connected in series is expressed by the equation $t = \pi \sqrt{L K}$ when the resistance is low, and t = time of complete cycle in seconds; L = inductance in henrys; K = capacity in farads.

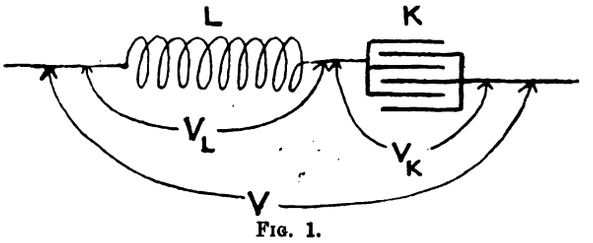

FIG. 1.

Now, if an alternating voltage be applied to such a circuit (Fig. 1), the current which flows produces between the ends of the inductance a counter E.M.F. = $V_L = 2 \pi n L C$, where n = frequency in cycles per second, and C = current in amperes. The same current flows into the capacity, and produces a counter E.M.F. $= V_K = \frac{C}{2 \pi n K}$. Now V_L lags 99deg. in phase behind C, while V_K leads C by 90deg. Hence these two counter E.M.F.'s tend to cancel one another, and if $2 \pi n L = \frac{1}{2 \pi n K}$, they exactly neutralise, leaving only the counter E.M.F. due to the resistance. The current is then limited only by the resistance, and the equation of the current is given by Ohm's law, or $C = \frac{V}{R}$. This is the condition of so-called "resonance." When R is very small, C becomes very large, causing V_L and V_K to become also very large, resulting often in the breakdown of K, whether a cable or other condenser. As stated above, we have

$$2 \pi n L = \frac{1}{2 \pi n K}$$

or,

$$4 \pi^2 n^2 = \frac{1}{L K}$$

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or, $$n = \frac{1}{2\pi}\sqrt{\frac{1}{L\,K}}$$

Let t = time of one cycle $= \frac{1}{n}$,

then $$t = 2\pi\sqrt{L\,K}.$$

But, as seen above, this equation also expresses the natural time of oscillation of L and K, so that it is clear that resonance occurs when the period of the generator equals the natural period of the circuit.

The above formula only holds for the case where the resistance is small. With resistance in circuit, the neutralisation of L and K gives the maximum current for a given voltage, the current being $\frac{V}{R}$. When L and K are in parallel across the mains, a different case is presented (Fig. 2). If the resistance is vanishingly small, the con-

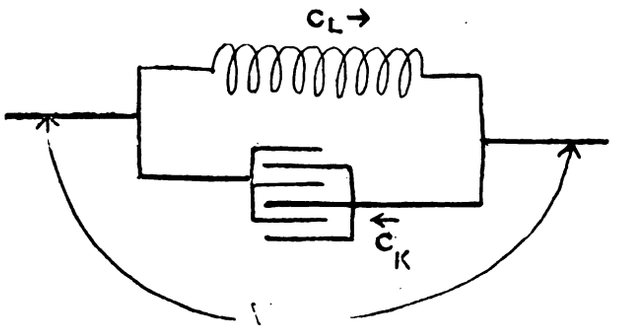

FIG. 2.

denser current, C_K, leads the voltage, V, by 90deg., while C_L lags by 90deg. Hence, if $C_L = C_K$ (the resonant condition), the resultant current flowing from the mains is zero, and no current will flow, however large V may be. But as the circuit must possess some resistance, the two currents, C_K and C_L, are not exactly 180deg. apart, and a resultant current flows from the mains and in phase with V. This may be seen more clearly by the clock diagram of Fig. 3. O V is the applied voltage, O C_L is the current in L, lagging behind O V by a little less than 90deg. (depending upon the relative values of L and R), O C_K is the capacity current. The resultant is a small current, O C_R, which, if L and K neutralise, is in phase with O V.

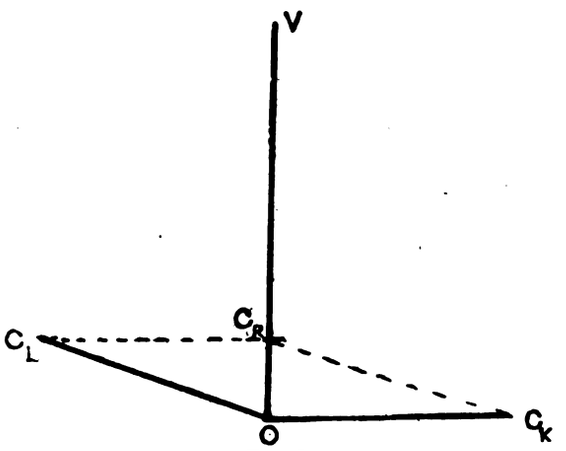

FIG. 3.

Summing up, we may say that when capacity and inductance neutralise, we have: (1) with a *series* arrangement, a large current and abnormal voltages across capacity and inductance; (2) with a *parallel* arrangement, a small current taken from supply and normal voltages across capacity and inductance.—R. C.

Answer to No. 621 (*awarded 7s. 6d.*).—In answering this question, it will be well to briefly consider the effects of an inductance and a capacity in an alternate-current circuit, when the impressed E.M.F. on the circuit follows a simple harmonic law. When an inductance exists in the circuit the current is $\frac{\pi}{2}$, or a quarter period behind the E.M F. as regards its phase. In the case of capacity in the circuit, the current is $\frac{\pi}{2}$, or a quarter period in advance of the E.M.F. In the first case the current varies inversely as the product of the inductance and the frequency, and in the second case current varies directly as the product of capacity and frequency. It will therefore be seen that the effects produced by inductance are the reverse of those produced by capacity, consequently a capacity may be used to neutralise the effects of an inductance in a circuit.

The phenomenon of the neutralisation of an inductance by a capacity is termed electrical resonance, and the advantage of this phenomenon is that it increases the current in an inductive circuit when the impressed voltage is insufficient to give the required current. When the effect of inductance is completely neutralised by capacity, the equation $Lp = \frac{1}{Cp}$ is satisfied, the current being in phase with the impressed E.M.F. Here L = inductance in henrys, $p = 2\pi n$ ($n = \sim$), and C = capacity. Perhaps an example might simplify the above remarks. Suppose it is required to neutralise an inductance of ·1 henry, the $\sim$ being 100, in a circuit having a resistance of 20 ohms and an impressed E.M.F. of 100 volts. Let C = required capacity.

Now, $Lp = \cdot1 \times 2\pi \times 100 = 62\cdot8$; also $Cp = \frac{1}{Lp}$

$\therefore Cp = \frac{1}{62\,8} = \cdot0159$ $\therefore C = \frac{\cdot0159}{2\pi n} = \frac{\cdot0159}{628\cdot32} = 25$ microfarads

Current $= \frac{100}{20} = 5$ amperes; also potential difference at terminals of condenser $= \frac{5}{Cp} = \frac{5}{\cdot015} = 333$ volts. Potential difference across the inductive resistance = current × impedance $= 5\sqrt{r^2 + p^2L^2} = 5\sqrt{20^2 + 62\cdot8^2} = 5 \times 65\cdot9 = 329\cdot5$ volts. This example shows how a small impressed E.M.F. may give rise to very high potential differences between certain points in the circuit, which may result in a breakdown unless suitable precautions are taken. Electrical resonance takes place in a circuit when capacity is placed in series with an inductance, and it will be well to consider the effect of shunting an inductance by a capacity. Under these conditions the total current is divided into two components—*i.e.*, the load current in phase with the impressed voltage, and the idle current which is in quadrature with it. As this idle current is $\frac{\pi}{2}$ behind the E.M.F., and the condenser current is $\frac{\pi}{2}$ in advance of it, these two currents always oppose one another. If the capacity is so adjusted that its current equals the idle current of the inductive resistance, then the only current in the main circuit is the load current. This effect is made use of in a method first introduced by Mr. W. Mordey for getting rid of the power factor in alternate-current distribution. As is well known, before an alternating current can do useful work in a circuit it has to (1) charge the condenser formed by the cable, (2) set up a magnetic field around every conductor forming the circuit. The charge for the magnetic field acts at an angle of 90deg, and the condenser charge at an angle of 270deg. behind the current. Hence the two charges are opposed to each, and if the capacity of the condenser is such that its current equals the idle current which is responsible for the power factor the latter disappears. In practice this is brought about by bridging a choking coil (giving the same current as the condenser formed by the cable) across the circuit. When there is a motor load on the service, the choking coil would only have to make up what the motors do not provide for. Mr. Mordey has found from actual measurements on a cable about six miles in length that it is possible to reduce the idle current from 6·5 to 1·3 amperes. From the above remarks it will be seen that a condenser of suitable capacity connected in series with an inductive resistance, will produce a rise in the potential difference across its terminals, and if the frequency of the supply current, Cp, is so related to the inductance and capacity that the equation $Lp = \frac{1}{Cp}$ is satisfied, then the

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current will be in phase with the impressed voltage, and electrical resonance is said to exist in the circuit. On the other hand, when a condenser shunts an inductive resistance, it supplies the idle current required by that resistance if the condenser is of suitable capacity.—J. W. R., SWANSEA.

Answer to No. 621 (*awarded* 7*s.* 6*d.*).—The statement that "T. G." asks for an explanation of is not quite right. Resonance does not occur only when the natural period of discharge of a circuit is equal to the generator frequency. It may and does occur when these two frequencies differ, when there is a certain relation between the frequency, capacity, and self-induction. Resonance is best explained by means of a mechanical analogue—the one usually employed is that of the spiral spring. If such a spring is set vibrating, its oscillations have a certain frequency and amplitude. If, now, a periodic force acts on this spring, giving it an impulse at definite intervals, under certain conditions resonance takes place on the spring's oscillations—*e.g.*, if the force gives an impact in the direction of motion of the spring, every time the spring passes through its point of rest in a certain direction the amplitude of the spring's oscillations is gradually increased until it becomes very large. This phenomenon is resonance. If the same force acts as above every second, third, fourth, etc., time the spring passes in a certain direction, resonance still takes place, but the amplitude increases more slowly, inversely as the interval between successive impacts.

Now, just as a spring has a certain period, if it is set oscillating freely, so every electric circuit containing resistance and self-induction and capacity has a certain natural period of vibration, only what vibrates is the current in the circuit. If the corresponding equations for the electrical and mechanical phenomena are examined (they can be found in many books—*e.g.*, Perry's "Calculus for Engineers," Rhodes's "Elementary Treatise on Alternating Currents"), they are found to be of exactly the same form—the mass, friction coefficient, want of stiffness, and displacement of spring in the mechanical case corresponding to the coefficient of inductance, resistance, capacity, and voltage respectively in the electrical case. The equations are:

$$\frac{W}{g}\frac{d^2x}{dt^2}+b\frac{dx}{dt}+\frac{x}{h}=\frac{y}{h}\ \text{(mechanical)}.$$

$$L\frac{d^2v}{dt^2}+R\frac{dv}{dt}+\frac{v}{K}=\frac{l}{K}\ \text{(electrical)}.$$

The usual notation is used, the equations being those for forced vibrations—*i.e.*, the case of a periodic force acting on the vibrating spring. The solutions of these equations are well known (Rhodes, pp. 31 and 201), and it is found that if the applied vibration has a sine function equation—*i.e.*, the E.M.F. of the alternator connected to the circuit under consideration is a sine function of the time—the magnitude of the current in the circuit depends on the value of the expression

$$\frac{pL-\frac{1}{pK}}{R}\ \text{(called the reactance)};$$

where $p=2\pi f$ and $f=$ frequency of alternator. This expression is in the denominator, hence the voltage and current are largest when it is zero—*i.e.*, when $pL=\frac{1}{pK}$; or $p^2LK=1$.

When the reactance is zero—*i.e.*, the effects of capacity and inductance equally balance—we have *electrical resonance*. The above equation, $p^2LK=1$, gives the condition for obtaining a completely resonating circuit. Of course, if the reactance is very small, though not equal to zero, partial resonance is obtained, but the occurrence of resonance depends essentially on the relationship of p, L, and K. If the inductance and capacity be suitably arranged, resonance can be obtained at any frequency. If an alternator have a wave containing the fundamental and higher harmonics, by suitably arranging the capacity and self-induction, resonance may be obtained with any desired harmonic. Thus it is not exactly true that the period of the circuit must be equal to the generator frequency to obtain resonance; if it is equal to the frequency of one of the harmonics, resonance may be obtained, and it is because of this that care must be taken with alternating circuits in which the wave is not approximately a sine wave.—A. C. G. I.

Question No. 622.—Explain how to find the efficiency of an alternating-current motor of 6 h.p., the speed being 1,500 revolutions per minute.

Best Answer to No. 622 (*awarded* 10*s.*).—The efficiency of any motor is the ratio of the electrical power supplied to the mechanical power given out at the shaft. Consequently there will be two quantities to be measured—(*a*) the input watts, (*b*) the output horse-power. Now, the input watts on an induction motor cannot be measured on ordinary voltmeters and ammeters, as the product of the readings so obtained would give the apparent watts, which would have to be multiplied by the power factor of the motor to give the true watts; and without knowing the details of the internal design of the motor, the power factor cannot be obtained except by means of a special instrument, but this would necessitate extra expense, which can be easily avoided by the use of two wattmeters, as is shown later. As "W. F. F." does not state what type of induction motor he wishes to test, it is proposed to show the arrangement of the wattmeters for single-phase, two-phase, and three-phase circuits.

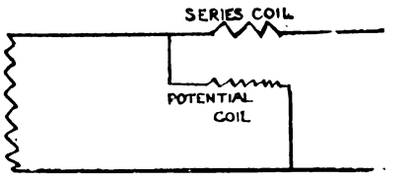

FIG. 1.

Fig. 1 shows diagrammatically the wattmeter connections for a single-phase circuit, the series coil being connected in series with one of the feeders, and the potential coil across the two. On a two-phase circuit with four feeders two wattmeters are required, each connected in a similar manner to the above (see Fig. 2). With only three feeders the wattmeters are connected with the series coils in series with the outside feeders, and the potential coils

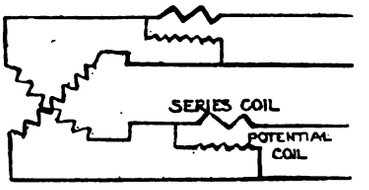

FIG. 2.

across the outside and the middle on each side. Fig. 3 shows the arrangement on a three-phase circuit with two wattmeters. A single wattmeter could be used (with a change-over switch for putting the potential coil first across the outer and middle and then across the two outers), provided that the three phases are balanced, which is unusual on motor circuits. Special meters are made for three-phase circuits which are not in balance, of which the British Thomson Houston Company's meter is an example.

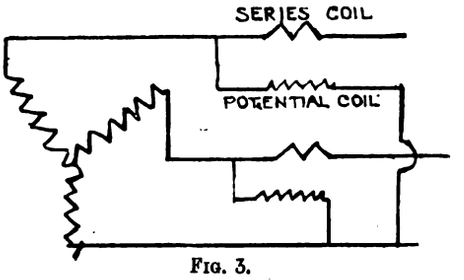

FIG. 3.

But the two-wattmeter method is the simplest and most accurate. In the above figures the sum of the readings on the two wattmeters in the two-phase and three-phase circuits give the true watts input to the motor. The most suitable type of wattmeter is the Thomson meter, and the meter should be well "damped" to avoid fluctuations in the readings.

Now with regard to the measurement of the horse-power

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output at the motor shaft, the cheapest and best arrangement is to use a brake on the pulley (as shown in Fig. 4). The pulley should be made with flanges each side to allow water to circulate inside round the pulley as it rotates to keep the surface cool, as the friction of the brake on the pulley will cause considerable heading. The brake band is fitted with wood blocks on the inside to form a better rubbing surface on the pulley than would be the case if the steel band was directly on it. The spring below the spring balance, S B, is used to obtain steady readings on the spring balance. With such an apparatus the brake horse-power given out at the shaft is obtained from the following formula:

$$\frac{x \times 2\pi \times \text{revs. per minute} \times \text{lbs. pull on S.B.}}{33{,}000 \times 12} = \text{B.H.P.}$$

It should be noted that with a single-phase induction motor the brake band cannot be put on until the motor has been run up to full speed, as it cannot start up under load, whereas two-phase and three-phase motors can do so. If the induction motor referred to is coupled to a continuous-current dynamo, the horse-power output of the motor can be easily obtained, as it will be the kilowatt output + internal losses of the dynamo divided by 746.

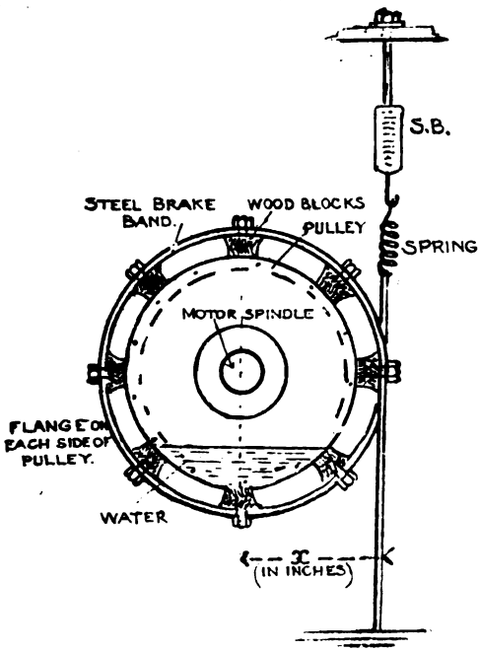

Fig. 4.

The kilowatt output can be measured on ordinary voltmeters and ammeters, and the C^2R losses can be obtained by measuring the resistances of the armature and field and multiplying them by the (current)^2. The other losses due to friction and core loss can be obtained by taking readings on the induction motor to find the input watts: (1) uncoupled from the dynamo and running light; (2) coupled to the dynamo fully excited but not loaded. Then the difference between the two readings will give the generator losses due to core loss and friction in the bearings, etc.—P.

Answer to No. 622 (*awarded* 10*s.*).—No mention is made of the type or class of the motor, or whether it is a three-phase or single-phase machine, but as the methods for determining the output will be the same in each case, we will first consider this point. In determining the efficiency, we have to find the relation between the output and input, and for this purpose the output of the motor must be measured in horse-power produced on a brake. This can be readily reduced to the output in watts, while the input can be measured directly in watts, thus giving the efficiency. There are numerous forms and types of "absorption" or "brake" dynamometers now in use. A well-known type is the Prony brake, which is shown diagrammatically in Fig. 4. The lever is fitted with a knife-edge, which moves in a suitable slot in the lower portion of H. The upper portion is threaded and provided with a handwheel, the latter being fixed in a tripod head. The handwheel cannot move up or down, but is free to turn round. A keyway is cut lengthwise in H, while a feather key in the tripod heads prevents H rotating when the handwheel is turned. A belt laps round the pulley, and the two ends are secured to the lever, J. When it is desired to take a test, the tripod is erected, and the counterweight, K, adjusted so that the lever, J, is horizontal. The knife-edge must be in a vertical line above the centre of the shaft, and the portions of the belt, T_1 T_2, must be parallel. When the pulley runs in the direction of the arrow and the strap tightened, by screwing up H, the scale pan will be moved upwards, and weights must be added to bring the lever again to its horizontal position. Under these conditions the horse-power can be calculated by applying a formula given later.

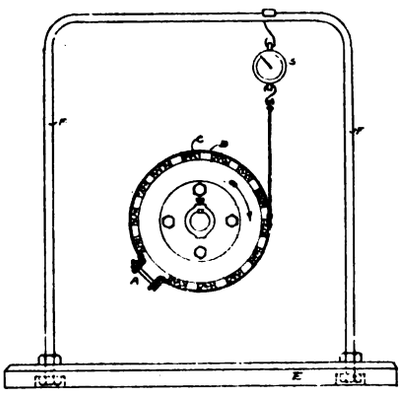

Fig. 1.

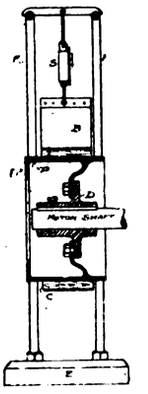

Fig. 2.

The writer, however, prefers the type of brake or dynamometer shown in Figs. 1 and 2; Fig. 1 being a front elevation and Fig. 2 a sectional side elevation. The brake consists of a rigid framing, F, secured to a base, E. This framing can be conveniently made up from pipes and strengthened by cross ties. A strip of thin sheet iron, B, having blocks of wood, C, secured to the inner side, is arranged round the pulley, P, as shown. A is a device, consisting of a bolt and nut, for increasing the pressure of the blocks on the pulley. The latter is of special construction, and should consist of a brass casting, P, secured to a boss, D, by four tap bolts. By this arrangement one pulley will suit for various sizes of shafts—a boss only being required for the particular size of shaft. At the outer edge of the pulley will be seen an annular projection, *f*, at right angles to the face of the former. The object of this is to keep the pulley cool when running, water being poured in the space thus formed before starting up. Centrifugal force keeps this water from coming out when the machine is running. By this means the writer has found that the friction can be kept constant for a complete test without the necessity for applying a lubricant to the face of the pulley.

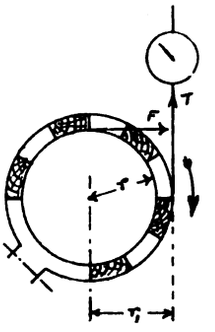

Fig. 3.

The method for calculating the horse-power when using this form of brake will be followed on reference to Fig. 3, which shows the brake in diagram form. In this figure

r represents the radius of the pulley (in feet);
r_1, radius of the sheet iron strip (in feet);
T, the reading (in pounds) on the spring balance, *s*, (Fig. 1); and
F_1 the force of friction at the face of the pulley.

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It is important to note that T should act tangential to r_1. By the principle of moments we have

$$F r = T r_1 \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

The work done per minute is

$$2 \pi r n F \text{ foot-pounds} \quad . \quad . \quad . \quad . \quad (2)$$

where n is the number of revolutions of the pulley per minute, and $\pi = 3{\cdot}1416$.

Hence from (1) and (2)

$$\text{Brake horse-power (B.H.P.)} = \frac{2 \pi r n T r_1}{r \times 33{,}000} = \frac{2 \pi n T r_1}{33{,}000}$$
$$= {\cdot}000019 \, T r_1 \, n.$$

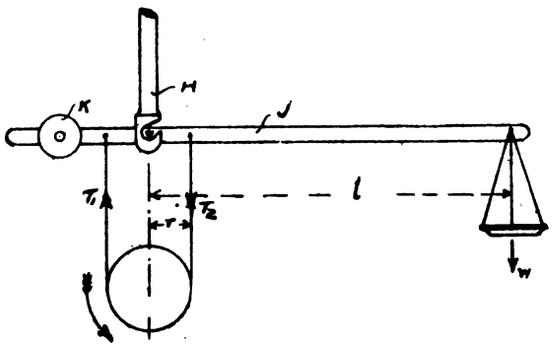

Fig. 4.

The corresponding equations for determining the brake horse-power when using the Prony brake (Fig. 4) are

$$(T_1 - T_2) r = W l \quad . \quad . \quad . \quad . \quad . \quad (3)$$

where T_1 and T_2 are the tensions in the tight and slack sides of the strap;

W, the weight (in pounds) needed to bring the lever, J, to its original position;

r, the radius of the pulley (in feet); and

l, the length of the lever (in feet) through which W acts.

The work done per minute is

$$2 \pi r n (T_1 - T_2) \text{ foot-pounds} \quad . \quad . \quad . \quad (4)$$

whence from (3) and (4)

$$\text{B.H.P.} = \frac{2 \pi r n W l}{r \times 33{,}000} = \frac{2 \pi n W l}{33{,}000}$$
$$= {\cdot}000019 \, W l n.$$

The direction of rotation should in all cases be that shown by the arrow in the figures.

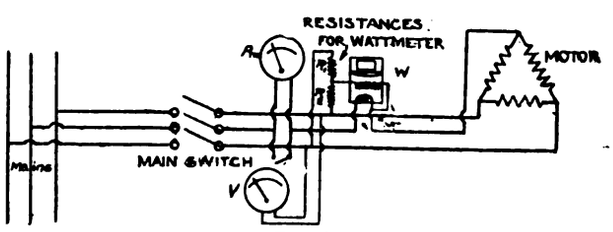

Fig. 5.

The connections for a three-phase induction motor test are shown in Fig. 5. A_m is the ammeter in series with one phase, as are also the series or main coil of the *indicating* wattmeter, W, while V is a voltmeter joined across the other two phases. The connections are for a symmetrically balanced three-phase circuit, which would occur in the motor under consideration. A little explanation is needed about the connection of the wattmeter, W. It will be seen from Fig. 5 that the series (or main) coils are in series with one phase, while the shunt (or pressure) coil is joined from the centre point of two resistances, R_1 R_2. These resistances should be equal, and both should be large in comparison with the resistance of the pressure coil. By means of these connections the total input can be measured directly on one wattmeter. When the test is being run, the following readings should be taken: amperes, volts, watts, speed of motor, and reading on spring balance of brake. The wattmeter is inserted in order to determine the "power factor"—*i.e.*, ratio between "true watts" and "apparent watts"—as if there be any phase difference between the current and voltage, the volt-ammeter reading, or "apparent watts," will be in excess of the true watts, as given by a wattmeter reading. If C be the reading on the ammeter, V that on the voltmeter, and W that on the wattmeter, then power factor $= \frac{W}{3 C V}$. If the number of poles of the motor be known, then the slip can be calculated, for the "synchronism" speed of the motor is

$$\text{revolutions per minute} = \frac{\text{frequency (cycles per second)}}{\text{pairs of stator poles}} \times 60$$

whence the slip is this number minus the actual number of revolutions per minute. The voltage is not given in the question, and if this exceeds 500, potential and current transformers should be used for the instruments.

With a single-phase motor, the readings and methods will be similar to the above, only that the voltmeter and ammeter readings will not have to be multiplied by 3 to give the apparent watts. Readings should be taken at various loads and curves plotted showing the relation between brake horse-power and efficiency, brake horse-power and power factor, brake horse-power and slip, and brake horse-power and amperes input per phase.—MONOPHASE.

Answer to No. 622 (*awarded* 7*s.* 6*d.*).—The above question would have been much more satisfactory, from an answering point of view, had "W. F. F." stated whether the motor was single or multiphase, also synchronous or

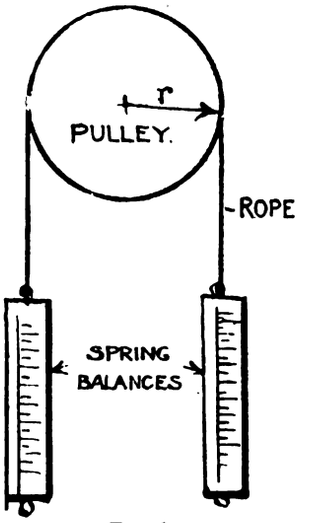

Fig. 1.

asynchronous. The probability being that it is a multiphase one, we will consider it so. The output of the motor will be tested on the brake. Place a rope over the pulley, and to each end attach a spring balance as in Fig. 1, so that each balance shows a small reading. Run the motor, and take simultaneous readings of spring balances and speed of motor. The output of motor in brake horse-power is

$$\frac{P \times r \times 2 \pi n}{33{,}000},$$

where P is difference of readings on spring balances;

r = rod of pulley; and

n = speed in revolutions per minute.

The above will hold good both for synchronous and asynchronous machines. Now consider the motor to be of the asynchronous three-phase type. Fig. 2 shows the diagram of connections necessary. The sum of the wattmeter readings gives the actual power supplied to the motor. If only one wattmeter is available, Fig. 3 shows diagram of connections, the wattmeter connection, which is dotted in the figure, being first connected to one main and the reading taken, and then to the other main as indicated, and the reading taken, the sum of the readings again gives the actual power supplied to motor. The two latter readings should be taken as quickly as possible, and at the same time as the readings of the spring balances and speed. The product of the readings of the voltmeter and ammeter $\times \sqrt{3}$ gives the apparent power supplied to motor. The power measured by the watt-

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meters, volt and ammeters must be divided by 746: this gives us the input to motor in horse-power. The actual efficiency of the machine is obtained by dividing the

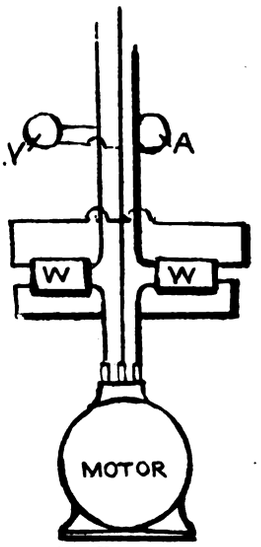


FIG. 2.—A, ammeter; V, voltmeter; W, wattmeter.

output as measured by the brake by the actual input (both values being in horse-power) and multiplying the answer by 100: this gives the actual efficiency as a percentage.

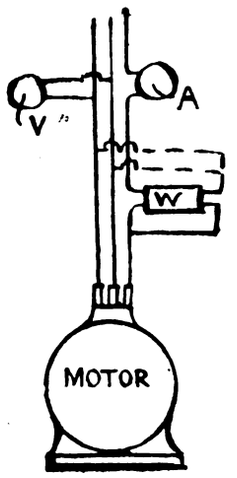


FIG. 3.—A, ammeter; V, voltmeter; W, wattmeter.

The apparent efficiency is got by dividing output by apparent input, and multiplying result by 100. The actual input divided by the apparent output gives us the power factor of the motor at that load. Take several

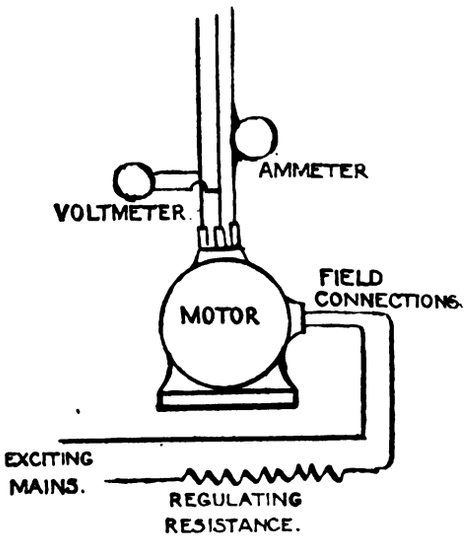
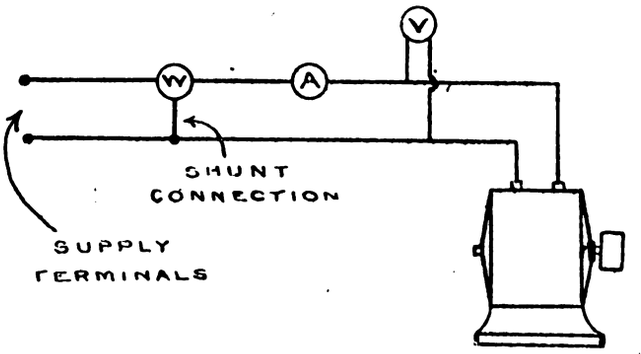


FIG. 4.

fresh sets of readings, after altering the initial readings of the balances before starting, by shortening the rope a little, and we obtain the efficiencies and power factors of the motor at different loads.

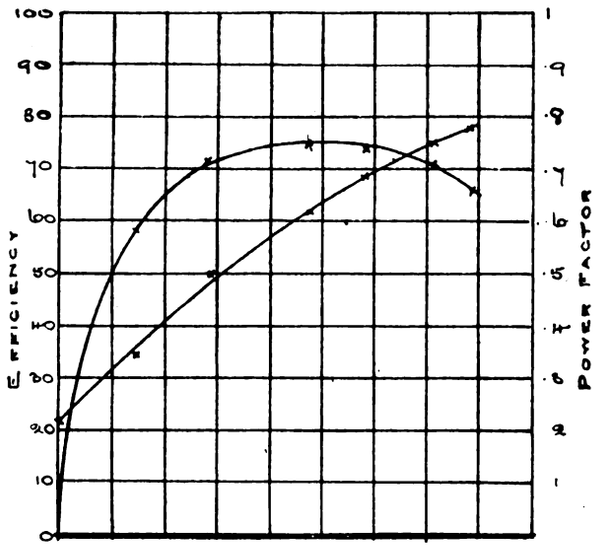
Now consider the motor of the synchronous type. The brake test is exactly the same as the previous case, but the only instruments *necessary* for the input are a voltmeter and ammeter. Fig. 4 shows the diagram of connections. When the motor has been started, it will be found that, by increasing and diminishing the exciting current, the armature current will also increase and decrease although the load is kept constant. Adjust the exciting current of the motor until the current taken by armature of motor is a minimum, and then take simultaneous readings of volts, amperes, and also the brake readings as before. The power given to motor is product of voltmeter and ammeter reading $\times \sqrt{3}$ and divided by 746. Divide output of motor by input, and we obtain the efficiency. If desired, the wattmeter can be inserted instead of the volt and ammeter.—ERG.

Answer to No. 622 (*awarded* 5*s.*).—To measure the efficiency of a single-phase motor the following instruments are required: a voltmeter suitable for measuring the voltage across the terminals of the motor, an ammeter or ampere-balance to measure the total current taken by



the motor, a wattmeter to measure the true watts, a brake of some kind to measure the power at the motor pulley, and a speed indicator. If a wattmeter is not available, a Siemens dynamometer can be utilised by inserting a non-inductive resistance in series with the movable coil and connecting it across the supply mains. It is a simple matter to calculate the number of watts represented by each degree of the dynamometer scale from the constant of the instrument and the amount of resistance inserted. The Soames absorption dynamometer is a good brake for small motors, but it is not a difficult matter to extemporise a brake. A tachometer, if reliable, is much to be preferred to a speed counter, but the latter will do quite well. The instruments should be connected up as shown in the sketch.

Readings of all the instruments should be taken at no



load, full load, and as many points between as is desired, the load being adjusted by the brake. The speed should also be taken at each load. From these readings the efficiency at each load can be calculated, and an efficiency

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curve can be plotted. The accuracy of these results will depend on the accuracy of the instruments employed and the care taken in making observations. The accompanying

Load.	Volts.	Apparent watts.	True watts.	E.H.P.	B.H.P.	Efficiency per cent.	Power factor.	Speed.
Starting light	214	6,492	4,194	5·62	0	—	·62	—
	214	2,419	485	·65	0	—	·22	3,066
	214	2,617	909	1·22	·71	58	·34	3,106
	213	2,992	1,478	1·98	1·43	72	·50	3,118
	212	3,578	2,316	3·10	2·31	75	·62	3,088
	210	4,358	2,918	3·91	2·85	73	·67	3,098
	210	4,925	3,696	4·95	3·52	71	·75	3,060
Full	208	5,660	4,415	5·91	3·90	66	·78	3,000

table and curve give the results of a series of tests made on a 4-b.h.p. motor in the manner described above. In this case a Siemens dynamometer was used as a wattmeter, and an ordinary voltmeter and ammeter were used.—E. I.

FULHAM ELECTRICITY WORKS.

REPORT ON PARALLEL RUNNING.

It will be remembered that in the early part of this year the Fulham Council instructed Mr. James Swinburne to report on the working of the electricity works. This report was to cover the following grounds: (1) the adaptability, efficiency, and suitability of the whole of the plant at or in connection with the Fulham electricity works; and (2) the design and construction of the station. Messrs. Swinburne, Cooper, and Baillie's report, dated Oct. 9, 1903, reads as follows:

"In pursuance of instructions we received, we have made numerous visits to the Fulham electricity works, and have carefully examined the working of the plant, and in this we have given especial attention to the point specifically mentioned—namely, the parallel running of the alternators. As regards the design and arrangement of the station, it would probably be of little use for us to discuss such questions as whether it would have been better to have adopted direct current or alternating current in place of the existing two-phase system, or other broad questions of design. These are very largely matters of opinion, and it would be as useless as it is easy to criticise what has been done, and, in the light of later experience, to point out where changes in the design would have led to greater convenience in working. We consider that the original design of the station is, broadly, good and quite satisfactory, and reflects credit on those concerned with it. Our report deals essentially with details of improvements that can be carried out in extending with present knowledge and experience. Certain portions of the plant do, we consider, require alteration, either immediately or when the increasing load calls for the erection of additional plant, and what we have mainly considered in this report is, to what extent additional plant should be laid down on the lines of the existing plant, and to what extent the present arrangement should be modified.

"*Alternate-Current Generators.*—One of the first questions we considered was the behaviour of the alternators, complaints having been received from consumers of unsteadiness in the light in the early evening. When the load is light enough for one machine to do the whole work, there is no difficulty; but when a second machine is put in parallel, the running is far from perfect. There is what is technically known as 'hunting,' and this gives rise to unsteadiness in the lights of a kind that may be very annoying to consumers. As the load increases as more light comes on, this hunting and the consequent flicker of the lights goes down, and finally practically disappears. Though it was not within the reference, we have carried out a good deal of experimenting with your machines, in which work we received all assistance from your engineers. We naturally could only take the machines as they are, and examined them to find if the hunting is due to faulty governors, or other cause that could be easily remedied. It is not caused by the governors, and we have so far found no means of stopping it. We could suggest several methods which might reduce the evil. Running the engines at a higher speed has been found by your engineers to be beneficial, and we have no doubt that the speed could be increased sufficiently to entirely stop hunting. We could not, however, advise this course, owing to the danger attendant in running engines at much above their normal speed. Another method would be to modify the weight of the flywheel rim. This would probably remedy the evil, but here, again, we do not recommend this form of experiment. A third method would be to fit what are known as 'amortisseurs' on the pole-pieces of the alternator. This would certainly diminish the hunting, but might not be sufficient to stop it altogether. We shall be happy to go on with these experiments if desired, but we do not think it necessary, as the matter will soon be of little importance. In the first place, your engineers have studied the regulation of these engines, and work the paralleling with such care that the hunting is reduced to a minimum, and only lasts a short time each evening. In addition to this you have now a Belliss set which is practically ready for running; and your customers are rapidly increasing in number. The day load can then be run by one of the small engines until it is full up. This will be pretty early, that is to say, before it is very dark. Then the Belliss set will be started, and will take the whole load, until it is fully loaded. Then the smaller engines will be added one by one as needed. We think this will overcome the difficulty and prevent any further complaint. In any case we would advise that the working of the station with the Belliss set be tried before entering on any costly alterations to the alternators, which after all might not quite eliminate flickering in the lights.

"As to extensions of the engine-room, at present you are putting in a Belliss set, which is practically finished. At the rate you are developing you will soon have to consider further extensions. As a station increases in size the size of its engines should increase too, and it is quite possible it may pay you better rather to replace one of the smaller horizontal steam dynamos with a large vertical set which takes the same or less room, than to go to the expense of enlarging the buildings and making more foundations. This suggestion, which is due to your engineer, Mr. Fuller, will demand a careful estimate, which can only be made at the time when you have settled what extension to make. We do not think any blame can be attached to the engine or dynamo makers, or to anyone else, as regards the trouble; in the present state of knowledge, 'hunting' is rather a misfortune than an avoidable evil, and certainly credit is due to your staff for the care with which they have minimised the evil.

"*Dust Destructors.*—We have nothing to say against the dust destructors; quite the reverse. We are putting in the same type elsewhere, and consider your plant thoroughly efficient, but we do not think the arrangement of the destructors in the boiler-house good. While the station is young the destructors are especially economical, but the station will increase far faster than the refuse to be burned. The boiler-house should not therefore be sacrificed for the destructors in any way. The present state of affairs in the boiler-house is far from satisfactory, the intolerable atmosphere of dust and smoke from the destructors being injurious both to health and to machinery in the boiler-house. The best arrangement would be to have the destructors walled off from the boiler-house and to be as open as possible, and, in making extensions in the boiler plant, it will have to be carefully considered whether the advantage of such an arrangement would not warrant the expense either of shifting some of the boilers and destructor cells, or of discarding some of the present boilers. If this be not done, we would suggest the less drastic but less perfect remedy of furnishing the cell doors with hoods leading into a flue with up-draught produced either naturally by connection with the main flue or by a fan. The system is used by Messrs. Horsfall in connection with their destructors, and gives satisfactory results. The expense of fitting would be, of course, far less than that of shifting the position of boilers and cells.

"*Economisers.*—The economisers have given rise to trouble from a rapid deterioration of their tubes. This is probably due to the action of the gases from the dust destructors, and is, we think, unavoidable. We gather that the cost of renewal of the tubes would be so great as to annul the advantages of the economisers. Under these conditions we think it would be best to cease using economisers in the flues from the destructors. The economisers need not be idle, however, as before long the increasing load will require the use of boilers which are purely coal-fed, and they can then be fixed in the flues from these boilers.

"*Feed Pumps.*—These we consider require attention in the immediate future. There are at present only two steam-pumps, which are used simultaneously. If one were under repair or broke down, the other would be hard pressed, and might in turn break down and cause a complete stoppage of the station. Further, the pumps are located in an inconvenient position, being too far from the boilers, the attendants of which have to regulate them. On the other hand, we fear that pumps in the boiler-house with its present atmosphere of dust might give trouble. We would recommend replacing the existing pumps by others of a more suitable type, rather than adding to those now installed. The new pumps should be fixed in the boiler-house if the dust question be dealt with in time, and if not in the most convenient position available which is free from dust.

"*Circulating Pumps.*—There are at present four small centrifugal pumps, and in view of their consumption of energy we think they might be with advantage replaced with one large pump and a spare.

"*Well Pump.*—We believe it would lead to more economical running if this were replaced by a steam-pump, more suited to the work. There is, however, no immediate need to alter this or the circulating pumps.

"*Condensers.*—These appear to be most satisfactory, with the one trouble that the water taken from the river carries with it a considerable quantity of fine sand, which entails continual work for its removal from the tanks. This trouble could be avoided by replacing the present Korting condensers by a surface condenser in the river, which could be of comparatively small size. We think it very questionable, however, whether this would be worth doing. It would be a matter of calculation between the cost of labour in cleaning out the sand and the capital cost of the new condenser. As to the engines, we would recommend the adoption of safety governors. The present governors have dashpots, which have had to be regulated to secure as good parallel running as possible. This made the engine system unstable at very light loads, and the safety or runaway gear has had to be detached, as it was apt to act without occasion. The result is that an engine might, under certain circumstances, run away and burst its flywheel—a most serious matter. This should be attended to at once. It is not that it is in the least likely an accident will occur, but that it is possible, and such an accident would probably be a very serious affair if it did occur.

"*Superheaters.*—At present there are no superheaters in your station, and the steam is sometimes rather wet. As the load is small,

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and the dust destructors provide a large part of it, there was no reason why superheaters should have been included in the original design. In the near future, however, we would recommend the adoption of superheaters in connection with purely coal-fed boilers."

We trust that the above report will end the lamentable disputes which have done much to hinder the progress of the Fulham undertaking. The details given in the report respecting parallel running are most interesting, and it recalls the paper read by Mr. H. Görges before the Verband Deutscher Elektrotechniker this year* on the same subject. In it he shows the bearing of the natural period of oscillation of the alternation on the success or otherwise of parallel running. A concrete example taken by the author shows that trouble was likely to occur at 90 revolutions per minute—*i.e.*, the speed of the Fulham engines. This conclusion is, of course, not a general one, but in this instance it applies.

EDINBURGH ELECTRIC LIGHTING ACCOUNTS.

Attached we give an abstract of the above accounts for the year ended May 15 last. The total expenditure on capital account on that date amounted to £800,710.

Dr. Revenue Account.	£	s.	d.
Generation—Coal and other fuel	10,561	10	4
Oil, engine-room stores, etc.	1,630	18	3
Salaries of engineers	1,279	3	5
Wages at station	2,951	5	3
Repairs, etc.—buildings	208	10	3
Machinery and plant and instruments	4,246	6	4
Distribution—Salaries of engineers	216	19	9
Wages	930	11	4
Repairs, etc., of mains and cables	1,934	12	1
Repairs and maintenance of meters	873	9	11
Public lamps—wages	2,539	2	2
Carbons	707	6	10
Repairs	823	1	5
Rents	12	10	6
Feu-duties of stations	396	1	8
Rates and taxes	5,554	19	0
Insurance	1,073	8	4
Management—Salaries of engineers	500	0	0
General establishment charges	1,370	1	8
Stationery and printing	206	7	2
General expenses—proportion	2,320	0	0
Miscellaneous—Expenses connected with loans	587	14	8
Allowances to dependants of army reservists	21	9	3
Maintenance of properties let to tenants	125	3	0
Law expenses	49	9	7
	41,120	2	9
Surplus carried to net revenue account	62,244	16	7
	£103,364	19	4

Cr.	£	s.	d.
Sale of current per meter—private lighting	81,006	17	1
Motor power	10,547	2	10
Charges for arc lamps—public lighting	11,504	17	7
Private lighting	13	0	0
Meter rents	61	17	0
Rents of properties in Torphichen-street	218	0	0
Miscellaneous receipts	13	4	10
	£103,364	19	4

Balance-Sheet.

Dr. Liabilities.	£	s.	d.
Bank balance	14,407	4	2
Sundry creditors	450	8	0
Deposits by consumers	116	10	0
Reserve fund	8,224	1	0
Contributions towards liquidation of capital expenditure	114,185	11	2
Premium reserve	2,554	18	6
Net revenue account balance	14,532	0	8
	£173,681	16	6

Cr. Assets.	£	s.	d.
Capital account—balance at debit thereof	116,740	9	8
Stores on hand	3,880	7	3
Advance to resident engineer to meet petty outlay	50	0	0
Sundry debtors	25,575	15	7
Reserve fund investment	27,436	4	0
	£173,681	16	6

Statement of Electricity Generated, Sold, etc.

Quantity generated in B.T. units			10,196,954
Quantity sold	Private lighting	6,019,815	
	Motor power	1,695,153	8,995,808
	Arc lamps	1,280,840	
Quantity used in stations			390,624
Quantity unaccounted for			810,522

* *Electrical Engineer*, vol. xxxii., pp. 171, 199, and 284.

ST. HELENS ELECTRIC LIGHTING ACCOUNTS.

Below we present abstracts of the above accounts for the year ended March 31 last. The total capital expenditure on that date amounted to £132,658.

Dr. Revenue Account.	£	s.	d.
Coal or other fuel, etc.	1,336	2	2
Oil, water, engine-room stores, etc.	204	11	8
Wages at generating stations	881	18	6
Repairs and maintenance of buildings and plant	1,347	17	0
Repairs, etc., of mains and free wiring	308	19	3
Repairs, etc., of transformers, meters, switches, etc.	13	16	2
Repairs, etc., of overhead equipment	1,044	19	2
Rents payable	166	17	8
Rates and taxes	186	5	0
Salaries—engineer's department	587	0	0
Accountant and clerical staff	491	15	0
Town clerk and treasurer's departments	150	0	0
General establishment charges	301	19	5
Interest on loans, etc.	3,959	5	11
Sinking funds, repayment of loans, and stock redemption fund	3,742	16	11
Superannuation fund	6	18	10
Subway charges	51	3	11
Insurances, etc.	47	16	9
Total expenditure	14,830	3	4
Amount carried to net revenue account	576	12	3
Balance profit for the year	£15,406	15	7

Cr.	£	s.	d.
Sale of current, less discount, etc.	12,365	10	8
Public lighting	215	17	2
Rental of meters	33	16	7
Sale and repair of lamps	8	16	8
Motor account	69	1	10
Fitting account	95	12	0
Rents receivable (traction)	2,497	8	8
Interest—technical education *re* purchase of plant	17	4	7
Ditto, gas account	103	7	5
	£15,406	15	7

General Balance-Sheet.

Dr. Liabilities.	£	s.	d.
Capital account, less amount paid	99,121	8	8
Sundry creditors	2,195	17	11
Net revenue account—balance at credit thereof	576	12	3
Sinking fund account	4,085	8	1
Reserve fund account	487	4	10
Deposits (consumers)	479	12	5
Parr's Bank, Limited (overdraft)	36,213	14	1
Due to treasurer	48	5	5
Stock redemption fund	657	11	3
Premium on stock	354	4	6
Loans repaid from revenue account	5,144	6	10
Stock redeemed	1,080	0	0
	£150,444	6	3

Cr. Assets.	£	s.	d.
Capital account—amount expended on works	132,658	7	6
Stores on hand	5,057	5	2
Sundry debtors for current supplied	2,765	12	4
Other debtors	4,409	19	7
Suspense account	78	2	4
Parr's Bank, Limited, stock redemption fund	1,389	11	3
Parr's Bank, Limited, sinking funds	4,085	8	1
	£150,444	6	3

Statement of Electricity Generated, Sold, etc.

Quantity generated in B.T. units			1,780 468
Quantity sold	Public lamps	51,704	
	By contract	1,014,218	1,514,745
	Private consumers by meter	448,823	
Quantity lost in batteries			138,012
Quantity used on works			77,246
Total quantity accounted for			1,730,033
Quantity not accounted for			50,465
Total maximum supply demanded (kw.)			874

Number of public lamps, 35.

FORTHCOMING EVENTS.

Friday, Oct. 23.

Junior Institution of Engineers.—At 8 p.m., annual general meeting, Westminster Palace Hotel.

Physical Society of London.—At 5 p.m., first ordinary meeting. Papers: "The Bending of Magnetometer Deflection Bars," by Dr. C. Chree, F.R.S.; "On the Magnetism of Basalt and the Magnetic Behaviour of Basaltic Bars when Heated in Air," by Dr. G. E. Allen; "Some Experiments with Electrical Oscillations," by Dr. W. Watson.

Monday, Oct. 26.

National Free Labour Association.—Eleventh annual congress at the Memorial Hall, London.

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TO CORRESPONDENTS.

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All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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PIONEERING BUSINESS.

The discussions between our leading statesmen which are now taking place on the fiscal policy of this country and her colonies, will be closely followed by our manufacturers. The questions involved are of vital importance to the electrical industry and to the thousands of employés connected with the same. Under the strong light which has been brought to bear on the state of our various industries, it has been unfortunately shown that certain of these are on the down grade, due, as we believe, to the fiscal policy of foreign countries. The figures published clearly show that our markets for manufactured goods are being restricted, and that without we undertake some pioneering work to develop new markets or to improve old ones, other industries will follow those which have already begun to decay. The figures, in fact, show the relative importance of the business and the technical side of a manufacturer's undertaking, and at the same time refute the too frequent argument that technical education is all that is required to enable us to hold our supremacy as a manufacturing nation. In other words, we may educate the rising generation up to the highest pitch and secure, as is now being tried, a closer relationship between our technical education and the manufacturers. All this will be quite useless unless the manufacturer, assisted though he may be with the highest technical skill, has a market for the goods he produces. It is for this reason that the business staff of a firm command higher remuneration than the purely technical man, who, in spite of a good college education, is not able to influence the sales directly. It is interesting in this respect to review the steps by which foreign firms have proceeded when pioneering for electrical business in this country. In the first instance all the firms who have been at all successful in this respect have found it necessary to spend large sums in order to get their goods on our market. The mode of expending these sums is exceedingly simple in view of the fact that the bulk of electrical work in this country is put up to public tender. The foreign manufacturer selects a contract which will enable him to show what he can do, and then offers to carry out the work below cost price. The loss on the contract is put down to pioneering expenses, and he looks to recoup himself for this loss by extra profit on other orders to be obtained. Unfortunately for him, and still more unfortunately for our home manufacturers, the number of firms from abroad wishing to build up business on these lines in our free market in Great Britain is by no means limited. The result has been that first American, and latterly German and Belgian, firms have taken these pioneering orders at low and unremunerative prices, with the result that the home market has been more or less spoiled for all concerned. An interesting incident has recently been brought to our notice which shows how far this temporary interference with our home business might be reduced under a new fiscal policy. A Continental firm, whose country we need not specify, recently determined to try for its share of the business to be had in this country. It had selected its engineer and manager, and resigned itself to accepting a certain amount of pioneering business at a loss in order to gain some advertising orders. The whole scheme was abandoned, however, after the members of the firm had read Mr. Chamberlain's Glasgow speech. The expenses which these various foreign firms have borne in order to build up new markets for their goods in this country and elsewhere are quite legitimate in business, and in certain instances have been quite warranted by subsequent events. It is noteworthy, however, that both the British Thomson-Houston

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Company and the British Westinghouse Company have found it advantageous to start as home manufacturers, so that they may now be looked upon more in the light of English undertakings. By so doing they become directly interested in the progress of electrical industries in this country, and share in the cost of maintaining our markets both at home and abroad. It is interesting to compare the above progress of electrical undertakings with the progress of the British Empire as a whole. In the eighteenth and nineteenth centuries England spent large capital sums on the building up of her Colonies, which sums were free gifts to the same, almost comparable with the pioneering expenses referred to above. They were, however, taxes on the inhabitants of England, which have since been remunerative in sentiment, if not in cash. They may be looked upon also as the prime cost of establishing markets, which has been entirely borne by us, although we have left these markets equally open to other manufacturing nations. Viewed in this light, Mr. Chamberlain's proposals by giving preferential trade throughout the Empire will only make a fair return for pioneering expenses borne in the past. These proposals, if adopted, will also stimulate Colonial development, and by so doing render these markets which we have developed even more valuable to us than they are at present.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

PRIORITY IN OIL-BREAK SWITCHES.

SIR,—Reverting to Mr. Woodhouse's letter in your issue of Oct. 2, the oil-break switches designed by Mr. Partridge in 1891 were used for service in street boxes, whereas I read Messrs. Ferranti Limited letter of the previous issue to refer to central-station switchgears of importance. I am open to correction, but I do not think Mr. Partridge intended to apply the idea in its initial stages to large central-station switches, otherwise he would have done so on the important extra high-tension switchboard work which he designed for the London Electric Supply Company, and also for the Metropolitan Company, about the period in question.

However, whilst agreeing that considerable credit is due to Mr. Partridge, it will be remembered that others have experimented with the idea. For example, it was used some 25 years ago in connection with Prof. Pepper's induction coil at the old Polytechnic in Regent-street.

Messrs. Ferranti Limited were, I believe, the first to apply the idea for the purpose of central-station switchboards of moment. In any case, it would appear that this great feature in switchgear design emanated from British, and not from Continental designers.—Yours, etc.,

H. W. CLOTHIER.

INDEPENDENT TELEPHONY.

SIR,—Referring to the interesting article on "Independent Telephony in Great Britain," by Messrs. Gardner and Home, which appeared in your issue of the 2nd inst., I would like to point out that, as put by the writers, the increase in the cost of a multiple switchboard as the subscribers increase does not appear a very considerable item, but the case has hardly been put fairly.

I give below the number of multiple jacks required for increases from 800 to 6,000, from which it will be seen that the amount concerned, if only estimated at 2s. per jack, is a very serious item. For 800 subscribers only three multiple jacks per line are required, but this figure continually increases as subscribers are added, and for an exchange of 3,000 to 3,300 subscribers the number required is 11 per line; for an exchange of 6,000 subscribers, 120,000 multiple jacks would be required, or 20 per line, and the same rate of increase would, of course, go on continually. But the multiple jack itself is not by any means the only or the chief cost; every jack involves additional cabling, which, apart from the material, necessitates very considerable labour. I think it only fair that this should be pointed out.

Subscribers.	Multiple jacks.	Multiple jacks per line.
800	2,400	3
1,200	4,800	4
1,600	9,600	6
2,000	1,400	7
2,400	1,920	8
2,800	28,000	10
3,200	35,200	11
6,000	12,000	20

So that the jacks alone at 2s. each would cost 34s. *per line* more for 6,000 subscribers than for 800!—Yours, etc.,

R. M.

REVIEWS.

Practical Notes on Electric Mains.* By B. L. R. LEE. Biggs and Co.

FROM AN EXPERT CORRESPONDENT.

This is a most unpretentious-looking pamphlet, and it has evidently been written in a hurry during the odd moments snatched from a busy life. Nevertheless, it is a book that will be welcomed by the ever-increasing army of town distributing engineers, cable men, and by contractors generally who aim at a broader sphere of action than fixing wood casing and gas barrel.

The text of the book is that a higher factor of safety should be allowed for underground work than is at present in general vogue. This is not actually mentioned in the text, but one can draw conclusions from such items as the following:

Page 17: "Wood for troughing should be at least 1¼in. thick," whereas in practice ¾in. to 1in. are the most usual thicknesses.

Page 16: "Junction pieces should be at least 1ft. long." Six inches is really ample, and it is seldom that any are used at all, as the compound successfully joints the ends of the abutting troughs together unless very carelessly poured in.

Page 17: "Each two lengths of (earthenware) troughing ought to fit together by self-locking socketed joints." There is no self-locking joint on the market, however, and the precaution would be usually considered unnecessary, for, as before mentioned, the compound makes a binding joint almost equal to cement, irrespective of the socket itself.

Page 26: "Cable ends buried in the ground should be in wooden boxes 14in. long." This measurement seems exact enough to have been worked out by slide rule, but the round figure of 6in. is generally used if an old tomato can is not available.

Page 26: "Cables (ends) should be lapped over not less than 2ft. 6in. to allow for testing and jointing." A 1ft. lap is to be considered ample for most work, and the cost of the 5ft. cut off on ·5, ·25, ·5 square inch main, for instance, would be quite £1.

Page 27: "For mechanical reasons no cable should be laid that has an insulation wall less than $\frac{3}{16}$in. thickness." This equals 187 mils, and, further than stating that the C.M.A. sanction from 80 mils for ·025 square inch, to 130 mils for 1 square inch for 500 volts, comment is needless. All the same, Mr. Lee errs on the right side.

Page 29: "Wiped joints should not be used under any circumstances," will be a shock to a lot of people who have used wiped joints for a considerable time with reasonable success, and to whom a simple arrangement for lead continuity, and small diameter of joint, appeal. There is

[* This review is from an expert correspondent, and as our desire is to obtain the best practical information, we have no hesitation in givin expression to what may prove controversial points.—ED., *E.E.*]

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no doubt that a lot of trouble has been caused by plumbed joints being made by "hatters," but given an experienced, careful man and a solid system of laying, wiped joints are not appreciably inferior to cast-iron boxes.

The author is evidently a man with opinions of his own, and is not afraid to tilt against the fetishes of standard practice. Thus:

Page 8: His recommendation that "no attempt to earth the lead of any continuous-current cables should be made" is testimony enough to his heterodoxy, although his further remark (page 9) that "lead covering is better left without a serving of braid or yarn" seems to contradict this statement, and certainly omits to take into account the mechanical protection afforded by such serving.

He further stands up (page 10) for drawn-in distributors on the ground that withdrawal is "so easily done, even after it has been tapped in many places with service joints."

The methods described (page 10) of jointing cast-iron pipes with neat cement, of (page 11) building brick boxes opposite every other party wall during the mainlaying, and (page 12) of earthing the iron frames of manholes preferably to the nearest water-mains, are all examples of unusualities. Cast-iron pipes should follow the standard practice of lead jointing, if only for the sake of electrical conductivity. The second item is not much used because of the generally useless expense incurred, and reminds one of Prof. Fleming's suggestion made in a Cantor lecture in 1896, that each house or shop that the mains run past should have a service connected and laid up to a terminal box placed inside at the time of main-laying, on the chance of them becoming consumers in the course of time. The third item as to earthing manhole covers does not seem to take into account the handiness of using the lead sheathing, where used, of the cables, themselves earthed, for the Board of Trade connection.

In stating that (page 12) "cast iron cannot be recommended for conduits, as there seems always to be a deleterious action going on between the cast iron and the cable," the author is directly opposed to the standard practice of a large company interested in electric traction, who have laid this cast-iron pipe system in dozens of towns as the one most likely to preserve the cables (at, perhaps, the pipe's own expense) from electrolysis, and galvanic action is evidently an inappreciable quantity. His criticism of a generally used method of building watertight (?) manholes by means of two walls with a meagre frilling of bitumen poured in between is, however, to be commended as practical.

Other matters of opinion, concerning which there are other methods of operation than the one the author describes, may be cited as a further instance of the difficulty of writing a sufficiently complete practical treatise, even upon such a specialism as electrical distribution construction. The class of lubricant recommended (page 14) for drawing in cable is pure tallow worked up with powdered blacklead, but this makes positively too filthy a mess for a conscientious cable-hand to care to deal with, and is expensive. There are petroleum residues to be obtained which are innocuous, clean, and much cheaper. Also the method described (page 14) of fastening the draw rope to the cable end means wasting time and material for moderate runs with medium size cables, compared with the well-tried device of lashing the rope alongside the cable for about 18in. For long runs and heavy cable, a wrought-iron half-sleeve about 9in. long (with an eye at the end) can be used to partly encircle the cable end. Steel pins are driven through holes in this right through the cable, and piano wire is used to lash the whole thing together to keep the pins in place, this being a quickly made solid attachment, with only 9in. of waste cable.

Further, the statement (page 14), that "20 men will be sufficient for the whole work of drawing in a 200-yard length of $^{37}/_{15}$ concentric cable," evidently applies to the old-fashioned "Yo-heave-ho" method. No mention is made of the various means of hauling in by crabs, with the saving of labour occasioned. In this instance six men and a foreman would do the work, two of them being amply sufficient to ease the cable off the drum. And the shrill whistle mentioned (page 15) as a signal for stopping the hauling-in gang, should be supplemented by a red flag fastened to a drain rod, so that, should the noise of traffic interfere, the flag can be displayed at any required height by screwing other drain rods on.

The swab of spun yarn recommended (page 15) to be pulled in advance of the draw rope "to clear the duct of any dirty water that may be there" will certainly absorb its capacity, but nothing further, and, in any case, the rope itself will do this work much more completely. It should be remembered that water inside conduits helps the progress of the cables through, and having once got there (through broken or faulty joints) it will certainly get there again, so that any special swabbing, except for actual obstacles, is a mere formality.

"Service cables should always be concentric in form" (page 65) is a maxim based upon the risk of burning holes in domestic gas-pipes, and is supported by three "ifs" and a "probably." For continuous current and convenience, however, two singles take a lot of beating.

There are a considerable number of fairly palpable slips in this work, and it is to be hoped that the author will have more leisure for proof correction when the second edition is called for, as it surely will be in a short time. Some of the slips are as follows:

Page 8: Fibre and paper insulated cables are mentioned as a class apart from rubber, bitumen, and lead-covered cables, but, of course, these classes of insulation require to be either rubber, bitumen, or lead sheathed for drawing into conduits.

Page 13: Duct stoppers are said to prevent the "accumulation" of gas, but surely "circulation through the manholes" is meant; as the gas gets in, as a general thing, through defective places in the conduits, and duct stoppers are meant to keep it there in comparative safety.

On page 16 wood troughing and bitumen filling are decried as insulators, but these they have no need to be (except in the very rare cases where bare copper is used). This fact is, however, properly appreciated on page 20, where it is stated "if the wood soon rots it does not matter, as the bitumen is still left to protect the cable." In fact, the comparatively ephemeral wood trough may be looked on merely as a former for the comparatively everlasting bitumen which envelopes the cable.

A somewhat singular suggestion (page 17) is that to iron trough makers regarding the advisability of their keeping in stock "bends and angle pieces for several different angles and radii. The bends and angle pieces should be made in both planes (vertical and horizontal), also right and left handed. The engineer would then be able to order a percentage of these bends over the total length of trough required." It should be remembered that there can be used over 50 different sizes and types of troughing between the standard measurements of 2in. by 2in. and 12in. by 4in. (which is about the maximum likely to be made) without even going into fractions of an inch, also that cast-iron troughs are very seldom used on account of their high cost; and as the bends, etc., could be as easily ordered at the same time as the troughing (which would almost certainly require to be specially made), there would be no advantage gained by the engineer or by the maker in keeping such a very risky and expensive stock.

"Earthenware" troughing is generally mentioned throughout the book, but no distinction is drawn between it and the widely different glazed stoneware, the latter of which is most certainly meant in several instances by reason of its special qualities.

Page 17: Lead-covered cable is stated as allowable on alternating supply, without any warning about single cables being tabu.

Page 20: The following statement (referring to a semi-solid system) is too loosely worded to be of much use to anyone: "A gang of about 25 men can easily lay and cover up a trench 200 yards long into which four cables have been drawn in one day if the trench is on the footway." What one wants to know is, Do these men dig the trench as well as cover it up? or is "trench" a misprint for "trough"? Also, have the cables been drawn into the trench (or trough) beforehand? It would appear so.

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In any case the price of 6d. per yard thus shown for labour is too low for the entire job of excavating, laying trough and cable, pitching in, covering with trough top, and temporary reinstatement of this length of trench; but which part of this work is referred to is not clear.

Ventilation by manhole covers is mentioned on page 21, without any suggestion as to the proper method. The ordinary ventilated manhole frame and cover is a delusion and a snare.

The author's ingenious suggestion on page 27 for the neutral of a triple-concentric cable to be made up of a braided armouring of iron wire is spoilt by his seeming assumption of perfect balancing on three-wire networks, which even a professor knows is impracticable.

"Armouring" is mentioned (pages 28 and 35) in connection with disc cutters and pressure testing, when evidently "lead sheathing" is meant.

Rubber solution (page 33) is debarred from most joints by the author, as it should be, but why is it recommended for vulcanised jointing, where there is already the heat and pressure that are alone necessary for rubber joints?

The manhole covers fitted with wood blocks (page 53) are surely not "wrought," but "cast," iron.

In a work of this nature, where practical experience counts for so much, there are likely to be some statements that are open to considerable question, and among them: Rubber cables are decried by the author (page 18) for solid systems on account of having given trouble, but this trouble surely has only occurred upon drawn-in systems, for which (despite the counter-recommendation on page 8) they are not fitted without special precautions being taken. Rubber cables laid solid, though expensive, are generally considered to make the most reliable system of main-laying.

On page 8 it is stated to be unsafe to draw lead-covered continuous-current cables into conduits, but surely the amount of this type installed giving satisfaction is abundant evidence to the contrary. It may be that this statement is founded on an experience of the further ordinance on page 8 that the lead of continuous-current cables should be insulated from earth.

The fairy tale about copper-strip mains swaying into contact when heavily loaded is repeated (page 21) in this otherwise practical work. A surplus of current will certainly cause a sag in the conductors, but it is likely that this and the succeeding arcing to earth has caused effects which surely could only be explained by science and art teachers as electromagnetic swingation.

There should be no doubt as to the position of a switch contained in a switchbox (page 31) if a brass indicator is attached to the turning plug outside the box. This points to "On" or "Off" exactly as the concealed switch has been left.

Mr. Lee is not an adept at damning with faint praise. He goes straight to the point. Cable and switchboard makers will writhe beneath his vitriolic pen on studying pp. 27, 34, and 61, where longitudinal rubber covering is derided, professional joint-box designers are scoffed at, and switchboard experts held up to ridicule. Contrariwise, certain makers of insulating tapes (page 34), transformers (page 56), petrifying paint (page 60), meters (page 66), arc lamps (page 72), trimming ladders (page 73) will chortle in their joy on seeing their goods mentioned approvingly.

As before stated, much remains to be said in this book on the subject of distribution, construction, and maintenance that has only been fringed upon, and its concluding lines show that the author appreciates this. It should be understood that although there seems to be abundant material for criticism, yet this proportion is really small compared with the amount of useful practical matter contained in the 70 odd pages under review. The subject of what is best practice for mains is not one that can be settled in an armchair, or even in a cable works laboratory, and the men who really know by bitter experience what should be used and how things should be done, are the ones who have little leisure to write about these things. This book would have been a still more useful one if the author had been confined to his room with a broken leg while writing it, and when the second edition comes off may we suggest a preliminary course of motorcar riding.

PERSONAL.

Mr. A. Mitchell, R.N.R., has been engaged about 18 months at Durban as chief engineer for Messrs. Dick, Kerr, and Co. for that firm's contract for the Corporation tramways, and completed his work in September. Prior to his departure for England, his late staff presented him, at a farewell dinner, with a handsome solid silver flask and cigar case, suitably engraved, as a mark of their esteem for him. The presentation was made on behalf of the staff by Mr. G. A. Webb, A.I.E.E., who has been responsible for the electrical portion of this plant, and who has acted as assistant engineer to Mr. Mitchell throughout the work. The Council of the Durban Corporation have voted Mr. Mitchell £100 as a mark of their appreciation for his expeditious work, enabling them to start their tramways on May 1, 1902, 11 weeks after his arrival from Camps Bay, Cape Colony, where he also was responsible for the erection of the Camps Bay tramway plant.

Mr. G. F. Metzger has resigned the office of chief engineer to the Manchester Corporation electricity department. (This paragraph was inadvertently left over last week.)

Mr. L. H. Euler, A.M.I.E.E., has been appointed teacher of electric lighting and power at the Walthamstow Technical Institute.

The salary of Mr. Weston, assistant engineer at Watford, has been increased from £100 to £120 per annum.

We regret to announce the death of Mr. W. C. Hart, an engineer of the Plymouth Corporation tramways, which occurred last week from the effects of an accident referred to in a previous issue.

The Burslem Town Council have appointed Mr. Ashton Bremner, of Oswestry, borough electrical engineer at a salary of £200 per annum.

Three candidates have been selected for the position of tramway manager to the London County Council—viz., Mr. Hamilton, manager Leeds tramways; Mr. Fell, manager Sheffield tramways; and Mr. Nicholson, who is connected with the management of a railway in Lancashire. The Highways Committee's last report states that in consequence of the retirement of Mr. W. Scott, the traffic manager of the London County Council's tramways, and since the resignation by Mr. Alfred Baker of the position of chief officer of tramways, Mr. Bruce has been in charge of the general work of the tramways department when Mr. Baker has been absent in Birmingham, and that he had discharged in a very satisfactory manner the important duties which had in consequence devolved on him. The committee recommend that Mr. J. K. Bruce be appointed, as from and including Oct. 20, 1903, traffic manager in the Council's tramways department, on the same conditions as those on which he has held the position of veterinary surgeon; that his appointment as veterinary surgeon be terminated as from the above-mentioned date; and that Mr. Bruce's salary be at once increased from £550 to £700 a year, rising by annual increments of £50 to £800. Mr. H. B. Taite, general assistant at the tramways head office, has resigned.

Mr. Frederick S. Grogan, A.M.I.E.E., who has been with the British Thomson-Houston Company for the past three years, has been appointed chief assistant engineer to the British Electric Equipment Company in London. Mr. Grogan, during his association with the British Thomson-Houston Company, has been chiefly engaged in tramway construction work, among other places at Huddersfield and Croydon, but latterly has been attached to the company's construction department at their Rugby works. Previously he was for five years an assistant engineer in the Corporation electric lighting works at Belfast.

The Penang Municipality are about to establish a system of electric lighting in the town, and Messrs. Lux Bros., electrical contractors, have sent out Mr. P. Pinker Evans to take charge of the work.

Mr. J. B. Clarke has been appointed as electrical engineer at Stourbridge at a salary of £200 per annum.

Mr. Yeaman, of Islington, who had been appointed electrical engineer at Morecambe, having declined the position Mr. Hall, of Bootle, has been selected.

APPOINTMENTS VACANT.

Cable Jointer, Erith, 45s., Oct. 24. See advertisement in last issue.

Switchboard Attendant, Fulham Borough Council, 25s., Oct. 23. See advertisement in last issue.

Lecturer, South-Western Polytechnic, Manresa-road, Chelsea, S.W., 12s. 6d. per night. See advertisement in last issue.

Clerk of Works, Shoreditch Borough Council's Electricity Department. Salary, £3. 3s. per week (working hours same as contractor), Oct. 31. Also King's Norton and Northfield Urban District Council, Nov. 2.

Engineering Assistant in a borough engineer's office in the vicinity of London, with experience in the construction and maintenance of electrical tramways. Salary, £160 per annum, with annual increments of £10 to a maximum of £200. Applications to be addressed to Box W 14, *Contract Journal* Office, 139-140, Salisbury-court, Fleet-street, E.C.

Correspondence Clerk, Woolwich Borough Council, £90 per annum, Nov. 2.

Improvers at high-tension alternating station, London. See advertisement.

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TRADE NOTICES AND NOVELTIES.

The Excello Flame Arc Lamp.

As mentioned in our last week's issue, the Union Electric Company, Limited, of 151, Queen Victoria-street, are putting on the market a new type of flame arc lamp. In view of the novel features of the same, we have, through the kindness of the company, been allowed to take photographs of the mechanism of this lamp in order to illustrate the advances made in its construction. This new lamp, to which the firm have given the trade name of "Excello," will burn for 18 hours at 10 amperes with one pair of carbons. In order to get these hours of burning with one trimming the carbons have to be lengthened, and the first feature of the lamp to which we wish to draw attention is that of the carbons used. With the

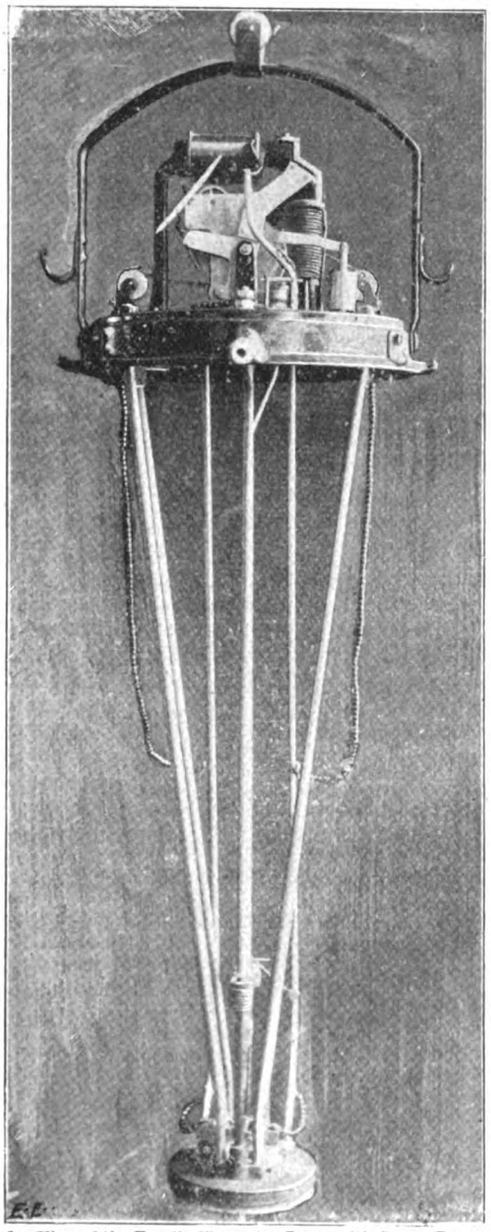

FIG. 1.—View of the Excello Flame Arc Lamp with Covers Removed.

increased length of carbon the drop in voltage in the same when the lamp is first trimmed is considerable, and it would interfere with the regulation. At first an attempt was made to ensure contact between the carbon and the clutches which hold the same in the lower part of the lamp, but it was found that after the lamp had been worked under commercial conditions, a connection at this point could not be relied upon. The difficulty has been ingeniously got over by using a thin metallic core in the carbon. For this purpose a hole is made through the length of the carbon and a metal wire is passed through the same. In order to get a good connection throughout the length, the wire is first passed through the hole in the carbon, and a length equal to the length of the carbon is then bent into a slightly zigzag form so that when it is drawn back the spring action at each of the bends secures a good pressure at the contacts between the wire and the carbon surrounding it. The hole for the metallic core is eccentrically placed in the carbon, leaving the middle free for the usual core, which is employed to carry the salts which give the characteristic colour to the arc. Fig. 1 shows a complete view of the mechanism of one of these arc lamps, which mechanism is, of course, encased when the lamp is in use. Fig. 2 is a larger view of the feeding mechanism, while Fig. 3 shows in more detail the lower part of the lamp. In it the two carbons can be seen projecting

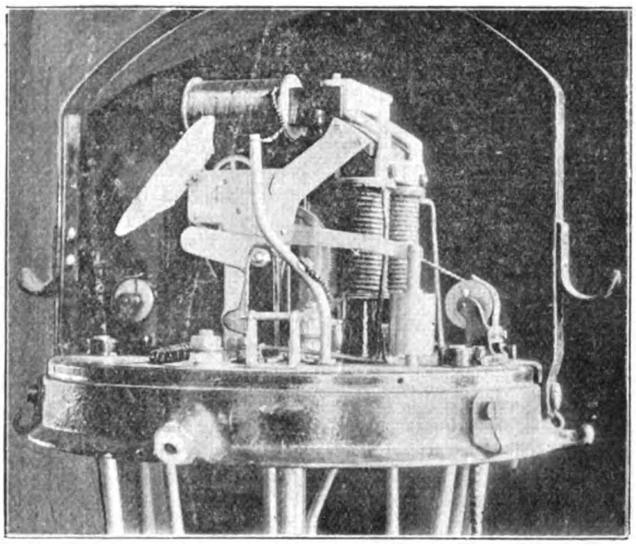

FIG. 2.—The Feed Mechanism.

through the fireproof material which forms a reflector to throw the light downwards. The two magnetic poles which blow the arc downwards can also be seen in the illustration, as can also the two small coils which excite this electromagnet. As will be seen from Fig. 2, these lamps are differentially wound. The arc is struck by the series coils, which operate on a long rod in

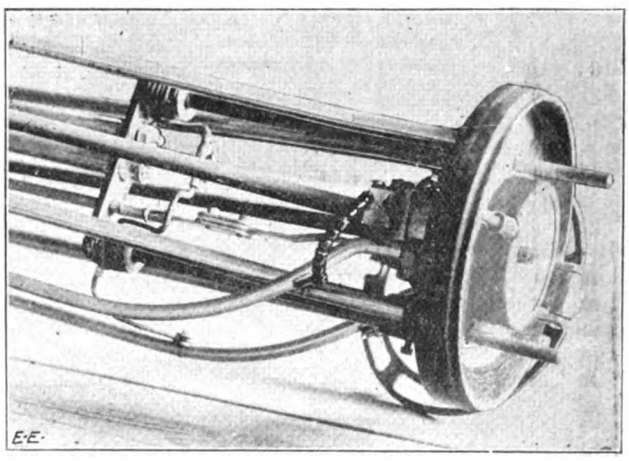

FIG. 3.—The Bottom of Lamp, showing Magnet for Deflecting the Arc down.

such a way as to draw the ends of the carbons apart horizontally. As the voltage across the arc increases, the shunt coils, which are seen in the horizontal position in Fig. 2, overpower the series coils, and by drawing over the common keeper, release the feeding gear and allow the carbons to descend. An ingenious arrangement is used to prevent the lamp being

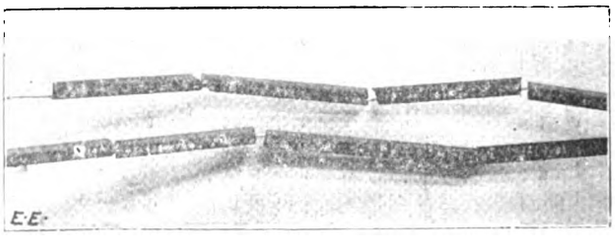

FIG. 4.—Carbon Broken to show the Metal Wire Core.

damaged when the carbons are nearly finished. Owing to the slight inclination between the carbons, there would be a tendency for the arc to travel up the same on to the carbon-holders if an ordinary stop-feed apparatus was used for this purpose. Instead of this, a catch on one of the rods is made to interrupt the shunt circuit of the lamp, whereupon the series magnets jerk the carbons apart and break the arc. The

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whole of the details of this lamp show careful design, and the workmanship leaves nothing to be desired. The characteristic colour of the lamp, combined with its long hours of burning with one trimming, make it extremely useful for street and railway lighting, while the large dock companies would find it of great service for wharves at which work has to be carried on continuously in winter months. The arrangement of the arc with the white reflector immediately over it gives a good distribution of light over the horizontal plane, as will be seen from the curve herewith (Fig. 5), which was taken on a 10-ampere

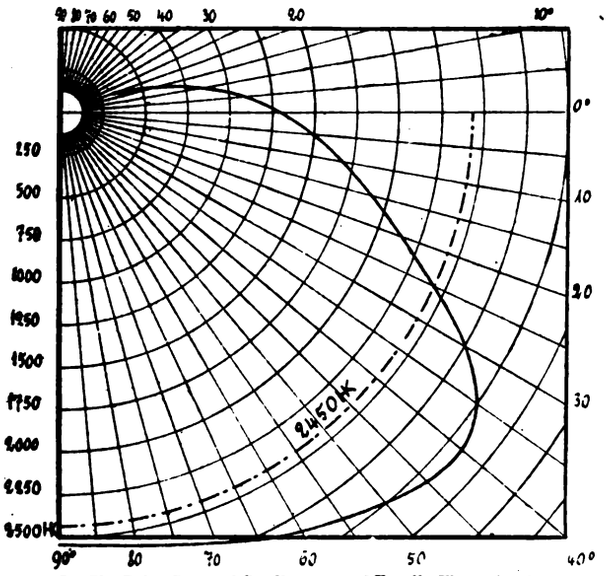
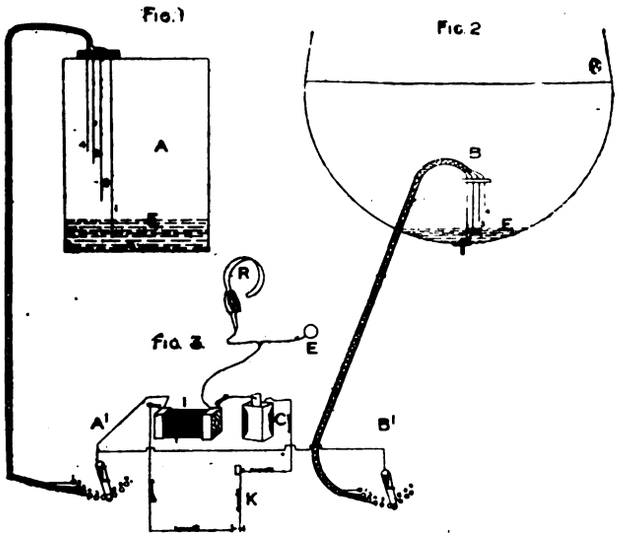


FIG. 5.—The Polar Curve of Candle-power of Excello Flame Arc Lamp.

arc with 48 volts between the carbons. The curve is given in Hefner candles.

Water-Level Indicator.

Mr. C. May, a partner in the firm of the May-Oatway Fire Appliances, Limited, of 92 and 94, Paul-street, Finsbury, is putting on the market an apparatus for ascertaining electrically the level of liquids from a distance. The apparatus is designed primarily for use on board ship, where a record is required of the amount of water in the ballast tanks, bilges, etc. The apparatus for carrying out the tests is illustrated in Figs. 1, 2, and 3, and will be readily understood by electrical engineers.



In each tank or compartment there is fixed a number of conductors of various lengths with their ends only exposed to the liquid. At the end of these rods a lead electrode is fixed in order to give more surface than would be obtained with the bared end of the insulated wire. These conducting wires are then led to a number of consecutive contacts, as illustrated in *Fig.* 3, and opposite each contact is marked the height from the bottom of the tank of the electrode connected to it. By means of an induction coil and a telephone, it can then be ascertained which of these electrodes is actually in the water and which are insulated above it. An officer on watch can readily ascertain in this way the depth of water in the various tanks. The testing arrangements for all the tanks could be grouped together at a convenient spot, and in this way much more reliable information can be obtained than is the case at present, when the ship's carpenter has to gauge approximately the water in the bilges, ballast tanks, etc. The apparatus is an exceedingly simple one. It can be viewed at the above-mentioned offices.

Nernst Lamps.

The Electrical Company, Limited, 122-124, Charing Cross-road, London, W.C., have just issued a new edition of their Nernst electric lamp pamphlet. This pamphlet contains a quantity of information, not the least interesting of which are the comparisons made between Nernst lamps of different types and ordinary incandescent lamps. These comparisons are all in favour of the Nernst lamp. True, the great saving effected in current is partly balanced by the extra cost for renewals entailed by the use of Nernst lamps in preference to ordinary incandescents, but even after adding this a substantial gain is shown in favour of the former type of lamp over a working period of 12 months, including 600 lighting hours. Full particulars are given of the "Luna" type, which, it will be remembered, was the subject of a recent notice in our columns. We understand that this type has been exceedingly well received on the market. Hitherto it has been supplied only for direct-current circuits, but alternating-current burners will shortly be introduced. Some useful hints are added concerning the treatment of the lamps, also several illustrations of their actual

Electrolier with B type Nernst Lamps.

application for interior lighting and street illumination. The accompanying illustration proves that the lamp lends itself to artistic embellishment. Several plainer designs of electroliers similarly fitted are shown in the pamphlet under notice, candle and projector Nernst lamps being further dealt with.

Blackwell "I.T.E." Circuit Breakers.

Catalogue No. 59 just issued by Messrs. Robert W. Blackwell and Co., Limited, 59, City-road, London, E.C., deals exclusively with this firm's well-known I.T.E. circuit breakers. Illustrations are given of a very large number of different types of the apparatus, and these bulk the catalogue out to some 130 pages, making it what Messrs. Blackwell believe to be the largest and most complete catalogue devoted to circuit breakers that has ever been issued; nor is this bulk due to superfluous matter. The numerous diagrams showing the manner of connecting the breakers in circuit should be especially useful. We understand that "I.T.E." circuit breakers have now been on the market for over 10 years. For the benefit of those unacquainted with the meaning of "I.T.E." it is explained that these letters stand for inverse time element, which may be defined in several ways—viz., that in inverse proportion to the current so is the time element of action; or, the heavier the current in excess of the normal the quicker the action; or again, the greater the danger the quicker the relief; or, better

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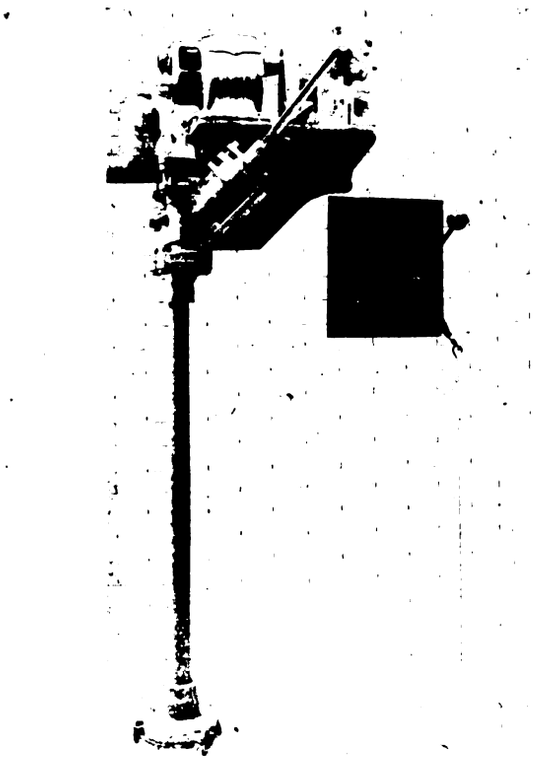
still, the time employed in opening a circuit is less as the nearer approach to a short-circuit.

Electrically-Driven Draw-Pit Pumps

For the purpose of dealing with the water that may accumulate in cable draw-pits and manholes, and for ordinary domestic use, the British Thomson-Houston Company, Limited, Rugby, have introduced a small combined motor and pump. The pump is of the double-throw, single-acting, plunger type, having a capacity of 7½ gallons per minute, and suitable for heads up to 55ft. The pump barrels are of special close-grained cast iron, with deep stuffing boxes fitted with glands and studs. The plungers, valves and seats, and connecting rods are of special hard and tough gunmetal. The sole-plate consists of a strong casting arranged to bolt on a wall, and is accurately machined to receive the pump barrels, motor, and gear-case. The pump is driven by a ¼-h.p. British Thomson-Houston motor through double-reduction gearing. The first reduction consists of cast-iron machine-cut spur gearing enclosed with a cast-iron guard. The second reduction is obtained by worm and worm-wheel, the worm being of steel and the worm-wheel gunmetal, running in oil and provided with a ball thrust bearing. The motor is controlled automatically by the rise and fall of the water in the pit raising and lowering a copper ball float connected by a rod to a fall-over switch, giving a quick make and break action. The pump is fitted with solid oil lubricators, and the motor with the usual oil-ring lubrication. This combined motor and



Electrically-Driven Draw-pit Pump.

pump requires very little attention, and is recommended for cases where drainage by gravitation is not available.

"Angold" Arc Lamps and Accessories.

We have received from the General Electric Company, Limited, 71, Queen Victoria-street, London, E.C., a copy of their new catalogue of "Angold" arc lamps and accessories. Among the many improvements made in the "Angold" lamp since it was first put on the market, our attention is called to the single-carbon type. It is maintained by the makers that the use of metal brakes and clutches does not ensure such a steady feed as is effected by rubber pads. Having regard to this fact, they have decided to adhere to the principle of the rubber brake, and have patented an arrangement for compensating the wear of the rubber, and at the same time getting an absolutely constant feed. To do this, a brake drum is employed which carries a band with rubber pads, one end of which is attached to a pulley controlled by a spiral spring in tension, and the other hooked on to the rocking frame controlled by the two cores. The tension of the spring takes up any slack of the band, as well as any slack caused by the wear of the rubber pads, and this keeps the brake in action. Owing to the improvement made in the dashpot action, a steady strike is obtained with as little as 7½ per cent. loss in line resistance. The carbon-holders are on the ball-and-socket principle, so that they can be brought into line and afterwards clamped up, when they remain a fixture. This type of lamp can also be supplied for reflection purposes, the only difference in the design being that the poles are reversed, so that the bottom carbon becomes the positive, thus throwing most of the light upwards. Attention is also directed to the small pattern enclosed type lamp listed on p. 742 of the catalogue. These lamps are very much used for shop-lighting purposes, and burn exceedingly well in series, it is claimed. The line resistance, which is supplied fixed inside the lamps, does not require adjusting. On p. 745 an illustration and prices are given of the new pattern "Angold" enclosed type, double-carbon arc lamp. This lamp has been specially designed to meet the demand for a more efficient method of lighting from a single point on 200 to 250 volt circuits. Each lamp has two arcs in the one globe, which burn in series. With this arrangement the same current gives double the amount of light, while no more energy is consumed in the line resistance than is required to keep the lamp steady. Shunt coils are dispensed with by the use of special apparatus for striking and keeping the arcs of even length. This same apparatus also ensures that one carbon cannot be gripped before the other, and when once the carbons are clutched they are moved up and down at the same rate. To meet the demand for a lamp that can be used for the purpose of photo-process work, the General Electric Company have designed a new and improved arc lamp, which, it is claimed, ensures a constant light, thereby enabling the correct exposure of negatives and prints to be exactly determined. To this lamp can be fixed, if desired, a specially-designed stand on which printing frames can be supported. The total capacity of this stand is 16 whole-plate printing frames, and they can be ranged any distance from the arc and at any required height or angle. The supports of the lamps are insulated. The catalogue under notice also contains particulars of the "Angold" automatic suspension gear and contact device. This gear, we understand, has been used with great success by several borough councils and municipal bodies, and is especially constructed for automatically holding the lamps when suspended and taking the strain off the steel wire. The crown of the lamp has an insulated plug mounted on it which is provided with two spring-controlled catches. The normal position is horizontal. When the lamp is drawn up by the winch inside the posts these catches first strike against the bell-mouth of the socket, and are depressed inside the plug until the first increased diameter inside the socket is reached, when they open out and support the weight of the lamp on the ledge. This relieves the suspension wire of all strain. When it is required to lower the lamp, it is first pulled a little higher until the catches reach the second increased diameter of the socket; here they open out horizontally, and when the winch is released the weight of the lamp is thrown on the suspension wire, and it can be wound down to the required position for trimming, etc. Arc lamp carbons of the "Witton" brand, than which the General Electric Company claims there is no better obtainable, are, of course, dealt with among the accessories listed.

Catalogues, Pamphlets, Etc.

BERGTHEIL AND YOUNG, 12, Camomile-street, E.C.—Two illustrated pamphlets, one dealing with special printing-press equipments, and the other with organ blowing by electricity, both mentioning a number of buildings where the firm supplied these appliances.

POCKET DIARY, 1904.—Containing a number of useful engineering notes, rules, and data. 6d. Manchester: Emmott and Co., *Mechanical World* Office, New Bridge-street, and 18, Chancery-lane, W.C.

COCHRAN BOILERS.—A special catalogue giving particulars of patent vertical multitubular boilers (illustrated). Cochran and Co. (Annan), Limited, Annan, Scotland.

CABLE ACCESSORIES AND JOINTING MATERIALS (illustrated).—Siemens Bros. and Co., Limited, Westminster.

MOTORS, DYNAMOS, AND MOTOR STARTERS.—The Keighley Electrical Engineering Company, Limited, Vulcan Works, Keighley.

GREEN'S ECONOMISER for utilising the waste heat from steam-boilers (illustrated).—E. Green and Son, Limited, 2, Exchange-street, Manchester.

"IDEAL" GAS-ENGINES (illustrated).—Southall's Patent "Ideal" gas and oil engines. Hardy and Padmore, Limited, Worcester Foundry, Worcester.

VERITY'S ELECTRIC SUPPLIES (illustrated).—Plant and machinery; motors and motor driving; wires, cables, and wiremen's sundries; switchboards and accessories; bells and telephones; surgical and medical; electric light fittings; dock ship, and arc light fittings; glass and silk shades and reflectors. Verity's, Limited, 31, King-street, Covent Garden, W.C.

Reports and Accounts.—Several reports and accounts of municipal electrical undertakings received this week are unavoidably held over until our next issue.

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LEGAL INTELLIGENCE.

STOCKTON TRAMWAYS COLLISION.

At Stockton County Court this week, before his Honour Judge Templer, Charles Turner, auctioneer, sued the Imperial Tramways Company for £50 damages for the loss of a horse which died from injuries received on Feb. 19 last through collision with a tramcar, the accident being caused, it was alleged by plaintiff, through the negligence of the company's driver.

The evidence went to show that plaintiff's employé was driving out of Westbury-street into Mandale-road, Thornaby, and in turning the corner the tramcar struck the horse on the near front foot. It was argued that had the driver stopped the accident could have been avoided.

His Honour did not think a tram driver should be expected to stop whenever he saw a horse. Trams being forced to run on fixed lines could not get out of the way, and, therefore, it became the duty of every driver of a vehicle to steer clear of the cars.

Judgment was given for defendants with costs.

LEEDS TRAMWAYS.

At the Leeds County Court, before his Honour Judge Greenhow, Simeon Copley, of Leeds, brought an action on behalf of his son, Sim Copley, aged 19, against the Lord Mayor and Corporation of Leeds, claiming £50 damages for personal injuries received as alleged through the negligence of the defendants' servant. About a year ago Sim Copley was driving a flat cart in Burley-road, when, nearing the tramway points in the neighbourhood of Cheswick-street and Burley-road, he saw a car approaching him. Turning off the tramlines the wheel of his cart "skidded," and while endeavouring to pull out of the way the car dashed into him, and he was thrown between the car and the cart, sustaining a lacerated scalp wound, which resulted in concussion of the brain and injury to the ribs, necessitating him staying in bed for three weeks.

Mr. Willey, who appeared for the plaintiff, said the question of liability was admitted, and it simply resolved itself into a matter of assessing damages.

The parties agreed to assess the damages at £25, and judgment was given accordingly.

"TUBE" TROUBLES.

At Bow-street Police Court on Tuesday **Mrs. Serling**, of Bernard-street, complained to Mr. Marsham that the "Twopenny Tube" ran under her house, and owing to the noise made, especially at night-time, life was almost unbearable.

Mr. Marsham: Well, I don't think I can stop them.

Applicant: Somebody ought to be able to do something; I have been living at this house 17 years, and I have had no rest for six months.

In reply to the magistrate the applicant said that many of the other residents also complained of the noise.

Mr. Marsham said he was afraid he could not interfere, and advised the applicant to go and see the owners of the estate on which she lived.

COMPANIES' MEETINGS AND REPORTS.

UNDERGROUND ELECTRIC RAILWAYS OF LONDON.

A general meeting of the shareholders in this Company was held at Hamilton House, Victoria-embankment, on the 15th inst., Mr. Charles T. Yerkes presiding.

The **Chairman** said the first report of the Company showed that it had up to June 30 last received out of its resources a total amount of cash of £6,519,672. 7s. 2d., and had spent of that sum £5,600,222. 1s. 1d., leaving a balance of £919,450. 6s. 1d., which was at the London and Westminster Bank, and also on hand and at short call. An amount of £6,999,931. 10s. 4d. of profit-sharing notes had been negotiated, and it was from these notes, and also from the sale of securities from the different companies with whom they had contracts, that they were realising the funds to carry on their work of construction. After these notes were negotiated, the total amount of capital required was then assured, and he congratulated the shareholders on the fact that, even in these hard times, the Company would certainly not want further funds to finish its work. The experiments they had tried in regard to safety devices had been very exhaustive. Owing to certain circumstances which had developed recently, the importance of non-flammable material in their tunnels had been much more intensely demonstrated, and consequently they had decided that nothing inflammable in the way of construction must go into their tunnels or other buildings. The underground work on the Baker-street and Waterloo road between Baker-street and Waterloo was practically finished, and attention was now being turned to the completion of this line, as it was desirable that it should be ready simultaneously with the Metropolitan and District road. They expected to make a connection between these two lines at the Charing Cross Station of the District Railway. The Baker-street and Waterloo Company had also decided to extend their lines from Waterloo Station to Elephant and Castle, and the work was now being pushed forward rapidly, while the extension from Baker-street to Edgware-road was about to be commenced. When this latter was finished the line will be still further carried on to Paddington. The other lines—the Great Northern, Piccadilly, and Brompton, and the Charing Cross, Euston, and Hampstead—were making good progress. The acquiring of the London United tramways had been a great advantage to their system, and they intended to connect directly both the Great Northern, Piccadilly, and Brompton and the District Railways with that line, so that passengers might have an almost uninterrupted passage from Bow, and also from Finsbury Park to Hampton Court.

The report was unanimously adopted, and a vote of thanks to the chairman and directors closed the proceedings.

CUBA SUBMARINE TELEGRAPH.

The ordinary general meeting of the shareholders in this Company was held at 58, Old Broad-street, E.C., on Wednesday, Mr. Charles W. Parish presiding.

The **Chairman**, in moving the adoption of the report, said that the past half-year's working from January to June showed a better result than they had been accustomed to for some time. The actual traffic receipts amounted to £17,244, while for the half-year of 1902 they were £12,784. The latter amount was afterwards increased by the payment received in respect of their claim from the West India and Panama Company, but the comparison could only be taken as a satisfactory indication that the revenue had improved. The island of Cuba had gradually settled down under the new Government, and there was every hope that the ruins of the war and former rebellions would give way to a speedy development of the natural riches of the island, which in time must add to the Company's business. Following the other items of the revenue account, beyond the £17,244 traffic receipts, there was £2,076 interest on investments and cash balances, and £5 for transfer fees, which gave a total of £19,325 to deal with. The working expenses amounted to £6,066, and after placing £5,000 to the reserve fund and providing £3,000 for the preference dividend, the directors recommended a dividend on the ordinary shares at the rate of 5 per cent. per annum, with a further bonus of 2s. per share, which, taken together, were equal to 3½ per cent. for the six months. In distributing that amount they had decreased the carry forward by £340, but they felt they were justified in doing so under the satisfactory conditions of the half-year. Turning to the balance-sheet, the Chairman said they had still to hold up the £8,174 of claim against the United States Government for the damage done to their cables during the Spanish-American war. He hoped they would soon have the matter settled, but he was afraid nothing could be done before it again came before Congress, which could not be for another three or four months. As to the subsidy due to the Company from the Government of Cuba in respect of coast cables, he was very disappointed that they had not yet received it, nor had they received any final explanation from the Cuban Government as to recognising their concessions. The subsidy was about £2,000 a year, and the arrears covered a period from January, 1899, so that altogether there was about £9,000 due to them. The Company's agent was continually negotiating with the Cuban authorities, and his Majesty's representative in Cuba had been instructed by the Foreign Office to assist them in every way. He had good reasons to know that the matter had been laid most carefully before the President himself, and he hoped before long they might receive some satisfactory news.

Mr. George Keith seconded the motion.

A Shareholder asked if there was any likelihood of Marconi's Wireless Telegraph Company competing with them.

The **Chairman** replied that the question was very much in the air at the moment, and he thought they need have no fear of harm from that quarter at present.

The motion was adopted.

KALGOORLIE ELECTRIC POWER AND LIGHTING.

The ordinary general meeting of the shareholders in this Company was held on Tuesday at Winchester House, Mr. Roger W. Wallace, K.C., presiding.

In moving the adoption of the report (which appeared in our last issue), the **Chairman** observed that important negotiations had been going on with regard to the business. It would not be advisable to say anything more on the point that day, but he hoped before long to be in a position to do so. At the date of the last meeting there were unpaid calls amounting to £36,000. During the period under review about £27,400 of this sum had been collected, and since the date of making-up the accounts a further £4,000 had been received. The Board had been enabled to finance the Company by an arrangement with their bankers without making the full issue of debentures. About £24,000 of debentures had been taken up, leaving £26,000 still to be issued. There was no immediate need to deal with the debentures in hand, and they would be reserved for such shareholders as might desire to apply for them. The Board were satisfied respecting the permanency of Kalgoorlie as a gold-producing centre. The output of gold there now was greater than at any previous period. The returns for 1902 aggregated 1,172,405oz., and would show an increase this year. Everything went to prove that the industry would last for many years—far longer, indeed, than the period for which concessions were granted to electric lighting companies in this country. The plant had worked most satisfactorily, and, owing to the improved water supply, it would be possible to sell electricity at a cheaper rate than was at one time anticipated. The directors could have made contracts for the sale of the whole of their available current had they chosen, but not on the most remunerative basis. Their object was to secure a 24 hours' load, or as nearly so as could be obtained. Hoisting and similar machinery gave a load for only a comparatively small number of hours daily, and therefore the Board had declined contracts of that class. New customers were being secured almost from day to day, and he had no doubt that they would succeed in getting their whole supply taken up on the most remunerative basis. He had no doubt that next year they would be in a position to pay dividends. Before

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that could be done, however, they must write off from revenue, or put to capital account, the sums expended in preliminary work, and the report recommended that the latter course should be adopted. Two of the directors had resigned, and in the future the fees would be reduced to £1,000 per annum.

Mr. Edward Pope seconded the motion, and after discussion and some criticism it was adopted.

Certain alterations in the articles were also agreed to in order to comply with the regulations of the Stock Exchange Committee prior to their granting an official quotation for the Company's shares.

GUILDFORD ELECTRICITY SUPPLY.

A meeting of the holders of founders' shares in this Company was held last week at the County and Borough Hall, Dr. F. R. Russell presiding.

The question before the meeting was a proposal to so modify the regulations under which the founders' shares are held as to convert them into preference shares, bearing a fixed rate of interest. Hitherto the holders of the founders' shares have been entitled to one-fourth of the net profits made in each year after providing for a dividend at 6 per cent. on the capital paid up on the other shares, in addition to which there are various other regulations. The increase of the Company's business has made it necessary to raise further capital, and promises of sufficient support to enable the Company to purchase new plant now required, and to pay for contemplated extension of mains, had been received on condition that the regulations in question were modified as described. A resolution was proposed that the conditions of the founders' shares be altered, and that the rights of cumulative preference shares, bearing interest at the fixed rate of 6 per cent. per annum, be conferred on the said shares.

The **Chairman** explained that it was impossible to exchange for the founders' shares any shares that were not of equal value with them.

After discussion, the motion was carried by the requisite three-fourths majority.

MONTE VIDEO TELEPHONE.

The directors present accounts for the year ended July 31 last, showing a net profit for that period of £12,224, after providing for all working expenses in Monte Video and London. To this amount should be added the sum of £1,064 brought forward from last year, leaving an available balance of £13,288. From this sum the directors propose to transfer £5,000 to reserve fund, and they recommend that, after payment of the full dividend at the rate of 5 per cent. per annum upon the preference share capital, a dividend at the rate of 3 per cent. per annum be paid upon the ordinary share capital, and that the balance of £1,783 be carried forward. The Company has acquired, as from June 12, 1903, the rights, privileges, and properties of the undertaking known as La Hispano Uruguaya, comprising a system of telephone lines and exchanges outside the city and province of Monte Video.

BRITISH COLUMBIA ELECTRIC RAILWAY.

The report of the directors for the year ended June 30 last states that business has largely increased in all departments, and the profits made during the year show a corresponding increase. The gross receipts show an incease over the preceding year of £19,143, and the net earnings, after charging renewals, show an increase of £7,834. The following charges have been made against the revenue account of the year—namely: renewals maintenance, £10,446; bonus to employés, £1,494; written off preliminary and issuing expenses, £1,000; added to capital amortisation fund, £1,595. The net profit for the year, after making the above deductions, amounts to £37,865, and adding the balance brought forward, £533, and deducting debenture interest, the dividend on preferred ordinary stock for nine months to March 31, 1903, and the interim dividend on the deferred ordinary stock for six months to Dec. 31, 1902, there is left available for distribution and reserves £15,779. The directors have decided to provide for the dividend on the cumulative perpetual preference shares to June 30, 1903, to provide for the dividend on the preferred ordinary stock for three months to June 30, 1903, to recommend a dividend on the deferred ordinary stock at the rate of 3 per cent., making 5 per cent. for the year, to transfer to contingency fund £1,000, and to transfer to reserve fund £3,000, leaving to carry forward £1,099. During the year 6,000 5 per cent. cumulative perpetual preference shares of £10 each have been issued by the Company, and a further 1,500 were issued in August last, making a total of £75,000. The construction of the Vancouver power installation by the Vancouver Power Company, Limited, which commenced in July, 1902, has proceeded satisfactorily. The general manager reports that he expects the Power Company will be in a position to deliver 2,000 e.h.p. by the beginning of December next. On the advice of the engineers, the scheme as originally designed has been enlarged so as to provide for the supply of an initial 9,000 h.p., with power of expansion to 30,000 h.p., instead of an initial 6,000 h.p., with expansion to 15,000 h.p. The size of the tunnel has been increased by 25 per cent., and machinery and transmission plant of greater electrical capacity are being provided. This enlargement of the original scheme will involve an additional expenditure of about £60,000, but the directors are satisfied that the importance of being fully prepared to meet the rapid increase in the demands for electrical power in Vancouver and New Westminster justifies the increased expenditure. Funds for carrying on the works of the Vancouver Power Company have been raised by the sale of £175,000 4½ per cent. Vancouver Power debentures, part of a total authorised issue of £220,000, and the Board propose at an early date to offer the remaining £45,000 to the stockholders and debenture holders to provide further funds as required. The directors have for some time past been carrying on negotiations for the purchase of the undertaking of the Vancouver Gas Company, which if brought to a successful issue, should materially add to the value of the company's lighting business.

BRITISH COLUMBIA TELEPHONES.

The report of the directors for the year ended June 30 last states that the expenditure for improvements and extensions during the past year has amounted to £7,334, and the purchase of the plant of the Columbia Telephone and Telegraph Company has involved a further expenditure of £7,668. A new switchboard is being installed in the Victoria exchange on the central energy system. This will necessitate the purchase of new instruments for all subscribers there, involving a total expenditure of at least £15,000. At the last session of the Provincial Legislature, an Act enabling the Company to lay a cable connecting the mainland and Vancouver Island was obtained; the cost of the cable and land lines necessary will be, it is estimated, about £35,000. Owing to the heavy but necessary expenditure before mentioned, and that contemplated, the directors of the subsidiary companies have decided to carry forward the whole of the balance standing to the credit of their respective profit and loss accounts. The directors of this Company, therefore, regret that they are unable to pay any dividend on the ordinary shares. At the meeting a scheme for the reorganisation of the Company, transferring the head office to British Columbia, and increasing the debenture issue will be submitted. The balance from last year's account was £322, and the directors have transferred from reserve fund £4,500, making a total of £4,822. Out of that have been paid expenses of English office, £146; income tax, £376; bank interest and charges, £164; interest on debenture stock to June 30 last, £1,271; and dividend on the preference shares to June 30 last, £1,694—leaving a balance of £1,170 to provide for directors' remuneration and to carry forward.

BRITISH ALUMINIUM.

The secretary writes to the shareholders as follows: "It will be within your recollection that, at a meeting held on Nov. 13 last, the holders of the debenture stock of this Company agreed to postpone the payment of all interest on the debenture stock for one year, and authorised their trustees, in their absolute discretion, to consent to the postponement of the payment of interest for a further period of one year. I am instructed by the Board to inform you that, owing to the improved circumstances of the Company, they have not felt justified in asking the trustees to sanction the additional postponement. The current half-year's interest will be paid on Dec. 31 next, and thereafter the interest will be paid half-yearly, on its due dates. Of the £10,000 authorised at the same meeting to be borrowed in priority to the debenture stock, £7,500 has since been repaid."

NEW COMPANIES REGISTERED.

Municipal Foundry and Engineering Company, Limited.—Capital, £5,000. Objects: to adopt an agreement between C. Hall and J. H. Bardsley, and to carry on the business of ironfounders, mechanical, electrical, chemical, and general engineers and contractors, electricians, etc.

Chichester and District Electric Supply Company, Limited (78,784).—Capital, £20,000. Object: to carry on in the United Kingdom and elsewhere the businesses of suppliers of electricity for light, heat, sound, and power, or otherwise. Registered office: Donington House, Norfolk-street, W.C.

Gent and Co., Limited.—Capital, £50,000. Objects: to acquire and carry on the business of manufacturing electricians, electrical engineers, wire and cable manufacturers, wire coverers, etc., carried on by A. W. Staveley and I. H. Parsons, at Leicester, as Gent and Co. and the Midland Electrical Wire Company, as telephone, water supply, and mechanical engineers, etc.

Hodgson Hartley, Limited.—Capital, £30,000. Objects: to acquire and take over as going concerns the businesses now carried on at Cleckheaton by H. E. Hodgson (trading as H. E. Hodgson and Co.), and at Manchester by James Hartley and Co., of Manchester, Limited, of mechanical, electrical, and hydraulic engineers, plant manufacturers, etc. Registered office: 55, Victoria-buildings, Manchester.

Piscicelli Electric Post Parent Syndicate, Limited.—Registered in Guernsey. Capital, £150,000. Object: to acquire and turn to account an invention of Count Roberto Taeggi Piscicelli, of Naples, for an aerial electric post, with the patent rights for the same, and to carry on any business incidental thereto. The first directors are Count R. T. Piscicelli (permanent), Le Duc de Morny (till 1905), Le Comte de Pradere (till 1905), H. S. Saunders (till 1905), and W. Digby (till 1905). Count R. T. Piscicelli is also technical director and constructional engineer.

CONTRACTS FOR ELECTRICAL SUPPLIES.

Caraminal (Spain).—The Municipality require tenders for installation and working of the village for 20 years. Tenders by Nov. 3.

Windsor.—The Town Council invite tenders for the supply of electricity or gas for the purpose of public lighting throughout the district for a period of five years.

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Dudley.—The Guardians invite tenders for the supply and fixing of the various appliances for the electric installation to the laundry and boiler house. See advertisement in last issue.

Swansea.—The Corporation invite tenders for the supply, delivery, fixing, and connecting of ducts, troughs, cables, wires, street boxes, etc. Tenders by Oct. 31. See advertisement in last issue.

Transvaal Colony.—The Chairman of the Tender Board, Pretoria, requires tenders for installing and working the electric lighting of Potchefstrom for about five years. Tenders by Oct. 30.

Wakefield.—The City Council invite tenders for the supply and erection of one 400-kw. two-phase generator, comprising engine, alternator, exciter, and accessories. Tenders by Nov. 7. See advertisement.

Brussels.—The Belgian Government Railways invite tenders for material and appliances to be used for lighting passenger trains. Specification No. 996 may be obtained from the above authority. Tenders by Nov. 4.

Munera.—The Municipality require tenders for installation and working of electric lighting. Particulars may be obtained from the Secretary of the Ayuntamento of Munera, province of Albacete, Spain. Tenders by Oct. 28.

Kilmarnock.—The Corporation invite tenders for the supply, delivery, and erection of three Lancashire boilers, engines and dynamos, overhead hand travelling crane, storage battery, and switchboard, by Nov. 18. See advertisement in last issue.

Blackpool.—The Corporation invite tenders for the supply of arc lamp carbons for the ensuing year. Specification, etc., may be obtained on application to Mr. Charles Furness, borough electrical and tramway engineer, Electricity Works, Blackpool.

London, S.W.—The London County Council invite tenders for the supply, for one year from Jan. 1, of electrical fittings, etc. Forms of tender may be obtained on application to the Clerk of the Council (Stores Branch), 19, Charing Cross-road, W.C. Tenders by 26th inst.

Shanghai.—The French Colony propose to instal motor-propelled tramways. Tenders may be sent by Oct. 31, 1903, to Secrétariat de la Municipalité Française de Shanghai. Particulars may be obtained from l'Office National du Commerce Extérieur, Rue Feydeau, 3, Paris.

Barrow-in-Furness.—The Corporation invite tenders for the completion of the electric lighting installation at Hawcoat and Walney police stations and the pig slaughtering hall and lairage at the public abattoirs. Further particulars may be obtained from the Borough Engineer.

Portsmouth.—The Tramways Committee invite tenders for the supply of passengers' tickets for one, two, or three years respectively from Jan. 1, 1904. Specifications, etc., may be obtained from the General Manager, Town Hall, Portsmouth. Tenders by 10 a.m. on 30th inst.

Russia.—The Russian Minister of the Interior has sanctioned a plan for the reconstruction of three lines of municipal tramways—namely, those in Newsky, Sadovaïa, and Wassiliostrow districts. Each car is to provide for two classes of travellers, and will accommodate 52 persons.

Todmorden.—The Corporation invite tenders for one Lancashire boiler, two steam dynamos and balancer booster, two feed pumps and one injector, economiser, surface or jet condenser, switchboard and instruments, storage battery, cable work, and overhead hand crane. See advertisement.

West Ham.—The London County Council invite tenders for the supply and erection of (a) engine, dynamo, switchboard, etc., and (b) electrical wiring, mains, and fittings required in connection with the installation of electric light at the Abbey Mills pumping station. Tenders by Nov. 3.

Radcliffe (Lancs.).—The Urban District Council invite tenders for the construction of the switchboard and engine and dynamo galleries at the electricity works. Specification, etc., may be obtained of Mr. W. L. Rothwell, engineer, Council Offices, Radcliffe. Tenders by 12 noon on 26th inst.

Devonport.—The Corporation invite tenders for the supply, delivery, and erection of a motor-driven booster. Specification may be obtained from the Borough Electrical Engineer, Newport-street, East Stonehouse, Devon. Tenders before noon on Oct. 24. See advertisement in last issue.

Halifax.—The Tramways and Electricity Committee invite tenders for (a) 750-kw. continuous-current dynamo, driven direct by horizontal engine; (b) two 9ft. by 30ft. Lancashire boilers; (c) high-tension three-phase cable, etc. Tenders to Mr. Keighley Walton, town clerk, by Oct. 21.

Holyhead.—The Urban District Council invite tenders for erection of a chimney shaft in connection with their proposed destructor and electricity works. Specifications, etc., may be obtained from Mr. Price F. White, Electricity Works, Bangor, North Wales, on and after 23rd inst. Tenders by 10 a.m. on 30th inst.

Manchester.—The Paving, Sewering, and Highways Committee invite tenders for laying underground telephone pipes (Contract 8), with other appurtenant works. Drawings may be seen and specification, etc., obtained on application at the City Surveyor's Office, Town Hall, Manchester. Tenders by 10 a.m. on Nov. 5.

Chichester.—Tenders are invited for the installation of a system of electrical water-level indicators and recorder and telephones. Specifications may be seen and bills of quantities obtained at the office of the city surveyor and waterworks engineer, Mr. I. Pym-Jones, Lion-street, Chichester. Tenders by Nov. 6. See advertisement.

Radcliffe.—The Council invite tenders for the supply and completion of (Contract No. 12) lighting and traction switchboard and accessories; (14) rail bonds. Specifications may be obtained from Messrs. Lacey and Sillar, 2, Queen Anne's-gate, Westminster, and 78, King-street, Manchester. Tenders by Nov. 14. See advertisement.

Blackpool.—The Electricity and Tramways Committee invite tenders for one new 450-kw. traction set (vertical triple-expansion engine and multipolar generator). Specification may be obtained from Mr. Charles Furness, borough electrical and tramways engineer, Electricity Works, Blackpool. Tenders by Nov. 14. See advertisement.

Bradford.—The Guardians invite tenders for the electrical engineer's work for the erection of a hospital pavilion at the union workhouse, Horton-lane, Bradford. Specifications, etc., may be seen and bills of quantities obtained on application to Mr. Fred Holland, 11, Parkinson's-chambers, Hustlergate, Bradford. Tenders by 9 a.m. on 26th inst.

Swansea.—The Corporation invite tenders for (1) laying of permanent way, including rail bonding; (2) rails and fishplates; (3) steel tiebars, bolts, and nuts; (4) points, crossings, cast-steel curved rails, and special work; (A) overhead electrical equipment; (B) ducts, troughs, cables, wires, section and other boxes, etc. Tenders by Oct. 31. See advertisement in previous issue.

Beckenham.—The Urban District Council invite tenders for the electric wiring of houses in their district under a free wiring scheme. Specifications, etc., may be obtained from the consulting engineer, Mr. Reginald P. Wilson, 66, Victoria-street, Westminster, or Mr. John A. Angell, surveyor, Council Offices, Beckenham. Tenders by 4 p.m. on Nov. 9. See advertisement in last issue.

Wednesbury.—The Corporation invite tenders for the electric wiring and fittings for the following public buildings: town hall, municipal offices, art gallery, public baths, public library, and electricity sub-station. Specification, etc., may be obtained between 2 and 5 p.m. on and after the 23rd inst. at the offices of Mr. F. J. Warden-Stevens, A.M.I.M.E., A.M.I.E.E., consulting engineer, 34, Victoria-street, Westminster. Tenders by 12 noon on Nov. 20.

Bolivia.—The Director of Public Works to the Government o Bolivia is prepared to receive from British manufacturers, quotations, prices, catalogues, and printed matter, with discounts, shipping weights, &c., for the following materials: hydraulic power plant, piping, and turbines; alternating and direct current generators and motors; transformers and rotary converters; switchboards and measuring instruments; overhead trolley wire and fittings; third-rail insulators, plastic and copper bonds; hydraulic screw jacks and lifting tackle; contractor's plant and tools. All communications to Mr. T. Olive Sheppard, A.M.I.C.E., director-general of public works, general manager of the Guaqui to La Paz Railway, La Paz, Bolivia, and sent by registered post either via New York or by Royal Mail steamers (West India route) via Panama and Mollendo (Peru).

RESULTS OF TENDERS.

Walsall.—The tender of the Walsall Electrical Company, Limited, for connecting up four new sub-stations with telephones, for the sum of £7. 6s. 6d., has been accepted.

Erith.—Three tenders have been received for electric lighting St. Augustine's-road new schools: Rawlings Bros., Limited, £184; F. A. Glover and Co., £121 (accepted); Ward Bros., £156.

Shoeburyness.—The Hart Accumulator Company, Limited, Marshgate-lane, Stratford, E., report an order from the War Office for the storage battery of 54 cells required at Shoeburyness.

Croydon.—The Electricity Committee have accepted tenders for extensions to the electricity works (buildings) as follows: E. J. Saunders, builder's work; Dorman, Long, and Co., smith and iron-founder's work.

Ashton-under-Lyne.—The Market and Lighting Committee have accepted the following tenders for supply of arc lamp carbons and globes during ensuing year: De Grelle, Houdret, and Co., London, carbons; J. E. Taylor and Co., Ashton-under-Lyne, globes.

Radcliffe District Council.—The Electricity Committee have rescinded acceptance of the tender of Callender's Cable and Construction Company, Limited, for the electricity contract No. 11, for the sum of £5,339. 4s. 4d., in favour of the same firm's amended tender for the sum of £5,350. 2s. 2d.

Harrogate.—The tender of the British Thomson-Houston Company for the supply and erection of a 750-kw. Curtis turbine, with condensers and accessories, for the sum of £6,736, and for the temporary loan of a 305-kw. turbine, to be delivered and erected, and afterwards removed, free of cost to the Corporation until such time as the Curtis turbine can be supplied and erected, has been accepted.

Stoke Newington.—The tender of W. T. Henley's Telegraph Works Company, Limited, for the supply of cables for the High-street and Stoke Newington-road for the maintenance of the cables for one year after completion, free of cost, has been accepted; this includes an undertaking to maintain, if so required by the Council, for a further period of four years for an annual payment of 1 per cent. on the cost of the cables.

Hammersmith.—The Electricity and Lighting Committee have obtained the following tenders for supplying the motor-generators required in connection with certain electrical machinery about to be installed by Messrs. J. and H. Gwynne, Limited, and Messrs. J. Baker and Sons: Witting, Eborall, and Co., £615 or £691; F. A. Glover and Co., £700; Fuller, Wenstrom, and Co., £730; Geipel and Lange, £664 or £750; Lancashire Dynamo and Motor Company, £778, £832, or £971; Johnson and Phillips, £790 or £850; Electric Construction Company, £809; General Electric Company, £870; Bruce Peebles and Co., £890. Messrs. Witting, Eborall, and Co.'s tender of £691 for the two sets has been recommended for acceptance.

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BUSINESS NOTES.

TRACTION.

Portsmouth.—The Tramways Committee have agreed to try the experiment of covered tops to the cars.

Ince.—The District Council at its monthly meeting ratified the leasing of the tramways in the township to the Wigan Corporation.

Brighton.—The electric cars will commence to run on the London-road and Old-steine routes as soon as the Board of Trade license is received.

Radcliffe.—Application is to be made to the Board of Trade for sanction to an alteration in the plans for the proposed tramways in this district.

Southall-Norwood.—The Board of Trade have extended the time allowed for the completion of the light railway (Southall-to-Uxbridge) to April 9, 1904.

Woolwich.—Steps are being taken to urge the London County Council to proceed with the laying of the tramways from Beresford-square to the Herbert Hospital.

Hanley.—The Town Council are urging upon the Potteries Electric Traction Company the necessity for the construction of light railways to Bucknall and Providence-square.

Nelson.—The Town Council have appointed a sub-committee to visit Liverpool, Leeds, and Bolton, with a view to finding a suitable top cover for use on the Nelson cars.

North-Eastern Railway.—Another experimental electric train has been run on the Riverside branch of the North-Eastern Railway at Newcastle between Percy Main and Carville.

Barrow.—Rapid progress is being made in the reconstruction of the tramways, and there is every prospect that at least one section of the system will be opened in a few months' time.

Guildford.—The promoters of the West Surrey light railways scheme have submitted a modified proposal to the Town Council, which is for a line from Stoughton to the railway station.

Northleach.—The Rural District Council have been informed by the Light Railway Commissioners that the promotors of the proposed light railway are prepared to go on with the scheme.

Elsenham.—The proposed light railway from Elsenham as far as Finchingfield is now almost assured. The amount still required has been reduced to about £600, and the end is felt to be in sight.

Woking.—An amended scheme of tramways for the district came before the Urban District Council at their meeting last week. Eventually the Council gave a qualified approval of the scheme.

Worsley.—Arrangements are being made for an early start in the construction of the tramways in the Worsley and Walkden districts, and the connection of the South Lancashire system with Eccles at Worsley-road.

Croydon.—In the course of discussion at the last meeting of the Town Council it was stated that the British Electric Traction Company made a profit of £10,000 last year on the tramways in the borough which are leased to them.

Leeds.—The question of an improved method of laying tramrails was considered at the last meeting of the Tramways Committee, and was referred to the Works Sub-Committee to be dealt with in conference with the Highways Committee.

Bournemouth.—The Corporation have decided to obtain powers to construct an electric tramway from the present terminus at Pokesdown to Southborne and Christchurch, the estimated cost being £50,000. The scheme is generally approved by the ratepayers.

Mid-Yorkshire.—Arrangements are being made for the transfer of the Mid-Yorkshire branch tramlines running from Nabwood to Thackley, and from the Branch Hotel (Saltaire) to Baildon Bridge, to the contractors, Messrs. J. G. White and Co., of London.

Douglas.—At a meeting of the Town Council the chairman of the Tramways Committee said that the earnings to the end of September, after all expenses had been met, left a credit balance of £8,520, being an increase over the same period of last year of £653.

Batley.—Westinghouse magnetic brakes will be mounted on the new electric tramcars now being built by the British Electric Car Company, the equipments having been recently ordered from the British Westinghouse Electric and Manufacturing Company, Limited.

Hull.—The service of electric cars was opened on Tuesday between the Hull Whitefriargate Bridge and Victoria Pier. The Board of Trade have approved the Tidwell lifeguard for the trams. The patentees have agreed to furnish additional lifeguards for a royalty of £1. 10s. per car.

Derby.—A petition signed by members of the Town Council has been sent to the mayor to reconsider and, if desirable, to rescind a resolution of May 5, authorising the construction of tramways to Littleover. The mayor has accordingly decided to call a special meeting of the Council for Oct. 28.

Newcastle.—Members of the Tramways Committee have made a survey of Benton Bridge with a view to seeing the best arrangements for widening the bridge, or making such other improvement as will enable a double line of rails to be laid over that portion of the Dene so as to complete the tramway circuit.

Prestwich.—The District Council have arrived at a satisfactory arrangement with the Salford Corporation as to the share Prestwich shall receive of the profits made on the tramways in the district. The amount Prestwich will receive will be equal to 1d. in the £ on the Prestwich rates for the next five years.

Perth.—The first meeting of the Tramway Reconstruction Committee was held last week, when various matters of a preliminary character were discussed. The Council on Monday considered the appointment of a consulting engineer, and it was eventually decided to remit the matter to the Council to report.

Cheltenham.—Last week a fire broke out at the stores department of the Cheltenham and District Light Railway depôt, before the reduction of which considerable damage was done. Roughly the damage is placed at about £1,000. The buildings are insured, but not the contents. The origin of the fire is unknown.

Bradford.—The Tramways Committee have decided to increase the wages of drivers and conductors by ½d. an hour. This will mean a minimum wage of 6d. and a maximum of 7d. an hour for drivers, whilst conductors will receive a minimum of 5d. and a maximum of 6d. an hour. The increase will amount in a year to £2,846.

Snowdon Light Railway.—Messrs. Bruce Peebles and Co., Limited, inform us that they have obtained the whole contract for the construction of the proposed Snowdon light railway. By a printer's error in our last issue we erroneously stated that the power to be developed was 60,000 h.p. This should have been 10,000 h.p.

Electric Signalling.—The final Board of Trade inspection is about to take place of the large electric signalling installation which has just been completed at St. Enoch's Station, Glasgow, by the W. R. Sykes Interlocking Signal Company. The subordinate and subsidiary cabins at St. Enoch's have already been inspected and approved by the Board of Trade.

Soothill Nether.—At a special meeting of the District Council the following resolution was unanimously adopted: "That the Council do apply in the next session of Parliament for an Act to enable the Council to construct tramways, and work or lease the same, to purchase land and erect a generating station and refuse destructor thereon," and for other purposes.

Richmond.—A meeting of the Tramways Committee last week considered a series of proposals submitted by the London United Tramways Company for the more effective carrying out of the scheme, to which legislative sanction has already been given, for the introduction of electric tramways into Richmond. The proposals, however, were ultimately rejected.

Llanelly.—The tramways question was again before the District Council at their last meeting. It will be remembered that things have been at a standstill for some months owing to the alleged failure of the Insulated Wire Company to carry out their contract to purchase the tramways undertaking for £5,000. The matter was referred to the Estates Committee for enquiry and report.

Wandsworth.—The Borough Council at their last meeting again adjourned the question of a contribution towards the cost of street improvements proposed to be carried out at Streatham by the London County Council in connection with their proposal to link up their system with the Croydon electric trams at Norbury. The Streatham inhabitants are generally in favour of the scheme.

Glasgow.—We understand that the British Westinghouse Electric and Manufacturing Company have secured a contract for the equipment of all the Glasgow tramcars—numbering nearly 700—with their well-known magnetic brake. Exacting experiments, extending over nearly two years, on 100 cars have been carried out, and the present contract goes to indicate that the brake has proved very efficient in working.

Pietermaritzburg.—The British Westinghouse Company are supplying for the new tramway system at Pietermaritzburg, South Africa, six complete electric tramcar equipments. These will be of standard Westinghouse pattern, each including two No. 90 series-parallel controllers, two No. 200 (35 h.p.) motors, and all the usual auxiliary apparatus, including automatic cut-out, lightning arresters, etc.

Gower Light Railway.—There is now definite prospect of the proposed light railway for Gower being carried out somewhat on the original lines of the scheme. Notices to treat have been served on the owners of the property along the line from Killay Station (London and North-Western) down the peninsula. It is feared that property will not be very easily acquired, and a further difficulty will probably arise as to the Clyde Valley.

Chatham.—Correspondence has taken place between the Town Council and the Chatham and District Light Railways Company on the subject of universal penny fares. Mr. Minshall, the representative of the company, has pointed out that the matter is one for the Corporation and the Board of Trade. At the last meeting of the Town Council the clerk was instructed to write to the Gillingham District Council with a view to a conference on the matter.

Herefordshire.—A light railways scheme for Herefordshire was further considered at last week's meeting of the Ross Rural District Council, when it was said that it would be a good plan to connect Ross and Ledbury and Ross and Bromyard by light railways. As favourable replies have been received from most of the district councils affected by the scheme, the clerk was directed to write to the chairman of the County Council requesting him to convene a conference for the purpose of further considering the proposal.

Moving Staircase.—The directors of the Great Northern and City Railway are considering a proposal for a moving staircase at their Lothbury Station now in course of construction. If the scheme be adopted it will be a complete novelty in London so far as tube railways are concerned; but those who have visited either the Crystal Palace or the Earl's Court Exhibition lately will have noticed the moving staircases which are working at these places for conveying people from a low to a high level. They are operated electrically.

Flintshire.—A large gathering of Flintshire gentlemen have been in conference with regard to the application to Parliament during the

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coming session for powers to construct an electric tramway connecting the districts of Bagillt, Greenfield, Holywell, Halkyn, Northop, Mold, Buckley, Hawarden, Sandycroft, Queen's Ferry, Shotton, and Connah's Quay. The general tone of the meeting was a unanimous approval of the scheme. The capital of the proposed syndicate is £10,000, to which a number of gentlemen subscribed in the course of the meeting.

Devonport.—Major A. Druitt, R.E., has made an inspection of the new lines from Milehouse to Tor-lane and from St. Budeaux Station to Saltash Passage, which have been constructed by the Corporation and are leased to the Devonport and District Tramways Company, who will work them. Owing to stringent regulations by the Board of Trade, provisional permission could not be granted to open the extensions until the official certificate is issued, and this, it is expected, will be done in a few days. The lines will then be opened for traffic.

Hampstead.—At the last meeting of the Borough Council the Works Committee recommended that, with reference to the letter from the London County Council on the subject of the reconstruction for electrical traction of the County Council's northern tramways, which include the route from Hampstead-road to Hampstead Heath, and asking the views of this Council as to the adoption of the overhead trolley system, they be informed that this Council strongly objects to the overhead system being adopted. The recommendation was adopted.

Lambeth —Consideration was resumed at the last meeting of the Borough Council of the resolution moved at the previous meeting urging the London County Council to run a line of trams to Westow-hill, Upper Norwood. The motion was now adopted; also the following: "That as, in the opinion of this Council, it would be a great advantage to the inhabitants of Lambeth and to the general travelling public if the London County Council acquired and worked the London Southern Tramways, this Council respectfully urge the London County Council to give the statutory notice for the purchase of the undertaking."

Bury.—The Acquisition of Property Sub-Committee report that they have acquired other property for tramway purposes, and that there were only two outstanding bits of property in regard to which there was likely to be arbitration. In order to obviate the cars being in darkness when the trolley arm is being reversed at the termini, the electrical engineer has submitted two schemes, one by which the lamps would be prevented from going out, and the other for the fixing of one lamp inside the cars, which would be lighted when the arm was being reversed. It was decided to adopt the simple lamp scheme, and use it at the Fairfield end only.

South Shields.—The Tramway Sub-Committee have decided to recommend to the Council the adoption of the overhead trolley system for the borough. The routes have been considered by the committee, and it has been decided, instead of continuing the route through Corstorphine Town to Tyne Dock, to recommend that the line be carried as far as the present terminus at Green-street. The dropping of the Corstorphine Town route means a reduction in the total approximate cost of £20,029. It has been decided, in accordance with a resolution of the Council, to advertise for the best terms for leasing the system before considering the question of municipalisation.

Dewsbury. — A special meeting of the Corporation has agreed that application be made to the Board of Trade for a provisional order to empower the Corporation to construct tramways in the borough, (*a*) commencing in Vicarage-road, passing along Vicarage-road, Longcauseway, through the Market-place, and along Wakefield-road to the boundary of the borough with Soothill Nether; (*b*) commencing in the Market-place and passing along Crackenedge-lane to the boundary of the borough with Soothill Upper; and (*c*) commencing at the junction of Wakefield-road with Leeds-road, and passing along Leeds-road to the boundary of the borough with Soothill Upper.

Llandilo-Aberayron Light Railway.—The project of constructing a light railway from Llandilo to Aberayron seems to be proceeding in earnest. Meetings have been arranged to be held at Llandilo, Lampeter, and other places along the proposed route to further the project. Several local authorities through whose districts the proposed railway will run have passed resolutions approving of the scheme, and great interest is taken in the matter throughout the country affected. Guarantees of capital have been obtained for the construction of the line, and it is proposed to ask the County Councils of Carmarthenshire and Cardiganshire to contribute towards the initial expenses. The total length of the line will be 35 miles.

Southend.—At the Board of Trade Sir Herbert Jekyll, assistant secretary to the Railway Department, sat to hear objections to the confirmation of the Southend-on-Sea and district light railways (extension) order. The scheme is one by the Southend-on-Sea Corporation for the extension of their present light railways system, the principal extension being as far as Shoeburyness, so as to give means of communication by the light railway system between Southend and that place. The present system runs between the Southend district and Leigh-on-Sea. Colonel Burges, a large landowner, through whose property it is proposed to construct part of the extension, is the only objector. Sir Herbert Jekyll will report to the Board in due course.

Lowestoft.—The Light Railway Commissioners held an enquiry on Wednesday with reference to the application of the Corporation to amend the East Anglian light railways order. The amendment sought is in the direction of obtaining sanction to carrying out this undertaking—a light railway through the town to Kessingland beach—in conjunction with the tramways undertaking, and the Commissioners announced they were prepared to submit an order on these lines. The tramways manager reports that the total traffic receipts to the 15th inst. amounted to £2,945. 18s. 10d.; passengers carried, 636,650; miles run, 44,819; average receipts per car per day, £4. 16s. 7d.; average receipts per day, £52. 12s. 1d.; average receipts per car mile, 13·7d.

Folkestone.—After many months' delay the Corporation are at length taking steps to carry out the tramway scheme for which they obtained powers some time ago, and an expert is to be retained to advise them in the matter and report upon the tenders received. The borough engineer has prepared a report, in which he gives the cost of the different systems as follows: Surface-contact system—G. B., £11,743 and 10·065d. per car mile; Lorain, £11,881 and 10·185d.; Dolter, £11,370 and 9·746d.; Schuckert, £11,421 and 9·79d. Conduit system—J. G. White and Co., £12 462 and 10·683d.; Dick, Kerr, and Co., £12,618 and 10·815d. The Corporation are not favourable to the overhead trolley system, and either the surface-contact or conduit system will be adopted.

Electric Tramways in Germany.—A recent report from United States Consul H. W. Harris, Mannheim, Baden, deals with the street car lines in Germany. Recently published figures, he says, place the total number of miles of electric car lines in Germany at 2,117. Considering the area and population of the empire, these figures show a comparatively slow development of this branch of railway building—this, too, in spite of the fact that in electric lighting and in other applications of electricity Germany has taken advanced rank. The cause of this backwardness is to be sought mainly in the fact of State ownership of the larger part of the existing steam railways, and the unwillingness on the part of the city and other authorities to grant charters to private companies.

Hackney.—At the last meeting of the Borough Council, a letter was received from the London County Council with reference to their proposals for the reconstruction, for electrical traction, of the northern tramways, which are leased to the North Metropolitan Tramways Company, and the construction of new tramways in connection therewith, and stating for the information of the Borough Council the reasons which have induced the Highways Committee of the County Council to suggest that the overhead trolley system should be adopted for certain of the tramways. The committee recommended that the London County Council be informed that the Council will strenuously oppose any adoption of the overhead trolley system for the working of tramways within the borough.

Birmingham.—Notice of motion has been given for the next meeting of the City Council as follows: "That in the opinion of this Council it is much to be regretted that the Tramways Committee should have considered it necessary to purchase tramrails from abroad at a time when British industry needs encouragement and support." Another resolution runs; "Instructions to committees.—That in asking for tenders for manufactured articles of any description, if the same are made or can be made in Great Britain, they shall be specified to be of British manufacture. This is to apply to all manufactured articles purchased without tender, and to manufactured articles used in buildings, machinery, plant, stores, rolling-stock, etc., in every department of the Corporation."

Additional Traffic Returns.—Anglo-Argentine, £2,227 increase; Barcelona Ensanche y Gracia, £136 increase; Barcelona, £59 decrease, Brisbane, £77 decrease (month of August, £11,736, increase £294); British Columbia Electric (month of March), gross earnings £10,352, net income £2,659; Buenos Ayres and Belgrano Electric, £265 increase (month of September, £13,793, increase £1,317); Calcutta, £393 increase; Cape Town (month of September), receipts £15,174, expenditure £8,503; Isle of Thanet Electric, £33 decrease; Lisbon Electric (month of September), receipts 89,636 milreis, expenses 51,231 milreis; Mexico Electric (month of August), receipts £48,600, expenses £27,900; Perth Electric, £139 increase; Port Elizabeth (month of September), receipts £3,730, expenditure £2,767.

Aberdeen.—At this week's meeting of the Tramways Committee a report was submitted by Mr. Moonie, tramway superintendent, with reference to the possibility of getting suitable car tops to be used during the winter. Mr. Moonie reported that no portable top had yet been invented that was of any practical value, the only thing which he had seen being a double-topped car, which had been constructed with the top upon it. The committee remitted the matter back to Mr. Moonie, in order that he might make further enquiry. Loans and mortgages to the amount of £25,000 were renewed, and authority given to borrow other £25,000 to pay for lines at present being constructed. The convener reported that the newly-opened Torry route was doing very well, £143. 11s. 8d. having been drawn during last week. This was considered very satisfactory for a start.

Finsbury.—A letter was received from the London County Council at the last Borough Council meeting stating that they propose at an early date to proceed with the construction of the tramways in St. John-street and St. John-street road, and asking the consent of the Council to the tramway in Rosebery-avenue being also constructed at the same time, it being a condition imposed by the Act authorising the latter tramway that such consent shall be first obtained, unless and until the tramways in St. John-street and St. John-street-road and certain widenings in Goswell-road shall have been completed. The Clerk said the old Clerkenwell Vestry had opposed this scheme, and had said they were willing to give their consent for trams to run up Rosebery-avenue as soon as certain things were carried out in Goswell-road and St. John-street-road. It was the wish of the London County Council to start the tramway scheme without further delay, and at the same time they were anxious to carry out this work under one contract.

Yarmouth.—The Corporation are in negotiation with the Yarmouth and Gorleston Tramways Company for the purchase of their property. The Tramways Committee at their last meeting further considered the extensions necessary in the tramways at the south end of Gorleston. The borough surveyor stated that, as England's-lane would, under the provisional order of the company, have to be widened before the tramway could be worked by electricity, it would be cheaper to take another route, and he recommended that the line should be taken up

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Lowestoft-road to Lower Cliff-road, down Lower Cliff-road, and by a bridge over Beach-road to the quay, and then southerly to the eastern end of the Gorleston Shelter Hall. A sub-committee appointed to view the locality reported in favour of a suggestion to continue the present line along Lowestoft-road to Springfield-road, and to take a second line from the tramway terminus, through Baker-street, The Plain, Pier-walk, and the quay, to the Gorleston Shelter Hall, the estimated cost being £11,400. This was agreed.

Chester.—At a recent meeting of the Tramways Committee of the Corporation, a letter was read from Messrs. Robert Blackwell and Co., Limited, the contractors for the tramways, confirming a settlement for the sum of £33,210, stating that they had incurred a large pecuniary loss on the contract, and requesting the committee to add to the sum mentioned the amount of £500, this being a proportion of the extra cost entailed by delays and difficulties which they outlined. The Electrical Engineer said there were a few items still remaining to be adjusted with the contractors, and it was resolved that consideration of the foregoing letter be not entertained until the items in dispute are settled. A statement of accounts were submitted showing that the total cost of construction approximated very closely to the figure mentioned in the report of the engineers of July 21, 1902, and that the total cost of acquisition of the tramways company's undertaking, construction, and equipment will be about £66,270. The manager again submitted a gratifying report as to traffic returns. School children's tickets continued to increase in popularity, and the earnings of the workmen's cars again showed a slight increase.

Londonderry.—Mr. Hinde, C.E., of the Board of Works, has held an enquiry into the Londonderry to Moville proposed electric railway. Mr. A. M'C. Stewart, C.E., explained the plan. The railway, of 3ft. gauge, started from the Rock, came out into the Strand-road beyond the Lough Swilly terminus, crossed the Lough Swilly Railway at Pennyburn, and went on to Moville. There was a small line connecting with the Harbour Commissioners' tramway, for the purposes of goods traffic. The line followed the road, and was on the road level save at two points. One was at Culmore (at the long hill), where a deviation took place, in order to get nearer the village and avoid the hill. The line emerged again at Liberty Bridge, Muff, and passed through Muff. The second deviation was at Quigley's Point, where for three furlongs the line left the road, going nearer the Lough. The generating station would be at Kerrykeel. The line terminated in the grounds of Ark House, Moville. The steepest gradient was 1 in 15, the ruling gradient being 1 in 25. The sharpest curve was three chains. Mr. Edward Rotter, consulting engineer, gave evidence of the absence of engineering difficulties, and the enquiry terminated.

Manchester.—Mr. J. M. M'Elroy, general manager of the Corporation tramways, has prepared a report on the half-year's working ended Sept. 30 last. The report shows that the traffic revenue amounts to £315,970. 17s. 5d., and other revenue to £4,298. 0s. 8d., making a total of £320,268. 18s. 7d. Working expenses (including depreciation, £35,027) were £228,496. 19s. 6d., so that there was a gross profit of £91,771. 18s. 7d. This it is intended to apply as follows: interest, £24,302. 7s. 11d.; sinking fund, £12,605. 10s. 4d.; rent of lines, £10,858. 6s. 7d.; and leaseholds, £600, the net profit being £43,405. 13s. 9d. Mr. M'Elroy points out that the half-year, embracing as it did the whole of the summer traffic, would, of course, show a much better financial result than the coming half-year, and consequently it would be fallacious to estimate the financial results for the year on the basis of the first half-year's profit. A proposal by a private individual for a form of underground electric tramway two and a-half miles in length, with the object of connecting up the five big railway stations in the centre of the city, is being considered by the Parliamentary Sub-Committee of the Corporation. The last horse-car in the city was removed from the tramways last week.

Huddersfield.—At Wednesday's meeting of the Town Council, on the recommendation of the Tramways Committee, it was decided to withdraw the system of merit rewards for employés in consequence of objections raised by them. The financial report showed a surplus of £2,914. 3s. 10d. for the half-year ended Sept. 30, but the statement does not include any provision for depreciation. In the course of discussion a councillor objected to the committee's action in obtaining car gear wheels from an American firm. He was informed that the wheels could have been obtained from the works of a firm at Crosland Moor, It was stated that the wheels came from the Westinghouse Company in Manchester. Mr. Dyson: That company is run with American capital. Mr. T. H. Moore (chairman of the Tramways Committee): It employs British workpeople. Mr. Dyson: And brings many from America. Mr. Moore remarked that the committee were most anxious to keep what work they could at home, but in this case it was thought best to get renewals from the firm which supplied the machinery originally. The problem of fares was a difficult one, and the committee had not been able to follow their consideration of the subject with action. That must be left to a future committee. There was a very substantial depreciation fund. The committee's minutes were then adopted.

Stretford.—The Light Railway Commissioners have issued their decision in regard to the enquiry held by them on Oct. 2 into the applications of the Stretford Urban District Council and the West Manchester Light Railways Company for orders to authorise the construction of light railways, and they are prepared to submit orders to the Board of Trade in respect of the same. The Commissioners have noted the observations made at the enquiry on behalf of the Stretford Urban District Council and of the Lancashire County Council as to the necessity of provision being made for the public safety in respect of the use of the railways within Trafford Park for passenger traffic, and for this and other reasons they are of opinion that these railways should be under some statutory form of authority and control. They therefore propose to insert provisions in any order authorising the new lines of the West Manchester Light Railway Company to ensure that the working of such traffic shall be conducted to the satisfaction, having regard to the public safety and otherwise, of the Board of Trade. In coming to this conclusion the Commissioners were of opinion that any future alteration of the facts and the law as to the roadways in Trafford Park is at present uncertain, and that it was necessary for them to deal with the matter upon circumstances as they now are.

St. Petersburg.—According to our Russian contemporary, *Elektritcheskij Wiestnik*, the Russian branch of the American Westinghouse Electric Company at St. Petersburg recently made an offer to the Municipality in which it proposed to change over all the existing tramway lines in the city now using animal traction to electric railways. The construction work, according to this proposition, is to be carried out entirely with Russian workmen, and no material to be used not exclusively of Russian production, the work to be completed within four years. The change from animal to electric traction is to be carried out on plans which have been already adopted by the Interior Department. The cost of the project has been calculated at 27,000,000 roubles within the city limits and 34,000,000 roubles if the lines are to be extended to Sosnooka in order to connect with the city the new Polytechnic Institute of St. Petersburg. All the rolling-stock was to be supplied by the Westinghouse Company at a special rate, to be established by the Municipality. The amount required for the motor-cars, which are to number 500 at least, will be about 5,000,000 roubles. The requirement is that the work on both the existing tramway systems is not to interfere with the horse car traffic. Should the city department decide to accept the proposition, the Westinghouse Company will deposit 300,000 roubles, but with the right to withdraw that sum in case the city does not sign the contract within three months after the proposal is adopted.

Liverpool.—Mr. Bellamy, the general manager, has reported upon the question of laying double lines in Everton-road from the Necropolis to Fitzclarence-street (a distance of 495 yards). He has prepared plans and a report showing that before double lines can be laid it will be necessary for several gardens to be set back. The work is to be proceeded with. The closing meeting for the municipal year of the Tramways Committee was held last week. Sir Charles Petrie, the chairman, said that the general public ought to feel grateful for the work which the committee had done. As to the progress of the tramway system, he pointed out that while, during the nine months ending September of the year 1897, the passengers carried numbered about 29 millions, the number was now 64 millions, or an increase of 192 per cent. The mileage, too, had increased from 4,489,000 to 8,713,000, and the traffic returns from £219,000 to £393,000. During the present year the abnormal weather had prevented a much higher increase in passengers and receipts. Rain fell on 117 days out of a total of 273 under review, against 102 wet days for the corresponding period of 1902, and 90 during the same period of 1901. In May last an important departure was taken, consisting of an arrangement with the South Lancashire Tramways Company for through running of their cars between St. Helens and the Pierhead. He did not know whether the present arrangement would continue, because only that morning he had had an interview with the chairman of the company, and he was afraid the company felt that the Corporation were perhaps getting too good a bargain. However, the arrangement would probably go on to the end of the year. The question of the extension of the tramways beyond the city boundaries in or two directions had been casually under the notice of the committee, and an inspection of the roads from Wavertree by way of Gateacre and Woolton to Allerton, returning *via* Calderstones-road to Smithdown-road, and also between Garston through Speke and Hale to Widnes, had been made, and this was a matter which would be brought under the further notice of the committee at an early date. Concluding, he alluded to the excellent services of the general manager (Mr. Bellamy) and his staff.

Plymouth.—The borough treasurer has issued his statement of the tramway accounts for the half-year from April 1 to Sept. 30 last. On the credit side the receipts were: Compton section, £6,416. 11s. 9d.; Peverell Park, £3,203. 11s. 3d.; Prince Rock, £4,384. 19s. 4d.; Beaumont-road, £1,689. 14s. 3d.; West Hoe, £525. 18s. 8d.; advertising and sundries, £217. 2s. 7d.—making a total of £16,437. 17s. 10d. The disbursements for the half-year were: salaries and wages, including proportion of town clerk, borough surveyor, and borough treasurer's salaries, £3,528. 14s. 1d.; repair of cars and wages of car-cleaners, £697. 11s. 2d.; electric current, £3,129. 1s. 4d.; repair and maintenance of track, £662. 10s. 11d.; overhead equipment, £54. 2s. 8d.; establishment charges and uniforms, £413. 18s. 11d.; stables, £333. 10s. 9d.; rent, rates, and taxes, £678. 3s. 8d.; miscellaneous, £164. 1s. 3d.—making a total expenditure of £9,670. 19s. 7d., and leaving a gross profit of £6,766. 18s. 3d. To the gross profit carried to the net revenue account was added £591, half-year's contribution from the Plymouth, Stonehouse, and Devonport Tramways Company in respect of the Union-street line, and some smaller items—making altogether £7,570. 13s. 3d. Out of this was paid dividends and interest, £2,127. 15s. 10d.; redemption of stock, £2,193. 2s. 8d.; and special redemption fund, £130. 16s. 8d.—making a total of £4,451. 15s. 2d., and leaving a net profit on the half-year's working of £3,118. 18s. 1d. Compared with the corresponding period of last year, the receipts have increased by £1,907. 17s 1d., while the expenditure has been reduced by £1,855. 4s. 9d., and the net profit has, in consequence, grown from £793 to £3,118. The increase of receipts is almost wholly due to the Compton and Peverell Park lines, which together have brought in £1,612 more than the Compton line did last year, Peverell Park not having then been opened. On the Prince Rock section the receipts increased by £345, but on the Beaumont-road line there has been a reduction of £173. On the debit side the large saving of £1,256 has been effected in the cost of electric current, although more current has been consumed. This saving is due entirely to the reduction in the price of

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the current of from 3d. to 2d. per unit. Nearly £200 has also been saved in the car-shed by a reduction in the staff. The net profit of over £3,000 will enable the committee to materially reduce the suspense account, consisting of accumulated deficiences, which at Lady Day last stood at £5,000.

London County Council.—From the fact that the County Council have accepted a tender for a new steel cable for the tramway route between Kennington and the Streatham terminus, it would look as if the section will not be electrified just yet. It will be remembered that in the original scheme this was put down as the last route to be converted to electric traction in South London. Among tramway matters touched on at the usual weekly meeting of the Council on Tuesday was a report brought up by the Highways Committee with reference to the northern tramways. The committee stated that in the North Metropolitan Tramway Company's system are several short lengths of tramway within the county, but not forming part of the system included in the lease of the London County Council tramways. The North Metropolitan Company have recently taken steps to reconstruct for electrical traction the portions of tramways referred to, having obtained the consent of the Board of Trade to the system of traction proposed to be used. The work is being carried out under the powers conferred upon the company by the North Metropolitan Tramways Act, 1897. This Act, however, limits the period for the completion of the work to two years from the date of its becoming law, and the company are, the committee are advised, acting illegally in proceeding with the work. It appears to them, they say, that as the tramways affected are purchasable by the Council, and will probably be worked in conjunction with the lines that are the subject of the lease, it is most important that the Council should have a voice in the system of traction to be adopted. Holding this opinion, the committee have given instructions for an action to be instituted to prevent the company proceeding with the works. In a further report the committee recommended the Council not to exercise for the present their powers of purchase in respect of the Highgate-hill tramways and the London, Camberwell, and Dulwich tramways. The Improvements Committee brought up a report as to the cost of local improvements, and Mr. Benn made the following statement with regard to tramways. He said it seemed to be necessary to correct an impression that the Council wanted to push their tramways everywhere, but from the state of the finances it seemed pretty clear that the Council had as much tramway business on hand as they could deal with at present. The matter therefore resolved itself into this—that if the local authorities did not want the tramways they must be prepared to wait for their improvements. He thoroughly believed in the justice of the one-third contribution from the local authorities. The average earnings of the electric trams have so far proved to be 13·47d. per car mile, against 10·42d. with horse traction. This exceeds the estimate, which was 1s. per car mile. On Monday morning this week much inconvenience was caused by a mishap to an electric car at St. George's-circus, Southwark. The rails and footpaths eventually became blocked, and the omnibuses and other vehicles were much impeded by the dense crowd awaiting seats. The accident is stated to have occurred through a Camberwell-green car getting stuck at the points, and a breakdown gang had to be sent for to put matters right. There is an agitation going on just now to endeavour to obtain seats for the use of the motormen on the cars. Three petitions are now being prepared for presentation to the County Council on the subject.

LIGHTING AND GENERAL.

Harrogate.—Some small extensions of mains have been authorised.

Battersea.—Arc lamp standards are being erected along Latchmere-road.

Leek.—The Urban District Council are raising £9,281 on electricity account.

Uxbridge.—The agreement with the electric supply company has been sealed.

Hammersmith.—A number of additional electric lamps are being provided in various streets.

York.—The Town Council have obtained sanction to borrow £10,800 for electric supply extensions.

Leeds.—During the past month electric installations have taken place in 10 places of worship in the city.

Sheffield.—The Council are about to apply for sanction to a loan of £10,000 for the purchase of motor for hiring.

Croydon.—An enquiry has been held into the Council's application to borrow close upon £30,000 for electricity supply purposes.

Globe Telegraph and Trust Co.—An interim dividend of 2s. per share is announced by the directors, payable on the 31st inst.

Doncaster.—The 125 storage cells now at the workhouse, and the standard lamps used for the outside lighting, are to be disposed of.

Prestwich.—Satisfactory arrangements for taking over the Council's electric lighting order have been made with the Salford Corporation.

Panteg.—The electric power company have decided not to proceed with the laying of their cable over the Pontrhydyrun River Bridge.

Sandgate.—Sandgate is to be lighted by electricity, and the Folkestone Electric Company have commenced the work of installation.

Hove.—An enquiry has been held into the Town Council's application for sanction to borrow £5,000 for electric lighting at Aldrington.

Cheshunt.—The proposed agreement with the electric lighting company will come before the next meeting of the Urban District Council.

Change of Address.—Messrs. W. T. Henley's Telegraph Works Company, Limited, have removed to 13 and 14, Blomfield-street, London-wall, E.C.

Bury.—The electrical engineer in his last report states that the number of consumers of current was 366, and the number of 8-c.p. lamps in use was 37,871.

Aberavon.—The Port Talbot Docks Company propose to ligh the road from the borough to the docks by electricity at an actual cos of £500 and annual cost of £109.

Tredegar.—The District Council have decided to light the village of Bedwellty pits with electric light supplied by the Tredegar Iron and Coal Company at 4d. per unit.

Watford.—The following scale has been adopted for charging motorcars: 4d. per cell up to 15 ampere-hours capacity; over that rate, *pro rata*. Minimum charge, 1s.

Saffron Walden.—Application is to be made for a provisiona order enabling the Corporation to supply electrical energy for both public and private purposes within the borough.

Hertford Asylum.—We understand that the County Council have adopted a report recommending a vote of £3,000 for an electric light installation at the county and city asylum.

Worcester.—Mr. Sutherland proposes that eight lamp-pillars be removed and arc lamps placed instead on the tramway poles near by. The cost of the alteration will be about £9 per lamp.

Callender's Cable and Construction Co.—The directors have decided to pay, on Nov. 2, an interim dividend of 5s. per share, being at the rate of 10 per cent. per annum, on the ordinary shares.

Dorchester.—The Town Council have decided to apply for a loan of £16,000 for the purposes of lighting the town with electricity. A ratepayers meeting will be held next Monday with regard to this question.

Poplar.—The Electric Lighting Committee of the borough report that, after meeting the deficiency of £392 at the beginning of the year, there remained a balance of £3,902 to be carried forward to the next account.

Dalkeith.—We understand that the position of 22 arc lamps proposed to be erected in the compulsory area of the burgh has been settled. The lamps will be in two sets of nine in series and one of four in series.

London County Council.—At Tuesday's meeting it was agreed to lend the Hampstead Borough Council £1,273 for street-lighting purposes, and the St. Pancras Borough Council £23,960 for electric light installation.

Limerick.—Mr. Enright, consulting engineer for the electric lighting scheme, has just been testing the works, etc., previous to the charge of the electric lighting being given over to the Gas Committee for the Corporation.

Faversham.—The Town Council have decided upon the erection of five additional arc lamps, making in all 10 such lamps, and they are about to ask the Maidstone Corporation to permit them to visit their electric lighting works.

Fife.—The County Council have decided that the expense of opposing the Fife Electric Power Bill, including the opposition by Kirkcaldy District Committee, and amounting in all to £239, be paid out of the general purposes fund.

South London Electric Supply Co.—This Company reports having sold during the first nine months of the current year 2,788,400 units, as against 645,000 units for the corresponding period of last year, showing a gross revenue of £27,065, as against £13,436.

Southwark.—At the last meeting of the Council the Chairman of the Electric Lighting Committee said that although the electric light station was producing an additional 200,000 units, the working expenses of the undertaking would be even less this year than last.

Stock Exchange Settlements.—Application has been made to the Stock Exchange Committee to appoint a special settling day in and to grant a quotation to Auckland Electric Tramways Company, Limited, £200,000 5 per cent. first mortgage debenture stock.

Aberystwyth.—The electric light company and the gas company are exhibiting test lamps, with the view of securing the order for lighting the promenade extension. The Town Council are asking the electric light company for their terms for lighting the new promenade.

Radcliffe.—The surveyor has been instructed to prepare specifications and quantities for the construction of the switchboard and engine and dynamo galleries. The question of the arrangement for offices, etc., at the electricity works has been referred to the Works Sub-Committee.

Hull.—The electrical engineer's last report states that the following number of units was sold by the Corporation in the past month: traction, 35,632 (an increase of 4,461 as compared with last year); public lighting, 7,016 (an increase of 579); private consumers, 15,982 (an increase of 6,089).

Harrow.—Important developments of the electric lighting company's business at Harrow are under consideration. It is reported that new engineering features are to be introduced with the object of promoting more economical working, and the tariff of charges for electrical energy is to be reduced.

Westminster.—The City Council have made an agreement with the Westminster Electric Company for the supply of electricity for lighting purposes at 3½d. per unit, and propose to make a representation to the Board of Trade with regard to the prices charged by the various companies in Westminster.

Clitheroe.—At the last Town Council meeting the appointment of a sub-committee was confirmed to consult an electrical engineer as to whether it was desirable to proceed with the application for a provisional order for electric lighting, and, if necessary, to engage him to prepare an estimate of the cost of works and land.

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Suffolk.—In the last report of the Visiting Committee of the county asylum appears a statement from the architect, Mr. A. J. Wood to the effect that the accounts for the electric installation had been adjusted as follows: Messrs. Reavell and Co., Limited, generating plant, £2,287. 2s. 9d.; Messrs. G. N. C. Mann and Co., wiring and fittings, £3,150.

Producer-Gas Engines.—We are informed that Messrs. Mander Bros., of Wolverhampton, have placed with the British Westinghouse Electric and Manufacturing Company, Limited, an order for the supply and erection of a producer-gas engine coupled to a 100-kw. electric generator. The engine will be of the Westinghouse, three-cylinder vertical type.

Oriental Telephone and Electric Co.—The directors have declared an interim dividend of 3 per cent. on the ordinary shares of the Company, free of income tax, payable to those shareholders whose names are on the register at this date. The warrants will be posted 31st inst. The transfer books will be closed from the 22nd to 31st inst., both days inclusive.

Eastbourne.—There has been a very marked diminution in the cost of the electric light at St. Saviour's Church. Recently the churchwardens expended £70 in improving the fittings and ensuring proper control, and they are now reaping their reward. There has been a saving of about £12 during the last nine months, as compared with the same period in 1902.

Penmaenmawr.—The Urban District Council having discussed a recommendation that the offer of Messrs. Lacey and Sillar, Manchester, to prepare a report on the district in connection with the proposed installation of electric light, for an inclusive fee of 25 guineas, be accepted, decided to accept Messrs. Cruse and Handcock's offer to prepare a report as required for 10 guineas.

Leadgate.—Arrangements have been made by the Northern Counties Electricity Supply Company, Limited, by which it is expected that a supply of current for lighting and other purposes will be ready for the district in the early part of the new year. The company then will be in a position to tender for the public lighting of the district, including Crookhall, for the season 1904-5.

Edinburgh.—We refer elsewhere to the Corporation electricity accounts for the year ending May 15, 1903. Since these accounts were printed the charge for electricity for motor power has been reduced to 1½d. per unit, and the charge for arc lamps to £11 per annum. One-hundred and fifteen new arc lamps are now being erected. When these are completed, the total number of public street arc lamps will be 995.

Western Telegraph Co. — The directors, after transferring £35,000 to the general reserve fund and £2,000 to the maintenance ships reserve fund, recommend a final dividend of 3s. per share, making, with previous distributions, a total dividend of 6 per cent. for the year ended June 30, 1903, and also a bonus of 2s. per share, both free of income tax. The balance of the account is carried forward.

Perthshire.—Mr. Duff, S.S.C., and Mr. Vaudrey, both of Edinburgh, last week discussed with a committee the proposal of a water-power electrical scheme for Perthshire, and whether, in the event of such a scheme being carried out, the Corporation of Perth would take a supply of electricity. After an interchange of views, it was arranged that Mr. Lambert, the electrical engineer, should give the engineers certain information as to the lighting.

London Gazette.—At an extraordinary general meeting of the Yorkshire Electric Power Syndicate, Limited, held at the registered office of the syndicate, 4, South-parade, Leeds, on Sept. 29, 1903, the special resolution was passed, and at an extraordinary general meeting of the syndicate held at the same place on Oct. 15, 1903, the special resolution was confirmed: "That the Yorkshire Electric Power Syndicate, Limited, be wound up voluntarily."

Electric Power in Ireland.—The *Sheffield Telegraph* learns that an industrial scheme, which owes its origin to a few Yorkshire capitalists, is being prepared to utilise the vast water supplies of Ireland in the production of electricity and its sale in bulk for manufacturing purposes. There is also another scheme in contemplation to supply electricity and power gas in the North of Ireland. These projects are to come before Parliament next session.

Govan.—The abstract of the burgh accounts for the year ended May 15 last has now been issued. The revenue-producing undertakings include electricity, tramways, baths, and private improvements. The electricity department commenced the year with a credit of £73 and ended with a debit of £168, making a total deficit of nearly £242. However, it should be borne in mind that no less than £1,300 falls to be collected for the summer months from May to September.

Strabane.—Mr. Llewellyn Preece and Mr. R. V. Macrory recently paid a visit to Strabane with a view to locating a site for the proposed electric light and power depôt, which the Ulster Power Company proposes establishing there in connection with their general scheme for the supply of electric light and traction power in the North of Ireland. The idea of the company is to establish electric power stations in Belfast, Portadown, Dungannon, Kilrea, and Strabane.

Walsall.—The last report of the Electric Lighting Committee states that the total number of consumers supplied on Sept. 30 last was 287. During the past month the total units generated at the station was 69,076. The total output from the main generators was 66,458 units. The total units from the transformers was 52,016 (estimated). The total units registered on the meters was 46,040. The machinery was run for 639 hours. The wages paid amounted to £117.

Hampstead.—The Lighting Committee in their last report state that during the three months ended September 8,881 8-c.p. lamps were connected for 136 customers, as against 6,450 lamps for 132 customers in the corresponding period last year. They also reported that a top load of 1,035 amperes was reached last week, against a top load last year of 945 amperes. Complaints are being raised in regard to an alleged nuisance arising from the emission of steam from the works of the Hampstead Electric Supply Company.

Hereford.—Electric light has been installed at the Hereford Constitutional Club, according to specifications prepared by Mr. F. G. Poulton, A.M.I.E.E., city electrical engineer. Messrs. Edwards and Armstrong, of 39, Broad-street, Hereford, were the contractors. The work had been executed in four weeks from the date of its commencement—*i.e.*, within the time specified. The installation consists of 80 16-c.p. lamps and the usual fittings, together with 11-way distribution boards. The light was switched on for the first time on Monday evening.

Finsbury.—At the last Council meeting the Works Committee considered an offer made by the County of London and Brush Provincial Electric Lighting Company to supply electricity in bulk for the purposes of street-lighting by not less than 100 arc lamps at the rate of 2d. per unit. The borough surveyor presented a statement showing that in the event of the borough adopting the suggestion, the cost of the columns, etc., and the electricity would be greatly in excess of the present cost of lighting. It was resolved that no further action be taken in the matter. This was agreed to.

Brighton.—The Council have adopted the following scale of charges for the supply of electricity to the outside authorities: for the first year, 7d. per unit for the first 200 hours' use in each half-year, and 1d. per unit for the balance; for the second and each subsequent year, such price as shall be agreed between the local authorities and the Council, and, failing agreement, as shall be determined by an arbitrator to be appointed by the Board of Trade; except as to price, the conditions of supply, including the right to make a minimum charge, should be those for the time being in force in the borough of Brighton.

Mansfield.—The engineer having obtained sufficient customers in the neighbourhood of Wood-street and Layton-avenue to justify the committee in extending the mains in that direction, it has been resolved that the mains be laid at an estimated cost of £971. 16s. 4d. The engineer has also been authorised to obtain six slot meters with a view to ascertaining as far as possible which in his opinion is the best to adopt in the borough. A letter from the Mansfield Woodhouse Urban District Council with reference to a supply of electrical energy to that Council has been referred to the engineer and consulting engineer for them to report.

Stratford.—The Town Council have received notices of intention to apply for provisional orders from the Empire Electric Light and Power Company, Limited, and the National Provincial Electricity Corporation, Limited. Messrs. Baker, Lees, and Co. have offered to put the Council into communication with a substantial company who would take over the powers granted by the provisional order of 1901 upon terms contained in the heads of agreement enclosed. It has been decided to apply to the Board of Trade for an extension of time for carrying out the undertaking, and at present not to accept Messrs. Baker, Lees, and Co.'s offer.

Hull Telephones.—The Town Council have received sanction to the borrowing of the sum of £43,202 for the establishment of a municipal telephone system. This is the actual amount applied for by the Corporation, as the result of the tenders accepted and other work in connection therewith. All the contracts were let some time ago on the understanding that the contractors were to proceed with the installation of a competitive system in Hull if the Local Government Board sanctioned the application of the Corporation for borrowing powers. The Corporation have already received a large number of applications to become subscribers, and it is expected that the first one will be connected six or nine months hence.

Canterbury.—An enquiry has been held into the Town Council's application for sanction to borrow £4,000 for purposes of electric lighting. The sum applied for was made up of £2,383. 3s. 8d., excess on the loan of June, 1901, and £1,616. 16s. 4d. for new works; £1,016 of the excess was made up of the cost of cable extensions in order to carry a light to persons who wished for a supply. The new works included a further supply of meters, indicators, and further cabling. Mr. Blascheck stated that they had in Canterbury over 20,000 8-c.p. lamps connected at the present time, and the increase was about 20 per cent. per annum. The mains were laid direct in the ground, and were keeping in good condition.

Greenock.—In the five weeks ended Oct. 3 141,590 units of electricity were generated at the Corporation works, as against 94,723 in the corresponding month of last year. A system of free wiring by the Corporation was agreed to at Wednesday's meeting. It was resolved to decline to agree to the proposal of the Parish Council, in relation to Smithston poorhouse and asylum, to forego the guarantee of a minimum payment; but as an alternative to the former offer the engineer was authorised, in the event of the Parish Council deciding that no other artificial light is to be used at Smithston, to offer a supply of electricity, on the understanding that the quantity to be taken would not be less than 20,000 units, which would be charged at the special rate allowed to public institutions.

Aberdeen.—At the last meeting of the Fires and Lighting Committee of the Town Council, the electrical engineer, in regard to complaints as to occasional temporary failures of the street electric lights, stated that he had made alterations and improvements on the cables with the view of preventing the lamps going out in future. He is about to report as to the necessary conditions to be attached to the supply of light from tramway mains where lighting cables are not laid. The Works Committee of the City Parish Council have received five tenders for the electric lighting of Oldmill poorhouse, four from Aberdeen firms and one from a Glasgow firm. That of one of the Aberdeen firms, amounting to £2,001, was the lowest, and it was agreed that it should be accepted, subject to its being in accordance with the schedules on its being extended.

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Rutherglen.—The Glasgow Corporation have arranged with reference to the application of the Town Council for a supply of electrical energy within the burgh that, if the Town Council of Rutherglen are prepared to apply in December to the Board of Trade and obtain a provisional order containing clauses repealing the powers of the Clyde Valley Electric Power Company, Limited, to supply electrical energy within the burgh in competition with the Town Council or their assignees, and empowering the Town Council, if they think proper, to transfer the order so obtained to the Corporation of Glasgow, the Corporation should agree to take from the Town Council a transfer of the order upon such terms and conditions as may be hereafter mutually agreed upon.

Natal.—From the recent report for the year 1902 of Mr. Charles J. Crofts, harbour engineer of the colony, we learn that various new plant was erected, including a combined set by the General Electric Company. The switchboard was extended, and the laying of the underground mains for arc lighting of the quay side; erection of standards, etc., was put in hand, and made good progress. One mile of cable was laid in pipes, and 13 manholes built; 1,358 lineal feet of cable was laid for lighting, etc., and 12 additional arc light standards were erected on concrete foundations. In November a trial trip was made with an electric launch which had been received from the Thames Valley Launch Company. Most of the members of the Advisory Board were present, and everything worked well.

Cape Town.—During the month of July 166,683 units of electricity were generated at the Cape Town electric lighting works, of which 31,147 were consumed for the purpose of street-lighting, 116,365 by private consumers, 2,000 upon the works, 8,000 units for meters, and 9,171 distribution losses, etc., the net revenue accruing from the supply of current to private consumers being £4,925, as compared with £4,064 for the month of July, 1902, the average price paid during July, 1902, being 10·15d. per unit, and for the year from Jan. 1 to July 31, 1903, 10·9d. The total number of private consumers has been 1,091, and the equivalent number of 8-c.p. lamps 67,000; whilst motors have been employed to the extent of 1,063 h.p., as compared with 810 private consumers, with an equivalent of 54,700 lamps, and motors to the extent of 642 h.p. during July, 1902.—*S. A. Exports.*

Fulham.—The Electric Lighting Committee in their last report comment upon a report from the borough electrical engineer pointing out that the charge of £20 per annum for public arc lamps is far below the actual cost, and that basing the charge upon the Council's present sliding scale, and adding 1d. per unit for labour, repairs, carbons, etc., it would work out at £34. 19s. 4d. per annum. The committee do not consider it advisable to increase the charge to so large an extent, but recommend that in future £25 per annum be credited to the electric lighting account for each public arc lamp. It is proposed that the loan of £13,509, in connection with the Council's electric light and dust-destructor undertaking, be taken up on the terms mentioned by the London County Council, and that the Council undertake to provide out of a sinking fund established for that purpose, or from maintenance account, for all renewals and replacements during the currency of the loan of £1,371 (part of the loan of £13,509) of plant or machinery provided with the proceeds thereof.

Redditch.—A special meeting of the Urban District Council was held on Tuesday. So far about £20,000 has been spent upon the electric works, but the Council have for some time past exhausted all their capital, and a new loan is now contemplated. The Council was induced to try a new gas-engine built by a Rugby firm, but this, after about a year and a half of experimenting and alterations, had to be taken away. The same firm then contracted for the erection of another new 300-h.p. gas-engine, but at the final test a few days ago it was found that the engine would not take anything like the stipulated load, and the committee decided to recommend the Council to call upon the contractors—Messrs. Willans and Robinson, Rugby—to remove the engine. Messrs. Willans and Robinson contended that the failure of the engine at the time of the test was due to the supply of gas being inadequate, and protest against the "harsh and arbitrary" action of the Council, and they were granted a further extension up to Nov. 1. The firm have offered in the meantime to put down a steam set to guard against any possible fear of loss of power until they had put the engine and plant in working order.

New Firm.—Mr. C. H. Wordingham, upon his acceptance of the post of electrical engineer-in-chief to the navy, has disposed of his consulting practice to Mr. Thos. L. Miller, M.I.C.E., who has carried on a similar practice for a number of years from his offices in Liverpool and London. Mr. Miller is arranging to complete a number of works undertaken by Mr. Wordingham, and has taken over the offices of the latter, and is continuing to practice from that address as well as from his own office, 7, Tower-buildings N., Water-street, Liverpool, and at 61, Old Broad-street, London, E.C., under the style of Miller and Collins. He has also arranged to take into partnership Mr. H. W. Wilson, who has for a considerable time been engineer to the Lancashire branch of the British Thomson-Houston Company, Limited, of Rugby and London. Mr. Miller's and Mr. Wordingham's former practice will in future be carried on in the name of T. L. Miller and Wilson at both the Liverpool and Manchester offices. We are informed that Mr. Wilson has had considerable experience in the electrical driving of factories, having devoted special attention to the electrical operation of textile machinery, in which class of work the British Thomson-Houston Company made numerous experiments.

King's Lynn.—The electrical engineer in his last report stated that since the last meeting applications had been received for 232 additional lamps of 8-c.p. or equivalent, making a total of 16,442 from private consumers, the applications including power for two motors, making a total of 425 consumers. He also reported that the outside electrical work in connection with motors, meters, and testing of wiring was getting very heavy, and it would require a competent electrician to deal with it, and that the most economical way of dealing with it would be to appoint two switchboard attendants in place of the third assistant (who resigned last May), which would set the first assistant partly at liberty from the station to attend to outside work. In consequence, Messrs. G. W. Johnson and E. Williamson, who have been trained at the work, were appointed switchboard attendants at 15s. per week each. The engineer submitted the following statement: units generated, August, 1903, 22,977 (1902 16,765); units sold to private consumers—light and power, 11 633 (5,993); units sold at power rates, 4,793 (1,409); cost of fuel, stores, repairs, and wages at station, £93. 11s. 1d. (£88. 15s. 8d.); cost per unit generated, 0·97d. (1 27d.); wages of lamplighters and outside staff, £17. 16s. 5d. (£16. 2s. 7d.).

Hackney.—The following report of the Electric Lighting Committee is under consideration: "We have been negotiating for several months with the Great Eastern Railway Company with a view to persuading them to light their stations in the borough by means of electricity. After discussing various methods of charging for the supply, we find that the only one which would prove satisfactory to both parties would be a charge of 8d. per unit for 100 units per kilowatt of the maximum demand per quarter and 2d. per unit afterwards. On this system the average price to be paid by the company would be as follows: hours use of maximum demand per quarter, 100; average price per unit, 8d.; 200, 5d.; 300, 4d.; 400, 3·5d.; 500, 3·2d.; 1,000, 2·6d. A supply on this basis can be profitably given, and we therefore beg to recommend that the tariff for electric energy used for the purpose of lighting railway companies' premises be at the rate of 8d. per unit for the first 100 units per kilowatt maximum demand per quarter and 2d. per unit afterwards." Current is to be supplied to the Eastern Hospital at a cost of £340, including the provision of a new feeder pillar at Brooksbys-walk, £75; distributor to Eastern Hospital, £265. The Council are obtaining from the London County Council a loan of £906 for electricity supply mains.

Bradford.—A proposal to supply current to the Cartwright Exhibition has been referred back to committee. It was proposed to bear the cost of laying the requisite cables, and to supply the current for lighting purposes at 2½d. per unit and for motive power at 1½d. per unit, these charges to be net, and to include a free supply of incandescent lamps, such lamps to be returned at the close of the exhibition. It was also proposed to grant to the Exhibition Committee the free use of the coloured celluloid lamps (about 900 in number) belonging to the Electricity Committee, on condition that any damage to the lamps should be made good by the Exhibition Committee. The total units of electricity sold for all purposes during the past 12 months have been 9,124,223, as against 4,901,172 for the previous year, being an increase of 4,223,051, whilst the equivalent number of 8-c.p. lamps connected was 239,509, as against 207,176 for the previous year, representing the very large increase of 32,333. The number of motors connected to the supply at June 30 last was 1,018, as compared with 913 at Dec. 31, 1902, showing an increase for the half-year of 105. The Baths and Team Labour Committee have decided to recommend the establishment of medicated and electric baths in connection with the new Morley-street scheme.

Cardiff.—The electrical engineer (Mr. A. Ellis) presented a very satisfactory report for the month of September to the Lighting Committee on Tuesday. He stated that there are 901 consumers of the municipal electric light, equivalent to 89,438 8-c.p lamps, against 58,096 last year—an increase of 54 per cent. The units generated were 220,815, against 116,689 for the corresponding month last year—an increase in output of 88 per cent. The revenue for the month was £2,658. 2s. 11d., compared with £1,600 for September, 1902—an increase of 72 per cent. The committee's reserve fund now amounts to £2,175. As a number of consumers have refused to admit meter-readers because they had nothing to show that they belonged to the department, it has been decided to provide the men with uniforms. A number of residents of Clifton-street attended to ask that the street should be lighted with electricity. The Chairman (Alderman P. W. Carey) said the committee hoped soon to get the consent of the Corporation to erect 13 lamps in this street. Subsequent to the meeting the members visited the central sub-station in the basement of the fish market, and, after inspecting the battery of accumulators, Alderman Carey, the chairman, set in motion for the first time the new electric booster lately supplied to the Corporation by Messrs. T. Parker and Co.

Grimsby.—Mr. Vignoles, electrical engineer, in a report adopted at the last meeting of the Public Lighting Committee, stated that the increases over last year were 4,461 units for traction, 579 for public lighting, and 6,089 for private consumers. The work in connection with the sub-station in Riby-square was well in hand. The laying of the cables was now complete. With reference to the suggestion contained in his last report, that a power consumer should be supplied with current during the daytime at 1d. per unit under certain conditions, the engineer suggested that a rental be charged for the time switch, to cover not only the cost of the switch, but also a portion of the interest on the service connection and office expenses. These charges might be as follows: for motors up to 5 h.p., £2 per annum; above 5 h.p. and up to 10 h.p., £2. 10s.; above 10 h.p. and up to 20 h.p., £3; and above 20 h.p, £4 per annum. In the case under consideration the motor would be larger than 20 h.p., therefore an annual charge of £4 would be made. The total revenue, therefore, would be £120. 10s., and the extra cost to the department £73. 18s., or a net profit of £46. 12s., equal to 38 per cent. on the turnover. His suggestion was to cut off at present from dusk until 10 a m., but he anticipated that after some experience had been obtained it might be found possible to renew the supply at 9.30, or even at nine o'clock, but he did not think it will be possible in Grimsby to renew it earlier than that.

Elland.—Last Saturday saw the inauguration of the Council's refuse destructor and electric lighting installation. The erection of buildings, the laying down of destructor and steam-raising plant, and

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the installation of electricity, has entailed an expenditure of about £17,000. The destructor consists of two cells, and will destroy one ton of refuse per hour. The electrical equipment consists of two engines and dynamos with a capacity of 280 kw., and there is storage for 700 ampere-hours. Mr. W. H. Eastwood (chairman of the Council) presided at the opening, and on behalf of the members of the Council presented to Mr. Sam Dyson (chairman of the Electricity Committee) a handsome electric reading lamp. Mr. Walter Emmott, the consulting electrical engineer, on behalf of the staff at the works presented Mr. Dyson with a telephone receiver. Mr. Dyson said in the buildings provision had been made for twice the present plant. The extra engine beds had been prepared and a condenser put in to deal with 1,000 h.p., and with the expenditure of another £2,000 they would be able to double the output. At present they were prepared to supply an equivalent of 10,500 8-c.p. lamps, and the battery was capable of storing 700 ampere-hours. There was already a demand for 2,000 8-c.p. lamps and 11 h.p. for driving purposes. Current would be supplied at 4d. per unit. The committee were also prepared for dealing with a tramway load, and if Halifax brought the trams to Elland they would be in a position to supply them with the necessary current.

Bridlington.—An enquiry has been held into the Council's application for sanction to borrow £26,500 for electric lighting purposes. The town clerk (Mr. A. E. Matthewman, B.A., LL.B.) stated that the Corporation had in May accepted provisionally eight tenders, amounting in all to £24,313. 14s. 11d. Engineering fees, costs, and contingencies brought the amount proposed to be borrowed up to £26,500. The proposed station, the freehold property of the Corporation, is situate in the central position. The Council had not yet come to a decision as to the site on which to erect the proposed destructor. The Corporation had obtained electric lighting powers under an order confirmed on June 25, 1900. A house-to-house canvass had shown that a considerable number of persons were desirous of using the electric light, besides which the Corporation would be large consumers, having at present for the Prince's-parade a small installation, and there would be the street lighting, which over the whole of the borough the Corporation proposed should be carried out by electricity. The Board of Trade had on Nov. 14, 1902, given their approval of the system. The plan of the buildings was explained by Mr. E. R. Matthews, C.E., borough surveyor, who stated that although there would be a good supply of water from the Corporation mains, it was proposed to sink a well in order to avoid risks. The buildings were so designed as to be easily capable of extension. In the regrettable absence, through severe illness, of Mr. F. H. Medhurst, B.Sc., M.I.C.E., his partner, Mr. Cyril E. Lloyd, A.M.I.C.E., gave information as the system, machinery, mains, and lamps.

Grantham.—Last week we shortly referred to the official opening of the Urban Electric Supply Company's station, performed, at the invitation of the resident engineer, Mr. W. E. Milns, A.I.E.E., by the mayor of the borough, Mr. William Hornsby, D.L. Three years ago parliamentary powers were obtained by the Corporation under a provisional order for the supply of electricity, and this order was subsequently acquired by the Urban Electric Supply Company. Messrs. Hockley are the contractors for the work, and they are already engaged in taking down part of the buildings in order to provide accommodation for more boilers. At present the boiler-house contains two 90-h.p. Hornsby water-tube boilers, each capable of steaming one engine with a full load. The boilers are fitted with Meldrum's patent stoker in combination with the same firm's forced-draught system. A third boiler is in course of construction. This will be another Hornsby, but of the new upright type. The feed pumps are by J. P. Hall and Co., of Peterborough, and are in duplicate. The water is drawn from a Boby feed-water heater and detartariser, in which the water is heated to nearly boiling point by the exhaust steam from the engines. In connection with this feed-water heater is a softening appliance and a grease extractor. An ample supply of water is obtained from a couple of specially constructed tanks. The steam-pipes have been supplied by Messrs. Stewart and Lloyd, of Glasgow, and the valves by Messrs. Dewrance and Co., of London. The engine-room is spacious, lofty, and well lighted, and contains two Belliss and Morcom engines of 136 h.p. each. They are of the compound, enclosed, quick-revolution, self-oiling type, and are direct-coupled to dynamos by Thomas Parker, of Wolverhampton, capable of supplying 3,000 lamps each. In connection with these is a set of balancer boosters, also by Messrs. Parker. The switchboard is Messrs. Edmundson's own pattern, made by Messrs. Kelvin and White, of Glasgow. The storage batteries are made by the D. P. Battery Company, of Bakewell, Derbyshire, and consist of 130 cells, each of 600 ampere-hours capacity.

PROVISIONAL PATENTS, 1903.

OCT. 12.

21858. Improvements in electrical switches. John Alexander Kennedy-McGregor and Harry Wren, 5, Corporation-street, Birmingham.

21875. Improvements in trolley heads for electrically-driven vehicles. George Varley, Penny Bank-chambers, Halifax.

21882. A new combination of motor and gearing for electric hoists and cranes. William Livingston King, 109, Farringdon-road, London.

21885. Improvements in or connected with the manufacture of electric lamps. Louis Heathcote Walter, 53, Victoria-street, London.

21921. Improvements in and relating to electrical fire-alarms. Wilhelm Kron, 81, High Holborn, London.

21898. Means for operating valves, cocks, taps, electric switches, and the like at predetermined intervals. William Player Miles, 62, Greyhound-lane, Streatham, London.

21909. Improvements in and relating to electric arc lamps. George Monroe Lane and Edgar Hiram Adams, 111, Hatton-garden, London. (Complete specification.)

21930. Improvements in or relating to means for preventing the fusing and flaring of electric wires carrying electric lights. Martin McDermott, 8, Quality-court, Chancery-lane, London.

21939. Improvements in and relating to signalling through submarine and like cables. Oliver Joseph Lodge and Alexander Muirhead, 18, Southampton-buildings, Chancery-lane, London.

21963. Improvements in wireless telegraphy. John Hodgson Lee, 115, Cannon-street, London.

21972. Improvements in dynamo-electric machinery. John Herbert St. Hill Mawdsley, Norfolk House, Norfolk-street, Strand, London.

21980. Improvements in and relating to electric arc lamps. Randolph Hulsart and Edgar Hiram Adams, 40, Chancery-lane, London. (Complete specification.)

OCT. 13.

21983. An improved trolley head for electric traction wires. Jasper James Carter, 1, Anglesea-villas, Ballsbridge, co. Dublin.

21984. Improvements in starting switches for electric motors. Thomas Edgar Weaver, 134, Claremont-road, Moss Side, Manchester.

21987. Improvements in clockwork electrical stopping and starting apparatus. Frank Mitchell, 11, St. Peter's-square, Hammersmith, London.

21996. Improvements in electromotor starters. Charles John Cassé and Harry Herbert Cassé, 2, Market-street, Bradford.

22008. Improvements in multipolar electric generators and motors. Thomas Large Boyden, The Elms, Newbridge, Wolverhampton.

22013. An improved electric heater or radiator. Edward George Rivers, Beverley Lodge, Sheen-road, Richmond.

24016. Electrical circuit breaker. Joseph Bow Tannahill, 65, Chancery-lane, London.

22044. Improvements in dynamo machines. Harold Edenborough, 33, Chancery-lane, London.

22053. Improvements in and relating to dynamo-electric machines. William Crammond Martin, James Lowson, and William Brooks Sayers, 46, Lincoln's-inn-fields, London.

22087. An apparatus for establishing electrical correspondence. Louis Despradels, 37, Chancery-lane, London. (Complete specification.)

22090. Improvements in the manufacture of electrodes and resistances. Giovanni Cornaro, 18, Buckingham-street, Strand, London.

22097. Improvements in or in connection with trolley or like current collectors for electric traction. Artemas Boutelle Upham, 6, Lord-street, Liverpool.

22101. Improvements in circuit breakers. Thomas Edward Daniels, jun., 18, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents Act, 1901, Jan. 2, 1903, being date of application in United States.) (Complete specification.)

OCT. 14.

22133. A device whereby the trolley pole is automatically controlled and held after leaving the trolley wire. Archibald Johnston and Clifford Alfred Bowen, St. Helen's Depôt, Swansea.

22181. Improved means applicable for use in transforming alternating currents. George Gatton Melhuish Hardingham, Clun House, Surrey-street, Strand, London. (Luigi Magrini, Italy.)

22182. Improvements in electrical switching apparatus. John Reid Dick, Norfolk House, Norfolk-street, Strand, London.

22185. Improvements in the manufacture of insulating material. John Brightwen Alexander, 37, Chancery-lane, London.

22190. Improvements in or connected with alternating-current induction meters. Louis John Hunt and the Sandycroft Foundry Company, 6, Lord-street, Liverpool.

OCT. 15.

22210. Rectifying transformer for alternating currents. Percy Dewhirst, 24, Birley-street, Blackpool.

22216. Improvements in laying electric conductors. Albert Edgar Tanner and Ernest Alexander Claremont, Trafford Park, Manchester.

22265. Improvements in welding metals by electricity. Johann Harmatta, 4, South-street, Finsbury, London.

22269. Improvements in or relating to brushes for electrical machines. Godfrey Marsden Gibson, Westinghouse-building, Norfolk-street, Strand, London.

22287. Improvements in electric arc lamps. William James Davy, 40, Chancery-lane, London.

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22291. Improvements in electric generating machines and motors for continuous current. John William Percy Scott, James Coghlan, and Eldin Swanzy Moulden, 18, Buckingham-street, Strand, London.

OCT. 16.

22324. A new or improved machine for developing electromotive force. John Henry Cox, 249, West George-street, Glasgow.

22356. Improvements in apparatus for use in the electrodeposition of metals. Sherard Cowper-Coles, 82, Victoria-street, Westminster, London.

22365. Improvements in electromagnets. William Baxter, jun., 55, Chancery-lane, London. (Date applied for under Patents Act, 1901, Nov. 21, 1902, being date of application in United States.) (Complete specification.)

22371. Improvements in overhead trolleys or collectors for electric tramway and railway vehicles. Thomas Blaney, 6, Lord-street, Liverpool.

22374. Improvements connected with electric arc lamps. Louis Carl Henry Mensing, 173, Fleet-street, London.

22388. Improvements in apparatus for enabling telephonic and telegraphic messages to be transmitted over the same line wire. Franklin Wise Howorth, 46, Lincoln's-inn-fields, London. (Carlo Turchi and Edmondo Bruné, Italy.) (Complete specification.)

OCT. 17.

22423. Improvements relating to electric generators and motors. John Henry Hindle, Glebe House, Moorside, Denton, Lancs.

22432. Improvements in electrical ceiling fittings. Charles Mark Dorman and Reginald Arthur Smith, Ordsal Electrical Works, Salford. (Complete specification.)

22439. An improved electrical connection for electro-chemical apparatus. Frederick James Turquand and John Frederick Wakelin, 5, Tottenham-street, Tottenham Court-road, London.

22440. Improvements in telephone systems and apparatus. Wallace Cranston Fairweather, 65, Chancery-lane, London. (The Kellogg Switchboard and Supply Company, United States.) (Complete specification.)

22443. An improved apparatus for winding inductive and non-inductive coils. William Hamilton Wilson, King's College, Strand, London.

22465. Improvements in safety devices for alternating-current electric distribution systems. The British Thomson-Houston Company, Limited, Reginald Charles Clinker, Edmund Basil Wedmore, and James Whitcher, 83, Cannon-street, London.

22470. Improvements in turnover or alternative switches for electric currents especially for lighting purposes. Robert Stuart Pilcher, 6, Lord-street, Liverpool.

22475. An improvement in collecting electric currents from armatures of unipolar dynamo-electric machines. Francis Edward Elmore, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

22486. Improvements in electrical range finders. Harry Shoemaker, 45, Southampton-buildings, Chancery-lane, London. ((Date applied for under Patents Act, 1901, Jan. 10, 1903, being date of application in United States.) (Complete specification.)

COMPLETE SPECIFICATIONS ACCEPTED.

To be published Nov. 5, 1903.

1902.

21901. Electric accumulators. Schmitt and Fabre.

22067. Conduits for electric cables. John Holmes Sutton and Leonard Gregson.

22140. Electrical signalling and indicating apparatus. Chiesa.

22352. Apparatus for locating breaks and grounds in electric circuits, or for comparing the resistance of one circuit with that of another. Myers.

22705. Electric motorcar. Hellmann.

24429. Insulated electrical conductors. Hooper.

24704. Ice scrapers for electric railways and the like. Carolan. (General Electric Company.)

25151. Electrical synchronism and phase indicators. British Thomson-Houston Company, Limited, and Clinker.

26034. Electrical recording instruments. Carolan. (General Electric Company.)

26038. Electric track brakes. Carolan. (General Electric Company.)

26041. Electric arc lamps. Carolan. (General Electric Company.)

26104. Apparatus for automatically moving the points of tramway and railway lines, applicable also to switches on trolley wires for electric tramways. King.

26380. Automatic electric potential regulators. Carolan. (General Electric Company.)

26876. System for the electrical transmission of type recorded messages. Steljes and Typewriting Telegraph Corporation, Limited.

27237. Electrical connection fitting for use in conduit boxes and the like. Byng and Casperd.

27838. Electric lampholders. Smith.

28762. Railway electric signal systems. Boult. (Huff.)

1903.

258. Rail bonds for electric railways, tramways, and the like. Compagnie Générale d'Electricité. (Date applied for under International Convention, Jan. 6, 1902.)

4016. Terminal box and cut-out. Crosta.

5725. Overhead equipment of electric tramways and cars therefor. Pearson.

8491. Contacts for telephone and other electrical signalling circuits. Bjorth.

10384. Overhead line and travelling contact (trolley) for electric traction of any kind. Bauco. (Date applied for under International Convention, July 3, 1902.)

12015. Coin-controlled locks for telephone receivers. Justice. (Controller Company of America.)

18336. Electrical interrupting devices for currents, particularly those of high intensity. Murphy.

18740. Method of actuating electric switches, gas and water taps, and the like. Evans. (Allgemeine Elektricitäts-Gesellschaft.)

18907. Electrical controllers. Fairweather. (Diehl Manufacturing Company.)

19521. Systems of alternating-current distribution for railways. Scott. (Date applied for under International Convention, Sept. 13, 1902.)

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.		Last price
Commercial and Industrial.—	£		£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1	..	⅛-¼
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1	..	⅛-¼
British Insulated and Helsby Cables, Ord., 1-100,000	5	..	5-5¼
—— 6 per cent. Cum. Pref., 1-100,000	5	..	5¼-5⅜
—— 4½ per cent. Mortgage Debentures	100	..	103-106
British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red.	100	..	104-106
British Westinghouse Elec. and Manuf., 6 per cent. Pref., 275,001-375,000	5	..	5-5¼
—— 4 per cent. Mortgage Debenture Stock	100	..	100-102
Brush Electrical Engineering, Ordinary, Nos. 1-105,731	2	..	¾-1¼
—— Non. Cum., 6 per cent. Pref.	2	..	1-1¼
—— 4½ per cent. 1st Debenture Stock	100	..	97-100
—— 4½ per cent. 2nd Debenture Stock	100	..	85-90
Callender's Cable, Debentures	100	..	106-110
—— Ordinary	5	..	11¼-12¼
—— 5 per cent. Pref.	5	..	5¼-5⅜
Crompton and Co.	3	..	2-2¼
—— 5 per cent. Debentures	100	..	100-104
Edison and Swan United, "A" Shares, 1-99,261	3	..	¼
—— "A" Shares, 01-017,139	5	..	1¼-2¼
—— 5 per cent. Debentures	100	..	76-81
—— 4 per cent. Deb. Stock, Red.	100	..	72-77
Electric Construction, Limited, Nos. 1 to 112,100	2	—	1¼-1⅜
—— 7 per cent. Cumulative Pref.	2	—	2¼-3
—— 4 per cent. Perp. 1st Mort. Deb.	100	—	97-100
Ferranti Limited, 5 per cent. 1st Mort. Deb. Stock, Red.	100	..	90-95
General Electric Company (1900), 5 per cent. Cum. Pref.	10	..	9⅜-10¼
—— 4 per cent. 1st Mort. Deb. Stock	100	—	96-98
W. T. Henley's Telegraph Works, Ordinary	5	..	14-15
—— 4½ per cent. Preference	5	—	5-5¼
—— 4½ per cent. Debentures	100	—	108-112
India Rubber, Gutta Percha, and Telegraph Works	10	—	18¼-19¼
—— 4 per cent. Debentures	100	—	100-103
Parker, Thos., Limited, Ordinary	10	—	14¼-15¼
Telegraph Construction and Maintenance	12	—	34-37
—— 5 per cent. Bonds	100	—	100-103
Electric Lighting and Supply.—			
Blackheath & Greenwich District Ordinary 1,201-101,200	1	—	
—— 4½ per cent. Deb. Stk. Certs., Red. and Conv.	100	—	116-119
Bournemouth and Poole, Ordinary	10	—	12¼-13¼
—— 4½ per cent. Cum. Pref., 7,501-15,000	10	—	10-11
—— 6 per cent. Cum. Second Pref., 15,001-22,500	10	—	11-12
—— 4½ per cent. Debenture Stock, Red.	100	—	103-106
Bromley (Kent) Electric Light and Power Co., 4½ per cent. 1st Debenture Stock, Red.	100	..	102-105
Brompton and Kensington, Ordinary	5	—	10¼-10⅜
—— 7 per cent. Preference	5	—	10-10¼
Calcutta Electric Supply Corp., Ordinary, Nos. 1-40,000	5	—	7-7⅛
—— Nos. 20,001-30,000	5	—	7-8
Cambridge Electric Supply Company, Ltd., £10 Ord.	8	—	14¼
—— " " £10 Ord.	6	—	10⅜
Central Electric Supply, Ld., 4 per cent. Guar Deb. Stock	100	—	107-110
Charing Cross and Strand, Nos. 1-70,000	5	—	9-9¼
—— 4½ per cent. Cum. Pref.	5	—	5¼-5⅜
—— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000	5	..	4⅜-5
—— 4 per cent. Debenture Stock, Red. (Prov. Certs.)	100	—	104-106
Chelsea Electricity Supply	5	—	5¼-6
—— 4½ per cent. Debentures	100	—	108-111
City of London, Ordinary	10	—	10-10¼
—— 6 per cent. Cumulative Pref.	10	—	13-14
—— 5 per cent. Debenture Stock	100	—	122-127
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100	—	102-105
County of London and Brush Provincial, Ordinary	10	—	7⅛-8¼
—— 6 per cent. Cum. Pref.	10	—	11¼-12¼
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	100	—	107-110
Edmundsons' Electricity Corporation, Ordinary, 1-50,000	5	—	6¼-6⅜
—— 6 per cent. Cum. Pref.	5	—	6¼-6⅜
—— 4½ per cent. First Mort. Deb.	100	—	105-108
Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-30,000	5	—	5¼-4¼
—— 5 per cent. Debenture Stock, Red.	100	..	96-98
Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000	5	—	6-6¼
—— 4½ per cent. First Deb. Stock, Red.	100	—	100-103
Hove Electric Lighting, Limited, Ord., 1-13,000	5	—	7⅛-8¼
Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000	5	—	10¼-11¼
—— per cent. Debenture Stock Red.	100	—	103-106

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Name.	Amount paid.	Last price.
	£	£
Kensington and Knightsbridge and Notting Hill	100 ..	101-104
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10 ..	9⅜-10⅛
London Electric, Ordinary	3 ..	1⅞-2⅛
—— 5 per cent. Pref.	5 ..	5⅛-5⅜
—— 3 per cent. 1st Mortgage Debenture Stock, Red.	100 ..	100-102
Metropolitan, Ordinary	10 ..	17⅞-18⅛
—— 4½ per cent. First Mortgage Debenture Stock	100 ..	110-114
—— 5½ per cent. Mortgage Debenture, Red.	100 ..	97-100
Newcastle-upon-Tyne Electric Supply, Ordinary	5 ..	98-101
—— Preference	4 ..	100-103
Notting Hill Electric Lighting	10 ..	13-14
—— 4 per cent. First Mort. Debs., Nos. 1-500 (Reg.)	100 ..	98-101
Oxford Electric, Ordinary, 1-96 and 407-14,310	5	5⅛-5⅜
—— 4 per cent. Debenture Stock	100	97-100
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100 ..	98-100
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5 ..	3-3½
—— 4 per cent. Debenture Stock	100 ..	85-90
South London, Ordinary	5 ..	3⅛-4
St. James's and Pall Mall, Ordinary, 101-20,080	5 ..	14⅛-15½
—— 7 per cent. Pref.	5 ..	8-9
—— 3½ per cent. Deb.	100 ..	97-100
Urban Electric Supply Co., Ordinary, 8-30,007	5 ..	4⅞-5⅛
—— 5 per cent. Cumulative Preference, 50,001-80,000	5 ..	4⅞-5
Westminster, Ordinary	5 ..	12½-13½
—— 5 per cent. Cum. Pref., 110,101-138,251	5 ..	6-6½

Electric Railways.—

Central London, Ordinary	100 —	94-97
—— 4 per cent. Pref.	100 ..	99-102
—— ,, ,, deferred	100 ..	99-102
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100 ..	115-118
City and South London, Consolidated Ordinary	100 ..	51-53
—— 4 per cent. Debenture Stock	100 —	116-119
—— 5 per cent. Pref. Stock '91	100 —	127-130
—— ,, ,, ,, '96	100 —	126-129
—— ,, ,, ,, '01	100 ..	124-127
Liverpool Overhead, 5 per cent. Pref.	— —	13-13½
—— Ordinary, 1-50,000	— —	7⅛-8
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	— —	102-104
Waterloo and City, Ordinary	100 —	93-96

Electric Tramways.—

Anglo-Argentine, 1-260,007	5 ..	4⅜-4⅝
—— Permanent 6 per cent. Debenture Stock, 1888	100 ..	125-130
Blackpool and Fleetwood Tramroad	10 ..	13½-14½
Brisbane Tramway Invest., Lim., Ord., 1-75,000	5 ..	2-3
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5 ..	4-4½
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100 ..	98-102
British Columbia Electric Railway Co., Ord., Nos. 1-20,000	100 ..	83-86
—— Non-Cum. 5 per cent. Pref., Nos. 25,001-38,600	100 ..	92-96
—— 4½ per cent. 1st Mt. Debs., Nos. 1-6,250, of £40 each	40 ..	102-104 p.c xd
British Electric Traction, Ord. 1-300,000 & 60,001-80,000	10 —	11¼-11⅜
—— 6 per cent. Cm. Pf., 30,001-60,000	10 —	11¼-11⅜
—— 5 per cent. Perpetual Debenture Stock	100 —	120-123
Buenos Ayres and Belgrano Tram., Ord., 1-100,000	5 —	2⅜-2⅝
—— "A" 6 per cent. Cm. Pf., 1-40,000	5 —	5-5⅛
—— "B" 6 per cent. Cm. Pf., 1-27,500	5 —	4⅛-5
—— 5 per cent. Deb. Stock, Red.	100 —	107-110
—— Prov. Cert., all paid	100 —	99-102
Cape Electric Tramways, Nos. 1-480,000	1 —	2⅛-2⅜
City of Birmingham Tramways, 5 per cent. Cum. Pref.	10 ..	5-5⅛ xd
—— 4 per cent. 1st Mortgage Deb., 1-3,000 (1917)	100 ..	99-102
Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red.	100 ..	102 105
Cork Electric Tramways and Lighting Co., Ordinary	10 ..	13-14
—— 5 per cent. Cum. Pref.	10 ..	11-12
—— Debentures	100 ..	96-99
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10 ..	12-13
—— 6 per cent. Pref., Nos. within 1-60,000	10 —	15-16
—— 3½ per cent. Mort. Debs., 1-3,000, Red.	100 —	94-97
Imperial Tramways Ordinary	all —	22-22½
—— 6 per cent. Cum. Pref.	all —	14⅛-15½
—— 4½ per cent. Deb Stock	100 —	112-114
Isle of Thanet Electric Tramways and Lighting, 5 per cent. Cum. Pref., Nos. 30,001-60,000	5 ..	3⅞-4⅛
—— 4 per cent. Debenture Stock	100 ..	92-95
Kidderminster and District Lighting and Traction, Pref.	5 —	3¾-4
London United Trys. (1901), 5 per cent. Cum. Pref.	10 —	11½-12
—— 4 per cent. 1st Mt. Db. Stock, Red.	100 —	104-106
Metropolitan Electric Trams., Deferred, 1,000 001-1,314,016	1 —	5/16-5/16
—— 5 per cent. Cum. Pref., 500,001-814,016	1 —	¼-1⅛
New General Traction, Ordinary	5 —	⅛-¼
—— 6 per cent. Cum. Pref.	5 —	2-3
—— 5 per cent. Mortgage Debentures, 1-1,713 (Regd.)	100 —	88-93
Oldham, Aston, and Hyde Tramway, Ordinary	10 —	10½-10⅞
—— 5 per cent. Cum. Pref.	10 —	11½-12⅛
Perth Elec. Tramways (W.A.) 5 per cent. 1 Mort. Deb. Stk.	100 ..	99-102
Potteries Electric Traction, Ordinary, 20,001-40,000	10 —	9-10
—— 5 per cent. Cum. Pref., 1-20,000	10 —	8½-9⅛
—— 4½ per cent. Debenture Stock	100 —	103-106
South Lancashire Electric Traction and Power Company—		
—— £250,000 Ordinary	1 —	1
—— £101,132 6 per cent. Preference	1 —	1
—— £528,093 4½ per cent. Debenture Stock	100 p.c. —	100 p.c.

Telephones.—

National Telephone, Preferred	100 —	99-101
—— Deferred Stock	100 —	72-74
—— 6 per cent. Cum. First Pref.	10 —	13-14
—— 6 per cent. Cum. Second Pref.	10 —	13-14
—— 5 per cent. Non. Cum. Third Pref.	5 —	4⅞-5⅛
—— 5½ per cent. Deb. Stock, Red.	100 —	93 95
—— 4 per cent. Deb. Stock, Red.	100 —	102-104
Oriental Telephone and Electric Company	1 —	⅞ 1

TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line	Traffic Returns for week			Increase or decrease.		Miles of single track open.		Accounts for past year.						Cost per car mile.
	Ending	1903.	1902.	Week.	Current year.	1903.	1902.	Ending	Total receipts	Passengers carried.	Car miles run.	Receipts per Pass'nger	Receipts per Car mile.	Receipts per Mile of track.	
		£	£	£	£				£			d.	d.	£	d.
Aberdeen Corporation	Oct. 17	1,211	925	+ 286	+ 3,827	19¼	17¼	May 31	37,931	9,099,715	794,641	0·98	13·02	1,970	6·14
Ayr Corporation	,, 10	207	220	− 3	—	8	6	Sept. 25	12,503	2,979,276	290,099	1·00	10·34	1,560	4·7
Birmingham Tramways	,, 17	5,133	5,230	− 97	+ 9,095	6¼	6¼	—	—	—	—	—	—	—	—
Blackburn Corporation	,, 16	816	788	+ 28	+ 713	24	24	March 25a	40,964	7,234,106	826,558	1·36	11·87	1,705	7·44
Blackpool Corporation	,, 15	535	507	+ 28	+ 231	17½	16½	,, 31	211,168	6,169,121	784,443	1·52	10·8	—	—
Blackpool-Fleetwood Tramways	,, 17	317	306	+ 11	− 140	16½	16½	Dec. 31	30,923	2,049,677	584,989	3·62	12·68	1,932	6·99
Bolton Corporation	,, 18	1,803	1,572	+ 231	+ 7,149	38	25	March 31	85,704	17,761,605	1,896,247	1·15	10·75	3,430	5·87
Bournemouth Corporation	,, 14	1,000	—	—	—	10½	—	—	—	—	—	—	—	—	—
Bradford Corporation	,, 18	3,757	3,363	+ 394	+13,570	41	—	—	—	—	—	—	—	—	—
Brighton Corporation	,, 18	894	802	+ 92	+ 6,074	6½	—	,, 31	—	10,432,508	1,031,928	1·00	10·10	—	—
Bristol Tramways Company	,, 16	5,048	4,805	+ 243	—	51½	51½	Dec. 31	223,480	41,192,899	5,724,114	1·30	9·38	4,348	—
Burnley Corporation	,, 17	805	718	+ 87	—	—	—	—	—	—	—	—	—	—	—
Burton Corporation	,, 18	361	—	—	—	—	—	—	—	—	—	—	—	—	—
Cardiff Corporation	,, 17	1,962	1,551	+ 410	+16,917	—	—	—	—	—	—	—	—	—	—
Carlisle Tramways Company	,, 17	192	183	+ 9	+ 576	—	—	,, 31	—	2,216,583	320,129h	—	—	—	—
Central London Railway	,, 17	6,443	6,971	− 523	− 5,084h	6	—	,, 31	367,225	45,305,110	1,276,971a	1·87	66·6a	59,076	35·6a
City and South London Railway	,, 18	2,761	3,273	− 512	− 5,814	6⅝	—	,, 31	165,003a	19,069,319a	—	—	—	—	—
Cork E. T. and L. Company	,, 15	492	682	− 190	—	—	—	—	—	—	—	—	—	—	—
Darwen Corporation	,, 16	224	239	− 15	− 208	7·23	—	March 31g	12,341	2,360,735	254,279	1·25	11·65	1,707	9·36
Dover Corporation	,, 17	208	204	+ 4	+ 112	3	—	—	—	—	—	—	—	—	—
Dublin & Lucan Electric Railway	,, 18	115	108	+ 7	— h	—	—	Dec. 31	5,796	364,796	102,087	3·81	13·62	859	7·68
Dublin U. T., electric cars	,, 16	4,023	4,093	− 70	—	46	46	March 31	126,121	24,553,133	3,429,356	1·23	8·82	2,741	5·06h
Dublin S. District, Electric	,, 16	859	835	+ 33											
Dundee City Tramways	,, 14	939	881	+ 58	—	22	22	May 15	35,874	9,084,522	752,814	0·93	11·276	1,630	—
East Ham Corporation	,, 19	667	477	+ 190	+ 5,922	10·75	7·52	March 31	25,341	9,971,337	650,224	0·61	9·35	2,357	—
Farnworth U.D.C.	,, 7	139	125	+ 14	—	—	—	—	—	—	—	—	—	—	—
Glasgow Corporation	,, 17	14,081	12,690	+1,391	+30,410	124	101	May 31g	656,572	177,179,549	14,008,750	0·88	11·25	5,489 b	7·40d
Halifax Corporation	,, 7	1,340	1,105	+ 235	+ 4,425	30½	27½	—	—	—	—	—	—	—	—
Huddersfield Corporation	,, 17	1,201	1,100	+ 101	—	34	35	March 31	56,631h	9,738,213	1,218,539	1·4	11·14	1,618	6·38
Hull Corporation, E. S.	,, 17	2,559	2,495	+ 64	+ 2,644	19	19	,, 31	87,707h	21,065,999	2,218,696	1·00	9·49	5,004	5·07
Ilkeston Corporation	,, 14	148	—	—	—	—	—	—	—	—	—	—	—	—	—
Kirkcaldy Corporation	,, 14	156	—	—	—	—	—	—	—	—	—	—	—	—	—
Leeds Corporation	,, 17	5,138	5,035	+ 73	+10,191	77	—	March 25	262,656	57,239,779	5,773,651	1·11	10·91	3,283	—
Liverpool Corporation	,, 10	10,474	9,873	+ 601	+13,756	101	95	Dec. 31	504,304	108,906,472	11,705,425	1·11	10·34	5,000	6·88
Liverpool Overhead Railway	,, 18	1,591	1,520	+ 74	+ 1,833	15½	15½	June 30	79,252	10,466,726	986,185a	1·82	19·30a	5,110	— a
Lowestoft Corporation	,, 10	206	—	—	—	—	—	—	—	—	—	—	—	—	—
Nelson Corporation	,, 17	92	—	—	—	3	—	—	—	—	—	—	—	—	—
Newcastle-on-Tyne Corporation	,, 17	3,493	3,118	+ 330	—	38½	36	March 25g	150,334	33,474,122	3,379,119	1·08	10·93	4,175	6·17
Portsmouth Corporation	,, 17	1,472	1,418	+ 54	—	29	29	Sept. 30	47,651	9,168,137	868,157	1·24	13·17	1,643	—
Rochdale Corporation	,, 12	111	126	− 15	—	4½	··	March 31	5,416	925,281	127,456	1·38	10·27	—	7·66
Rotherham Corporation	,, 15	457	—	—	—	—	—	—	—	—	—	—	—	—	—
Salford Corporation	,, 12	3,842	2,896	+ 945	+33,039	—	—	—	—	—	—	—	—	—	—
Sheffield Corporation	,, 18	4,840	—	—	—	53½	46¼	Mar. 25g	216,709	56,812,049	4,926,083	0·904	10·428	7,510	7·0
Southampton Corporation	,, 15	974	991	− 17	—	11	11	,, 31	35,874	9,084,522	752,814	0·946	11·436	3,760	—
Sunderland Corporation	,, 18	1,125	1,080	+ 45	+ 1,909	18·48	17·18	,, 31	59,930	13,987,121	1,270,957	1·03	11·3	3,243	6·43
Wallasey U.D.C.	,, 17	647	591	+ 65	+ 2,725	10·5	10·5	,, 31g	31,307	5,690,378	654,553	1·32	11·47	2,981	6·97

a Includes maintenance of permanent way and proportion of profits paid to the tramway companies for term of unexpired lease. c Train mile.
b Per mile of single track. e Include rail and tram. d including depreciation. f Including one section of horse traction. g 1903. h Half-year's figures.

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NOTES.

Physical Society.—This society opened its winter session at the Royal College of Science, South Kensington, on Friday evening last. During the session, which extends to June 24, meetings will be held on the second and fourth Fridays in each month, the annual general meeting being fixed for Feb. 12.

Institution of Electrical Engineers.—The parent section of the Institution of Electrical Engineers will inaugurate its winter session on Thursday, Nov. 12. The meeting will be held at the Institution of Civil Engineers at 8 p.m., when the president, Mr. Robert Kaye Gray, will deliver his inaugural address. The premiums awarded for papers read or published during the session 1902-03 will be presented at this meeting.

New York Electrical Society.—A postcard has reached us from New York announcing that the above society would open its twenty-third season on the 19th inst. The attraction of the evening was "an informal talk" by Prof. W. E. Ayrton on "Some Electrical Measuring Instruments and Recent Use of Them." Prof. Ayrton is now visiting the States as a member of the Educational Commission which recently sailed from these shores to enquire into educational methods as practised over there.

Royal Meteorological Society.—The council of this society have designated Hofrath Dr. Julius Hann, of Vienna, as the recipient of the Symons gold medal in recognition of the valuable work which he has done in connection with meteorological science. This medal, which is awarded bienially, was founded in memory of the late Mr. G. J. Symons, F.R.S., the distinguished meteorologist and originator of the British Rainfall Organisation. The medal will be presented at the annual meeting of the society, to be held on Jan. 20 next year.

Junior Institution of Engineers.—A large party of members of the above institution visited the Vauxhall New Bridge works on the 17th inst., Mr. W. C. Copperthwaite, London County Council bridges engineer, explaining all the important features of design and the methods adopted in executing the work so far as it has proceeded. At the conclusion of the visit a vote of thanks was passed by acclamation to Mr. Fitzmaurice, chief engineer, London County Council, and Mr. Copperthwaite for the excellent arrangements made for the reception of the members.

Profits of the Paris Exhibition.—The French Government should be well pleased at having secured the handsome sum of £300,000 out of the International Exhibition at Paris in 1900. This addition to the State's revenues, however, seems to have been accomplished only at the mortification of the private speculator, for whom, we are told, the exhibition has proved a "ghastly fiasco." The previous exhibition in 1889 brought the Government in £42,000, which, however, was not so good as the 1867 exhibition, which resulted in a gain to the State of £100,000. The exhibition of 1878 resulted in a loss.

Marconi's Experiments.—Mr. Marconi on Saturday sailed from Portsmouth on board the battleship "Duncan" for the Mediterranean, where he will carry out further experiments in wireless telegraphy. On the voyage he will endeavour to establish communication with Gibraltar before he loses connection with the "Hector," which is stationed off Portsmouth. The apparatus installed on the "Duncan" is said to differ in many essentials from the standard instruments with which most of the men-of-war are equipped. Captain Jackson, who commands the "Duncan," is an authority on wireless telegraphy, having recently served a commission in the "Vulcan" on the Mediterranean station, a vessel to which he was specially appointed to enable him to pursue his experiments. The "Duncan" took out a large quantity of wireless telegraph apparatus for distribution among the Mediterranean Fleet.

Electric Signalling.—Some successful experiments are reported to have been made on part of the railway belonging to the Societa Veneta, near Padua, of an electric signalling system invented by an engineer named Beer, and especially designed for prevention of collisions. Trains approaching each other on the same line perceived the signals warning them of danger in sufficient time to pull up. The experiments were watched by managers and engineers of different railway companies, and there were also present as interested spectators several foreign consuls from Venice. It is stated that the system is to be adopted by the Societa Venta for use on all its lines.

Electric Speed Trials.—The Siemens electric car with which the high-speed experiments have been carried on on the Berlin-Zossen military railway, has scored yet another triumph. On Friday it succeeded in breaking its previous record of 125 miles per hour, and reached a speed of 128 miles (some reports say 131 miles) over parts of the course traversed. From an experimental point of view, the extremely high speeds attained on this specially-constructed railway are of the first interest, but it is not to be supposed that they would be reached or even attempted on an ordinary electric railway and under normal conditions. They, however, serve to show what electric traction can do, but we are inclined to think that the originators of the trials have this time reached their highest ambition. We understand that some valuable data are being collected which will have an important bearing on high-speed railways in the future.

The Coal Commission.—Prof. W. Boyd Dawkins, F.R.S, was a witness before the Royal Commission on Coal Supplies last week, and gave evidence as to the existence of workable coal in South-East England, referring in particular to the various borings which have taken place at Netherfield, Dover, Ropersall, Ellinge, Brabourne, and the London area. He held that in the district referred to there is a coalfield or series of coalfields ranging from Dover north-westward, but it was impossible for him to define the range of the coalfield or coalfields, or to give any idea of its commercial value, although such coal as existed would probably prove to be within workable depths. He strongly advocated the advisability of further borings, as that was the only method by which the existence or value of the coalfield could be definitely ascertained. Finally, he regarded the finding and exploiting of the buried coalfield as of great national importance.

Radium Exhibits in London.—The exhibits at the Natural History Museum at South Kensington have lately been enriched by the addition of a case containing a few grains of radium bromide, and some pieces of pitchblende and barium platino-cyanide, and visitors to the historic institution may now witness a display of some of the properties of the recently-discovered metal. One of these effects is embodied in Sir Wm. Crookes's spinthariscope, where a small screen of zinc sulphide is placed opposite to a speck of radium bromide. Under the microscope it can be seen that the little screen is continually reflecting the rays which are thrown off by the radium. The effect is also shown of rays penetrating thin sheets of aluminium, and lighting up a platino-cyanide or zinc-sulphide screen beyond. There are yet other rays which will penetrate thick sheets of lead, and still have an effect on the screen beyond. These too are shown, and the exhibition is one which will doubtless attract many visitors.

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West Hartlepool Scientific Society.—Mr. J. Elders, the secretary of the above society, has sent us a syllabus of the papers proposed to be read before the society during the coming session, which is the first of its existence. The society has been formed in connection with the West Hartlepool Technical College, and has as its first president Mr. J. Archyll Jones, B.Sc. Altogether eight meetings will be held during the session. The president delivered his address at the inauguratory meeting on Sept. 12, and at a meeting held on the 10th inst. Mr. H. Henderson read a paper on "Arc Lamps and their Uses." Subsequent meetings have been arranged as follows: Nov. 14, "The Absurdities of the Present System of Measures," by Mr. Wm. C. Barrowman; Dec. 12, "Mr. D. B. Morrison's Scheme for the Advancement of Apprentices," by Mr. Wm. Kennedy; Jan. 9, "Boiler Feed Water," by Mr. J. W. Patterton; Feb. 13, "Balancing of Marine Engines," by Mr. J. V. Robinson; March 12, "Three-Wire System," author not stated; and April 9, annual meeting.

London Traffic Commission.—The commissioners delegated to visit the States and examine into the various means of transit and transport practised in the principal American cities arrived back in London on Saturday, after an absence of five weeks. They consisted of the chairman of the Commission (Sir David Barbour), Lord Ribblesdale, Sir John Dickson-Poynder, Sir George Bartley, M.P., Mr. George S. Gibb, and Mr. Lynden Macassey, the secretary. The party confined its investigation to the four cities of New York, Boston, Washington, and Philadelphia, in the order named, in each of which cities the enquiry took the form of an inspection of the systems of urban transit, followed afterwards by a discussion of various questions connected therewith with the traffic experts of the city. Mr. Macassey, in a preliminary journey of enquiry, also visited some other cities, including Chicago, Detroit, Cleveland, and Albany. It is understood that the impressions of the sub-commission on their visit will in due time be placed before the main commission in the form of a report.

Glasgow Scientific Society.—To give it its full title, the Glasgow Technical College Scientific Society, of which Mr. R. D. Munro, M.I.M.E., is the president for the ensuing year, opened its twelfth session at the Science and Arts Buildings, Glasgow, on the night of the 17th inst., when Mr. Munro delivered his presidential address. To-morrow (Saturday) evening the first ordinary meeting of the session will be held, the paper to be read being contributed by Prof. Alexander MacLay, B.Sc., entitled "The Evolution of a Technical College." Subsequent meetings have been arranged as follows: Nov. 14, "Motorcars," by Mr. Alexander Govan; Nov. 28, "Some Remarks on the Willans Engine," by Mr. J. Herbert Pocock; Dec. 5, "Superheat," by Mr. W. H. Booth; Dec. 12, "Steam-Turbine Machinery," by Mr. Arthur A. Wynne; Jan. 9, "The Manufacture of Weldless Chains," by Mr. Alex. G. Strathern; Jan. 23, "Some Observations on Mechanical Training," by Mr. Wm. D. Hamilton; Feb 6, anniversary dinner; Feb. 20, "Modern Conceptions of Matter," by Mr. Angus McLean, B.Sc.; March 5, "British Competition and Manufacture," by Mr. M. Pickstone; March 19, "The Diesel Engine for Marine Purposes," by Mr. A. J. Lawson; March 26, annual general meeting.

Liverpool Engineering Society.—The opening meeting of the thirtieth session of the above society will be held on the evening of Wednesday, Nov. 4, when the president-elect, Mr. Thomas L. Miller, M.I.C.E., etc., will deliver his inaugural address. For the succeeding meetings the following is the present proposed scheme of papers to be read on the dates given: Nov. 18, "Fuel Economy from the Chemical Point of View," by Mr. J. B. C. Kershaw, F.I.C.; Dec. 2, "Recent Telephone Developments in Liverpool," by Mr. E. J. Hidden; Dec. 16, "Polyphase Working," by Mr. H. W. Wilson; Jan. 13, "Motor Vehicles," by Mr. W. Norris; Jan. 20, "Voltage Regulation in Alternating-Current Plants," by Mr. H. S. Meyer; Jan. 27, "Induction Motors," by Prof. E. W. Marchant, D.Sc.; Feb. 10, "Electric Transmission from Water Powers," by Mr. E. Kilburn Scott; Feb. 24, "Conduit and Surface-Contact Tramway Systems," by Mr. George Balfour; March 10, "Steam-Boiler Failures," by Mr. J. R. Smith; March 24, "Notes on Design of Electrical Machinery," by Mr. J. L. Hunt. At this meeting the president and members of the Manchester Section of the Institution of Electrical Engineers hope to be present. April 7, a miscellaneous discussion upon marine subjects; April 28, annual general meeting.

Cooper-Hewitt Mercury Vapour Lamp.—Two patents have recently been granted to Mr. Peter Cooper Hewitt in the States for improvements in his electric vapour lamp, which are briefly described in the *Electrical World*. While the old familiar type of this lamp is held in a vertical position, Mr. Cooper Hewitt has found that operation in a horizontal position has certain advantages, and has now patented details of construction for this purpose. It is stated that a horizontally disposed lamp having a luminous element of considerable length placed in the upper part of a room furnishes a kind of illumination which is agreeable to the eye, and is well adapted to display the special features of architecture, decoration, or furniture, and at the same time the light is said to be agreeable for reading purposes. The other patent relates to details of construction which improve the method of starting the mercury vapour lamp. By adding certain other materials, such, for instance, as red sulphide of mercury, during the manufacture of the lamp, a condition is produced within the lamp which facilitates the starting, a much lower potential being sufficient than if such material is not present. It is also of advantage to provide a band of foil in proximity to the negative electrode and in electrical connection with the positive electrode. To start the lamp, it is connected to a special circuit having a higher potential than that upon which the lamp is intended to run after it has been started, this higher potential being produced by a spark coil.

The Automobile Industry.—Mr. S. F. Edge, the well-known automobilist and maker of motorcars, has been making some remarks on the prospects of the British automobile industry which are worthy of attention. His words should serves as a stimulus to automobile manufacturers in this country to capture the rapidly growing trade in automobiles from our foreign neighbours. Mr. Edge shows that Great Britain is the largest market in the world for automobiles; but, regrettable as it is, the greater part of the manufactures are imported principally from the Continent. Last year 3,500 cars, to the value of £1,046,000, came into this country from abroad, while for the first nine months of the present year this figure had risen to 5,330, valued at £1,600,000. The capture of this immense trade by English manufacturers is all the more desirable, as Mr. Edge pointed out, in that the raw material of motorcars being of inconsiderable value, the greater part of the money goes in wages. Of course, English manufacturers are very considerably handicapped by the fact that, in answer to the popular demand, cheap cars of indifferent quality are sent over here from the Continent; but things look brighter for the future. Many of the initial difficulties in the way of English makers are rapidly disappearing, such as the dearth of competent experts and mechanics; and several

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large firms in this country are now able to place on the market cars, by no means expensive, of great practical utility and efficiency. It is to be earnestly hoped that instead of the import figures increasing, as they have been up to now, as shown above, they may rapidly decrease, until the greater part of the demand in this country, if not the whole, is supplied by the home manufactories.

Benjamin Franklin.—This was the text of the address delivered by Mr. Choate, the United States Ambassador, as president of the Birmingham and Midland Institute, on Friday night. Benjamin Franklin's whole career, he said, had been summed up by a great French statesman — *Eripuit cœlo fulmen sceptrumque tyrannis.* Franklin enlarged the boundaries of human knowledge by discovering laws and facts of nature unknown before and applying them to the use and service of man, and that entitled him to lasting fame. But his other service to mankind differed from this only in kind, and was quite equal in degree, for he stood second only to Washington in the list of heroic patriots who on both sides of the Atlantic stood for those fundamental principles of English liberty which culminated in the independence of the United States, and had ever since been shared by the English-speaking race the world over. Mr. Choate reviewed at some length the principal characteristics and achievements of Franklin's life, and said his grateful country honoured his memory and cherished his ever-growing fame as one of the noblest treasures, and transmitted from generation to generation the story of his matchless service. His autobiography, written near the end of his wonderful career, was valued by all readers of the English language as one of the most fascinating contributions to its literature, and the lessons of his honesty, temperance, thrift, industry, and economy which he inculcated and practised with such brilliant success in his own person had been of priceless value to his countrymen, and contributed very largely to their social, material, and intellectual well-being. So that taking him for all in all, by general consent they classed him with Washington and Hamilton and Lincoln in the list of illustrious Americans.

Electricity in Mexico.—One of the largest electrical schemes of present times is about to be started in Mexico through the efforts of the Mexican Light and Power Company, Limited, which has its headquarters in the city of Mexico. Some of our readers may be familiar with the name of this company, as we believe that a large part of its capital was raised in this country. Important and liberal concessions have been obtained by the company from the Mexican Government, authorising it to utilise for motive power all the waters and natural falls now existing, and the falls that may hereafter be created between certain limits, which are defined, along the Tenango, Necaxa, and Catepuxtta Rivers, in the Puebla State. The powers vested in the company are full to the extreme. It may alter the course of the rivers; may build deposits or reservoirs; may erect, conserve, and exploit stations for generating, accumulating, and holding electric power; and it may transmit, distribute, and supply electricity to any points which it may be able to reach by means of overhead conductors. On its part the company agrees to establish within a period of four years a plant sufficient to produce 15,000 h.p., and within a period of 10 years a plant with a capacity to generate 30,000 h.p.; also to provide the electric apparatus and transmission lines necessary to convey the electric energy to the city of Mexico and other large centres of population. All the machinery, apparatus, and material of every kind required for the works is to be admitted free of duty for a period of four years for the first plant, and during 10 years for all additional installations. A further concession is that from the date of the charter all the capital invested in the undertaking is to be exempt from taxation, with the single exception of the stamp tax. The construction of the works is to be commenced within three months of the granting of the concessions.

London's New "Tube."—New Year's Day is provisionally fixed for the opening of the Great Northern and City "Tube" Railway between Finsbury Park and Moorgate-street. In many particulars the new "tube" presents features, both in construction and working, which are new to London, and represent the most recent and approved practice. For instance, the tunnels are larger than either those of the Central London Railway or the South London Railway, being 16ft. in diameter throughout, and the tubes themselves are constructed on what is known as the "composite" principle—*i.e.*, the top half of the ring is of cast iron, and the bottom half is of brick, the former resting on the latter by means of a sole-plate. This "composite" construction was introduced by Mr. E. W. Moir, of Messrs. S. Pearson and Son, the contractors. Another important feature of the new railway is the adoption of the third and fourth rail system, in which the track is fitted with insulated positive and insulated negative conductors. Both rails are outside the running track, one on either side, hence the four-foot way is kept quite clear. The multiple-unit control system will be adopted. The cars, which are carried on two four-wheeled bogies, measure 49ft. 6in. in length, and are of the corridor type, with a seating capacity for 60 persons. The motorcars, equipped by the British Thomson-Houston Company, have the motor compartment divided into two, and every protection has been taken against the fire danger. One division contains all the electric control apparatus, confined in a sheet-iron box, which is lined outside with a new non-combustive material known as uralite. Further, the line cables running throughout the train are asbestos-covered, held in non-inflammable cleats and enveloped in steel troughing. All the stations have concrete platforms, and no wood is used anywhere. Automatic signalling will be employed on the new railway.

The Post Office and Wireless Telegraphy.—It is stated in the daily Press that the Post Office has invited Mr. De Forest to give a demonstration of the system of wireless telegraphy which has been exploited in America under his name. The experiments will take place between Holyhead and Howth, which, we believe, was the scene of the earliest attempts in wireless telegraphy with which the Government was associated. Mr. De Forest is now in London, and the trials will probably be commenced within a fortnight. We note that among other claims which this inventor puts forward for his system is that of secrecy. According to the language of the daily Press, this is how he puts it: "While he could receive Marconigrams, Marconi could not receive his messages, owing to the higher speed of transmission." Mr. Cuthbert Hall, the managing director of the Marconi Company, has been telling an interviewer how his company regards the action of the Post Office in the matter. He naturally claims that the Marconi system has alone attained a notable measure of commercial success, but adds that when his company sees a wireless telegraph system which is technically satisfactory, and the owners of which are getting any considerable amount of business, patent proceedings will probably be instituted. It is an old story that the Marconi Company claims to have a fundamental basic patent without the use of which any wireless system is impracticable. In any event, the Post Office is pursuing the right course of

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not binding itself to any particular system until it has been proved in practice to be the best. An interesting rumour is current in well-informed circles crediting the Government with the intention to introduce legislation next session to deal with wireless telegraphy. It is suggested that owing to the increasing use which Government departments, and particularly the Admiralty, are making of wireless telegraphy, the Government is anxious to establish a monopoly of this means of communication in the United Kingdom.

Junior Institution of Engineers.—The annual general meeting of this institution was held at the Westminster Palace Hotel on the 24th inst, the principal business being the presentation of the council's report and accounts, and the election of officers for the ensuing year. The report stated that the total membership was now 746. Ten meetings for the reading and discussion of papers had been held, the institution premium having been awarded to Mr. R. W. Newman, A.M.I.C.E., for his paper on "The Effect of Design on Methods of Construction from a Contractor's Point of View." Twelve visits to engineering works, etc., had taken place, in addition to those of the summer meeting occupying one week, Sheffield and the Peak district having been the rendezvous. The accounts showed that the sum of £300 had been invested, and that the income had been £156 more than the expenditure. The election of Mr. J. Fletcher Moulton, K.C., M P., as the new president, and some proposed lectures on the theta-phi diagram by Prof. John Perry, were also referred to in the report. The election resulted as follows: chairman, Mr. S. Cutler, jun.; vice-chairman, Mr. Adam Hunter; hon. librarian, Mr. H. T. Gould; hon. auditors, Mr. H. N. Gray and Mr. H. B. Vorley; members of council, Messrs. J. N. Boot, W. H. De Ritter, A. H. Huddart, and J. H. Pearson; provincial members of council, Messrs. V. H. Chabot, T. D. Evans, E King, W. E. Lilly, F. S. Pilling, and E. W. Porter. The programme of papers for the new session was announced: Nov. 20, "Fires on Shipboard," by Mr. G. Canning; Dec. 4, "Gas-Engines," by Prof. D. S. Capper; Jan. 22, Mr. Moulton's presidential address; Feb. 5, "Producer-Gas Power for Ice Factories," by Mr. Hal Williams; March 4, "Electric Storage Batteries," by Mr. G. C. Allingham; April 8, "Heating and Ventilation of Factories," by Mr. K. Gray; May 6, "The Design of a Dry Dock," by Mr. A. W. Young. Engineers desiring particulars of membership of this society should communicate with the secretary, Mr. W. T. Dunn, 39, Victoria-street, Westminster.

Light Telegraphy.—The telegraphic transmission of messages without the use of wires has entered a new phase by the application of Ruhmer's light telephony for telegraphic purposes. It will be remembered that last year Mr. Ernst Ruhmer, in conjunction with the naval construction department of the Siemens-Schuckert Works, made experiments on the Wannsee to transfer by means of a projector certain flash signals to a selenium cell placed at varying distances. In that case the sound waves of the human voice were changed into electrical waves by means of a microphone. These electrical waves corresponded to the sound waves, and effected corresponding changes in the strength of the current and of the light of a continuous-current arc lamp. The rays from the lamp, which varied in strength, were then concentrated upon a selenium cell by means of a parabolic mirror. The current from the selenium cell varied with the light waves and reproduced the speech. Mr. Ruhmer has now perfected an arrangement by means of which this system of telephone may be used in telegraphy. The process is as follows: The arc lamp is acted upon by the induced current of a transformer coil. A mercury interrupter is placed in the secondary circuit, together with a Morse key. When, by means of the Morse key, the secondary circuit, which is frequently interrupted, is closed, an undulating current is set up in the primary lamp circuit, and hence in the light rays. The movement of the key can be followed in a telephone connected across the lamp. The uniform note from the transformer current continues as long as the Morse key in the secondary circuit is closed. It is, therefore, clear that it is possible to signal by means of dots and dashes corresponding to the Morse alphabet, which can be heard in the telephone connected to the selenium cell at the other end. This invention would be particularly valuable for secret military service, as it is not possible to follow the rapid variations of the light intensity either with the naked eye or with the telescope. So far, however, the range of signalling is limited. The apparatus can also be arranged to control the opening and closing of electrical circuits from a distance.

Association of Municipal Corporations. — The autumn meeting of the Association of Municipal Corporations, which was held last week at the Westminster Palace Hotel, was presided over by Sir Albert K. Rollit, M.P., and there was a large attendance, including the mayors and town clerks of many of the metropolitan and provincial boroughs. In his opening speech Sir A. Rollit referred to the fiscal controversy, and incidentally to the question of technical education. He remarked that whatever might be said for or against fiscal changes, there could be no doubt that in relation to the trade of our country we had to deal with a great plurality of causes constantly affecting it, and he did not hesitate to say that neglect by the State for a long period of that public instruction and of that knowledge of the application of science to trade and industry had been one of the causes which made us lament to-day that some other countries possessed that trade and those industries, many of which we once enjoyed, and which, through education, might be enjoyed again, and might be the means of permanently maintaining the commercial pre-eminence of this country. With regard to municipal trading, he observed that so far the association had no reason to be disappointed with what had taken place, and they were not afraid of the light that might be thrown on their proceedings. In the subsequent discussion the Town Clerk of Birmingham made some caustic criticisms of the action of the *Times* in publishing a series of articles on "Municipal Socialism," pointing out that the *Times* itself had gone in for a little trading in connection with the "Century Dictionary" and the "Encylopædia Britannica." Every case of municipal trading in the future would be considered on its merits; and he did not anticipate that capitalists or promoters, or even the *Times* newspaper, would ever be asked to form syndicates to take over the great trading undertakings of their corporations. The Town Clerk of Leeds offered some remarks to the same effect. Sir James Woodhouse, M.P., drew attention to the question of Government audit, remarking that Government audit as at present used was a great force for protecting the ratepayers. In connection with surcharges made by the Local Government Board auditor, and other financial restrictions placed upon metropolitan borough councils, the association agreed to promote legislation in the next session of Parliament to place metropolitan borough councils in an equivalent position to that of the provincial corporations. Before the meeting separated other resolutions were passed referring to local government legislation, trust investment, ground values and corporation loans.

New West Ham Electric Power Station.—At the invitation of the Mayor and the Electric Lighting and

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Tramways Committee of West Ham, a party of members of the Institute of Marine Engineers was recently shown over the new electric power station that is being erected at Canning Town for supplying the district with electric power for lighting and tramway purposes. The visitors were conducted round the station by the Mayor, the Deputy-Mayor, and Mr. F. James K. Bock, the chief electrical engineer. The new building is now rapidly nearing completion, and it is probable that within six months the machinery will be in full working order. The first installation of plant will consist of two 2,000-h.p., two 1,000-h.p., and two 500-h.p. alternating sets for lighting purposes; while for the tramway load there will be three 750-h.p. engines and dynamos. The boilers are of the water-tube type, supplied by Messrs. Babcock and Wilcox. Of these there are 17, each capable of evaporating 15,000lb. of water per hour. These boilers are all hand-stoked, it having been found in the old station that firing by hand resulted in a considerable saving. There are four condensers, each capable of condensing 40,000lb. of steam per hour, and two capable of condensing 20,000lb. per hour each. To supply the circulating water to the condensers four 15in. centrifugal pumps are installed. There are eight boiler feed pumps and four economisers of 480 tubes each The importance of an adequate supply of clean feed water for the boilers has received very special attention, the plant for softening the water being capable of dealing with 8,000 gallons per hour, whilst the water purifiers for extracting the oil from the condensed steam can operate 15,000 gallons per hour. That the feed water will be passed into the boilers in a clean condition and at a high temperature, was evidenced at the existing station at Abbey Mills, to which the visitors were afterwards taken. Here a sample drawn direct from the condenser was compared with another sample after purifying. It was found that no more than 1 per cent. of the oil remained. At the new station the coal will pass direct from the barges into the coal bunkers by means of a Temperley transporter. The coal bunkers will be fitted above the boilers, and will provide a three weeks' supply, the consumption of coal per week being about 400 to 500 tons. The new station occupies a large area, and in its equipment the comfort of the men employed has not been overlooked, a large messroom and well-arranged baths being noticeable features. As compared with the Abbey Mills station, the new building marks a progressive spirit on the part of the West Ham municipal authorities, and it is interesting to notice how the demand for electric power has increased of recent years. During the year ended March, 1900, 741,435 units were generated, whilst in the year ended March, 1903, the power generated had increased to 2,632,100 units. The existing station at Abbey Mills has generating plant of 4,850 h.p., as compared with 9,100 h.p. of plant at present on order for the new station, which is designed to allow of an increase of power up to 14,000 h p.

Rapid-Cutting Steel.—A joint committee, consisting of members of the council of the Manchester Association of Engineers and of members of the Manchester School of Technology Sub-Committee, together with Dr. J. T. Nicolson, professor of mechanical engineering at the school, have just completed a long series of experiments, the purpose of which was to test the capabilities of some of the high-speed tool steels that have recently been introduced. The report of the committee embodying the results of the tests was presented at the meeting of the Manchester Association on Saturday evening. In carrying out the experiments, the electric power mains of the school were drawn upon for the driving of an electric motor of 100 h.p., from which a large lathe capable of carrying a steel forging of three tons weight was driven through countershafts by 10in. belts. The power was measured by the use of carefully calibrated volt and ampere meters, and the net horse-power used in cutting was ascertained by the aid of a powerful transmission dynamometer and a large Prony brake, designed and constructed in the school. In addition, the actual force exerted upon the tool when cutting was measured by a lathe tool dynamometer having a capacity up to 15 tons, which was constructed in the school workshops and fitted to the lathe. Cuts up to $\frac{3}{8}$in. by $\frac{3}{8}$in. were taken with the tool fixed in this dynamometer, the load being read off in the simplest way by means of a standard pressure gauge. It appeared from the trials that speeds of from 110ft. to 150ft. per minute were possible for soft steel, 80ft. to 110ft. for steel of medium hardness, and 40ft. to 50ft. for hard steel. In the case of cast iron, speeds of 100ft. to 110ft. for soft, 50ft. to 60ft. for medium, and 30ft. to 40ft. for hard were obtained. It was also found that 45 square feet may be machined over in an hour by these rapid-cutting steels when operating upon soft steel with a cut $\frac{3}{16}$in. deep, the figures for medium and hard steel being 30 and 18 respectively. With cast iron a surface of 42, 18, and 15 square feet may be turned off at the same cut in the case of the soft, medium, and hard varieties respectively. But few specially heavy cuts were attempted, but it was found possible (when taking a cut $\frac{3}{8}$in. deep by $\frac{1}{8}$in. traverse) to remove 440lb., 330lb., and 180lb. of cuttings per hour from the soft, medium, and hard steel forgings respectively, and 450lb., 200lb, and 190lb. from the soft, medium, and hard cast-iron specimens. In one instance, with a $\frac{3}{8}$in. by $\frac{3}{8}$in. cut, cuttings were removed at the rate of 510lb. per hour from soft-steel bar. The tests further showed that the forces acting upon the tool point when cutting were over 100 tons per square inch of area of section of cut in steel, and from 50 to 80 tons per square inch for cast iron. One of the most noteworthy facts discovered is that the cutting force does not increase, but appears rather to diminisb, with increasing speeds This is contrary to the opinion generally held by turners and machine tool experts, as instanced by the objections raised by workmen to an increase of the cutting speed on account of the anticipated springing of the work. This objection can no longer be sustained, for although higher speeds of taking a given cut will, of course, require a greater driving power almost in direct proportion to the increased speed, no greater but rather a smaller force will be brought upon the tool, and the load acting on belts and gearing, and the tendency of the lathe and work to spring, will be rather diminished than otherwise. On the other hand, it has been conclusively shown by these trials that heavy cuts at moderately high speeds are much more economical in power than light cuts at the highest possible speeds the tool can stand. For the cutting speed does not increase as fast as the area of the cut diminishes, so that more material can be machined off in a given time with a heavy cut than with a light cut at its corresponding faster speed. Further, the total or gross horse-power required for cutting consists of the sum of that lost by friction of the intermediate gearing and of the lathe, as well as the effective work spent upon cutting. Now, the frictional power does not vary much, whether there is a heavy or a light cut on the machine; it therefore forms a much larger percentage of the whole at light cuts than at heavy cuts. The value of the report is enhanced by the exhaustive tests of the physical and mechanical properties and the chemical constituents of the six different materials operated upon—namely, forged steel and cast iron, each of three grades of hardness.

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THREE-PHASE PLANT AT PRESTON.

In January last year we were, through the courtesy of Messrs. Dick, Kerr, and Co., able to give full particulars of two large direct-current dynamos manufactured by the English Electrical Manufacturing Company, at Preston, for the Bolton Corporation. We then gave details (*E.E.*, vol. 29, page 114) of the methods employed in the manufacture of these direct-current machines, which for their excellency in design and in construction may be looked upon as typical examples of the best English practice. At the time of our visit in January last year the firm was just putting into the shops their first three-phase alternator, and since then they have made exceedingly rapid strides in the manufacture of two and three phase plant As have so good a repute. As a matter of general interest, it may be stated that, in addition to having carried out some important developments in alternating-current practice, the works are engaged in manufacturing other special apparatus. High-tension switchgear now ranks among their productions, and motors, direct current and alternating, for power purposes, with the necessary controlling mechanism, have now become part of the standard machinery turned out at Preston. This extension into lighting and power work has necessitated some important additions to the works, a new bay of some 450ft. long and 60ft. wide having been recently completed.

In order to show the progress which the firm have made in the short space of 18 months, we give the following list of orders which they have now in hand, or have just completed. The satisfactory feature in this list is the wide-

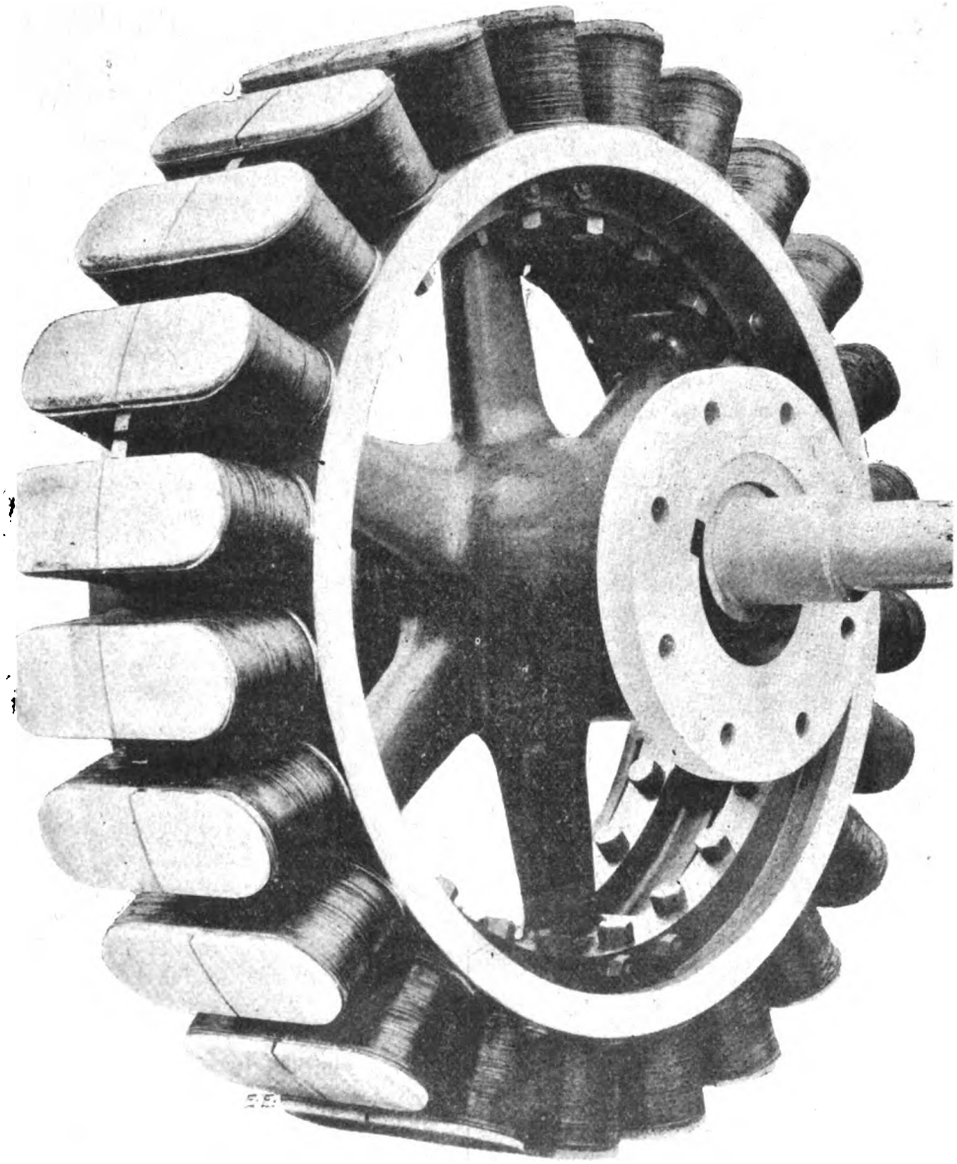

FIG. 1.—The Revolving Field Magnet System of a Dick-Kerr Two-Phase 600-kw. Alternator for Fulham.

was the case in the direct-current machines, the policy was first to establish the general lines on which the construction was to be carried out and then to standardise these details and employ them in all sizes of machines. In this respect they had considerable advantage from the fact that they started the manufacture of three-phase plant somewhat late in the day, as there was at their designer's disposal a vast amount of information from Continental and American firms which could be utilised. This enabled Messrs. Dick, Kerr, and Co., in starting, to avoid faults which had been revealed by practical tests on other machines. In this respect the plant manufactured at Preston will be free from certain objections which have been found in foreign-made machines, and it will compare well, both in mechanical and electrical details, with the direct-current machines for which the firm

spread destinations of the multiphase machines, which will soon be represented in practically all the Colonies. It is worthy of note, also, that Messrs. Dick, Kerr, and Co. have secured large orders for Canada, in spite of the American competition. There is no doubt that in this respect the preferential tariff offered by Canada to the Mother Country is of considerable assistance: London County Council, two 1,500 kw. (alternating), 12 motor-generators, each of 300 kw., and three motor-generators, each of 50 kw.; Horndean tramways, two motor-generators, each of 200 kw.; Portsmouth Corporation, two motor-generators, each of 200 kw.; Sydney, one alternator of 300 kw., two alternators of 600 kw., and six motor-alternators of 300 kw.; Stalybridge, three alternators, each of 500 kw.; Malvern, two alternators, each of 100 kw.; Fulham, one alternator of 600 kw.; Osaka, one alternator of 210 kw.; Durban,

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one alternator of 500 kw.; Lakefield Portland Cement Company, Ontario, Canada, one alternator of 1,000 kw. and one alternator of 450 kw.; Shawinigan Water and Power Company, Montreal, Canada, one alternator of 3,750 kw.; Metropolitan Electric Supply Corporation, eight motor-alternators, each of 500 kw. And amongst others may be mentioned complete plant, comprising generators and sub-station machinery, for Lancashire and Yorkshire

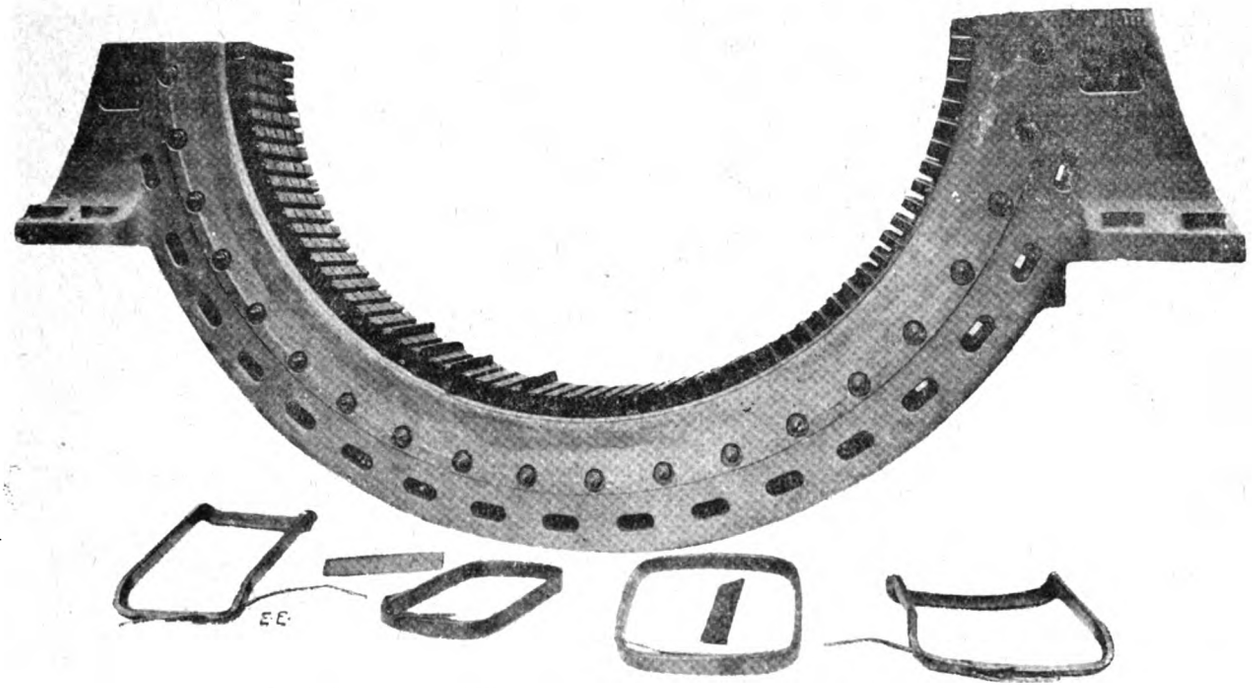

FIG. 2.—The Lower Half of a 1,500-kw. Stator Unwound, with Former-Wound Coils in the Foreground.

Railway, Leeds and Wakefield Light Railway, Tokio Electric Tramways.

The design of the polyphase alternators is necessarily varied somewhat to meet the conditions under which the machines are to be worked, and is also varied with the output of the machines. We propose to commence our description of these Preston alternators with the revolving part, which in every case is the field-magnet system. A typical example of one of these is shown in Fig. 1, which is the rotor for the 600-kw. alternator manufactured to the order of the Fulham Metropolitan Borough Council. In this case the spider is of cast iron, the ends of the spokes being disconnected, so that there are no casting strains in the metal. On each side of these spokes there is secured a ring of the best cast steel. These rings are made in two halves, and are secured together in the first instance by a steel tongue inlet into the T-shaped recess in the ends of the half rings. These tongues are inserted hot and draw the halves close together as they contract in cooling. The cast-steel cores of the field magnets are then secured on to these rings by the bolts shown. It will be seen that the poles are in two halves, which allows of ventilation up through the centre. The pole-pieces are of laminated steel, and when screwed on serve to hold the exciting coils in position. These pole laminations are held together between two cast-steel end plates of strong construction. The firm are making another type of pole in which laminated iron is used throughout, the cores and the pole-pieces being in one. In this case the lower end of the magnet pole is dovetailed into the rim of the rotor. The space between this dovetail and the V-shaped groove in the rotor is then filled in by two steel keys which are slightly tapered. The one key is driven from either side, so that they both secure and centre the pole. In the smaller machines, of which we saw a considerable number in construction during our visit to the works last week, the lamination of the field-magnet system is carried still further. In these machines the cast-steel ring is replaced by iron laminations of a large size, each punched complete out of a steel plate. On the outer periphery of these punchings there are the V grooves mentioned above, into which the laminated poles dovetail, and are secured by keys in the way explained. This construction is exceedingly neat, and allows of the removal of a pole and exciting coil should this be necessary. The laminated centre plates in this case are clamped together on an inner cast-iron

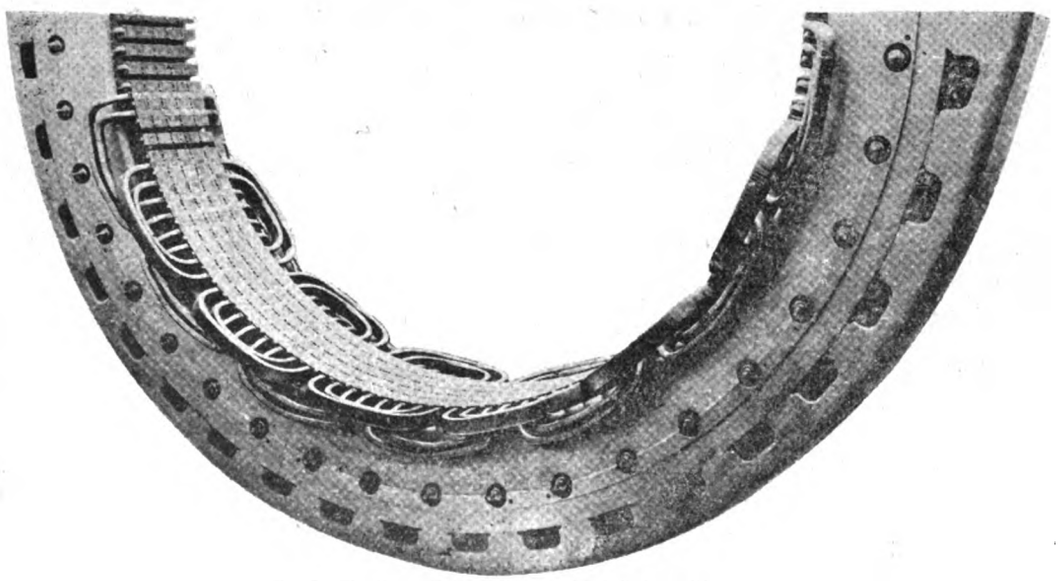

FIG. 3.—The Upper Half of a Stator with Coils in position.

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centre. The winding of all the field coils we saw at the works at Preston was being carried out with bare copper strip wound edgewise. Wherever the excitation of the voltage permits, the field coils are wound with a single layer of copper strip wound edgewise, and insulated between the turns by means of specially-prepared fibrous material. The external surface of the windings is left practically bare, being protected merely by insulating varnish, which allows a rapid radiation of heat. This accounts for the somewhat uneven appearance of the windings on the field coil shown in Fig. 1.

up of thoroughly annealed soft iron laminations, the individual laminations being well insulated from each other to minimise eddy-current losses. The laminations are held in position in the frame by means of retaining machined bolts. The coils used are all former-wound, which, after being thoroughly insulated, can be dropped into the slots in the laminated core. These slots are rectangular in section, and have grooves in their upper part into which wooden wedges can be driven to hold the coils in position. In Fig. 2 the lower half of a stator is shown without any windings in position. The three types of coils used in winding are shown

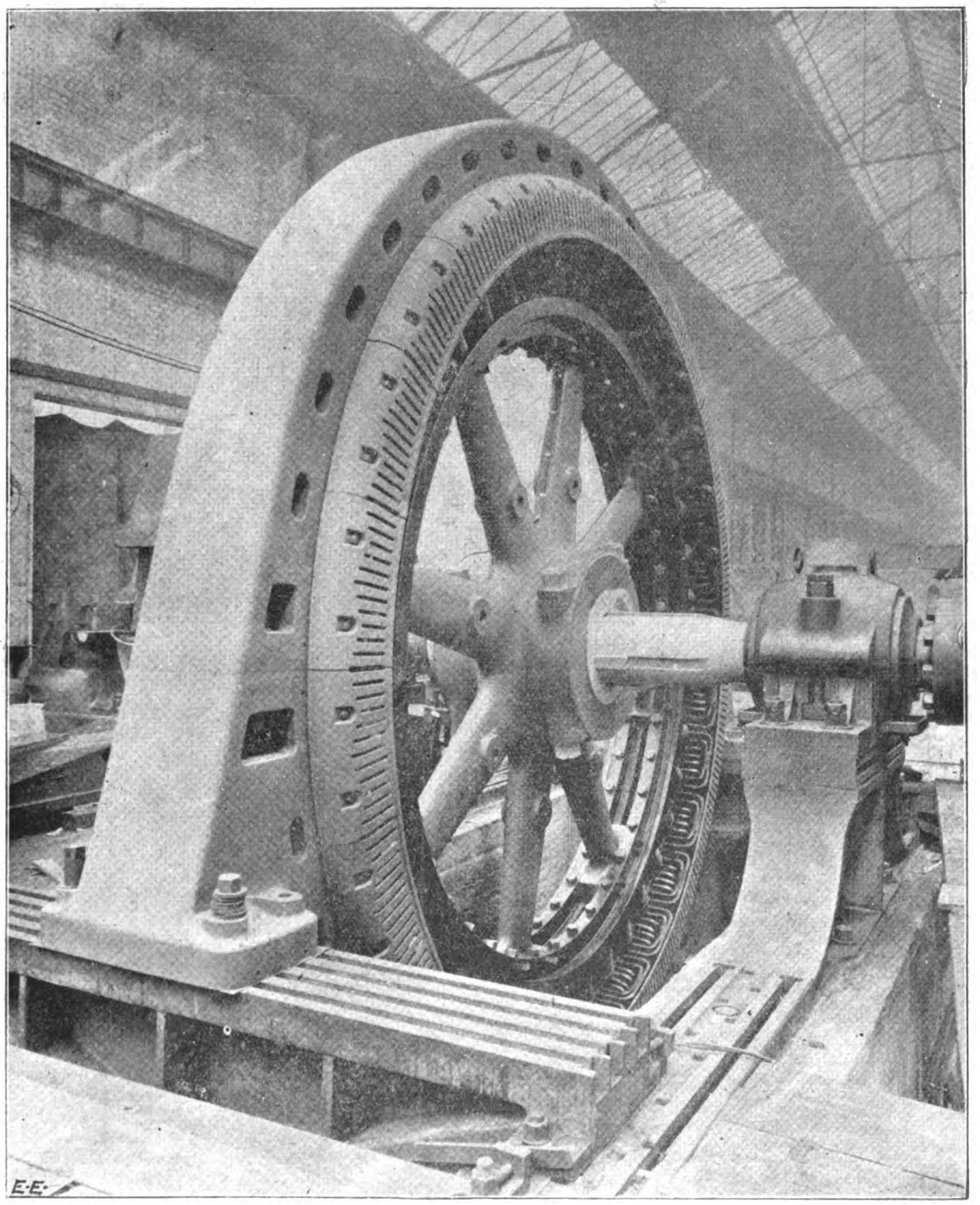

FIG. 4.—A Dick, Kerr, and Co. 1,500-kw. Three Phase Alternator complete.

The stator frame is built in two halves, which are securely bolted together by means of finished bolts The lower half of the frame is provided with feet, which rest upon the foundation bed-plate. In the larger size machines the lower part of the underframe is provided with a special screw for vertical and horizontal centering of the stator relative to the rotating field. The general construction of stator frame is shown in Figs. 2 and 3. The frame is made of high-grade cast iron, and is designed to allow complete ventilation of the laminations, and at the same time to secure rigidity of the frame. The core is made

below. Before the coils are put into the slots there is inserted a trough of insulating material, such as presspahn, as a mechanical protection to the insulation of the coils. In Fig. 3 of the upper half of the rotor the coils are shown in position. Connections between these coils are made by means of highly-insulated cables, and are easy to trace and locate. The coils are protected outside the laminations by means of a cast-iron shield, cast in sections, bolted to the frame and easily removable. This shield is of a perforated design, and does not interfere with the ventilation of the stator winding.

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The collector is composed of rings of suitable metal, fixed to the shaft next to the rotor by means of a spider and insulated pins, ample provision being made for free air circulation round the same. The brushes are in duplicate, and are made of carbon of ample surface. They can be set and replaced while the machine is running. The brush-holders are so constructed that the current will not pass through moving joints or tension springs, and will allow for tension adjustment.

The two completed machines which we were invited to see at the works of Messrs. Dick, Kerr, and Co, at Preston, last Friday, were respectively a 1,500-kw. alternator and one of 3,750. As would not be expected at first thought, the smaller machine had the larger output. This is, of course, owing to the fact that it runs at very much higher speed. Fig 4 is an illustration of the 1,500-kw. three-phase alternator, which is to be coupled on to a horizontal engine made by Messrs. Yates and Thom. This machine will give its full output at a voltage of 6,600 and with a frequency of 25. The other alternator (Fig. 5) is a two-phase machine with a capacity of 3,750 kw., and has been constructed for the Shawinigan Falls Power Company, Canada. It is to be coupled to an Escher-Wyss turbine, running at 180 revolutions, the periodicity being 30, and voltage 2,200.

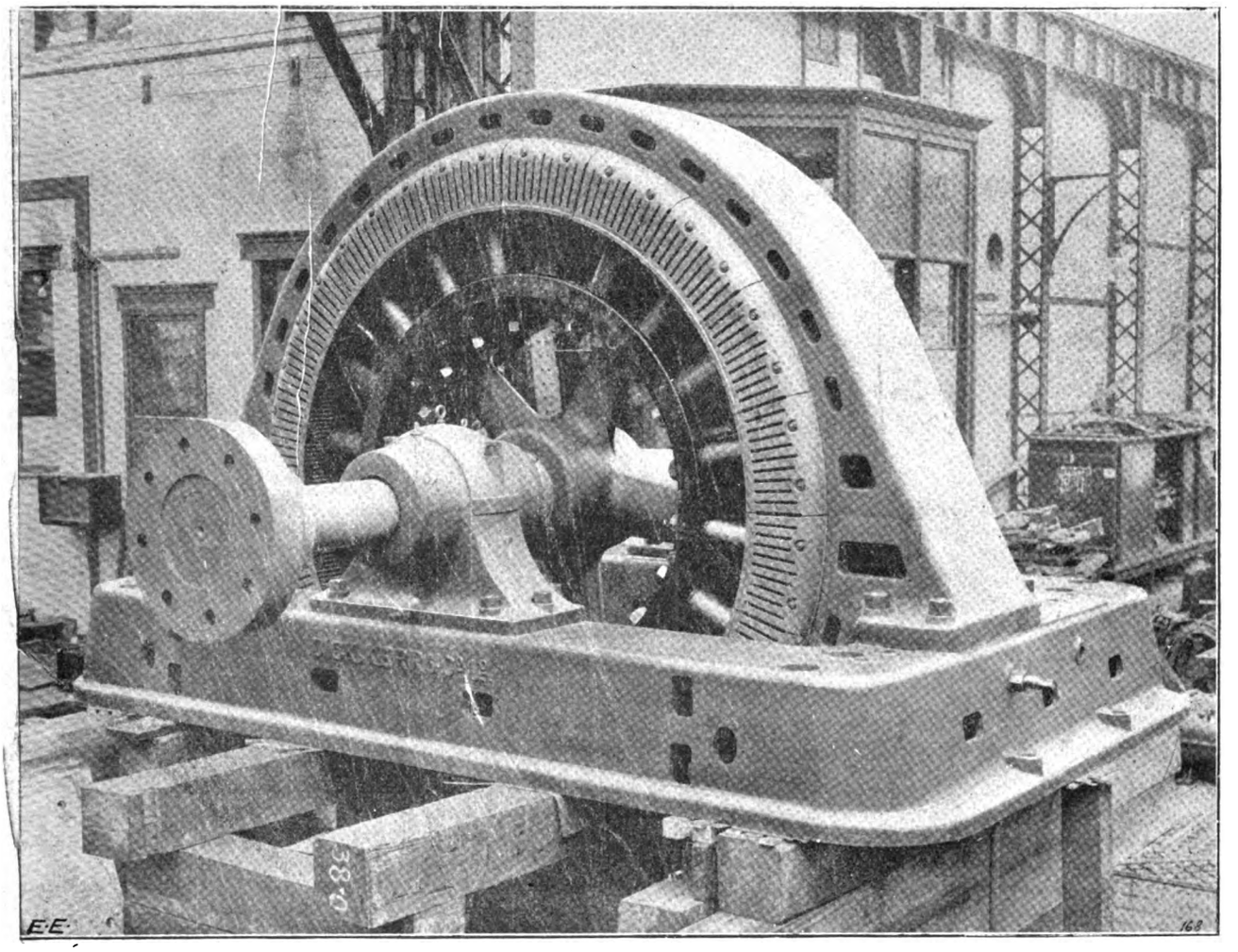

FIG. 5.—A 3,750-kw. Two-Phase Alternator built by Dick, Kerr, and Co. for export to the Shawinigan Falls Power Company of Canada.

It remains to be added that the alternators have been constructed to the designs of Mr. A. P. Zani, who, possessing unique experience in alternator design gained both in the States and on the Continent, has been enabled to improve and modify in the direction of sound mechanical design and efficiency of performance. Mr. Zani, it should be stated, has the co-operation of a very able staff of engineers, who possess exceptional ability and knowledge in polyphase work.

A pleasant feature in the visit last Friday was to see so many big machines and such a large number of motors in the shop at one time. The amount of work in hand is exceedingly creditable both to the designers and to the commercial heads of the firm.

OIL-BREAK SWITCHES AND FUSES.

BY AN A.M.I.E.E.

Oil-break switches are rapidly becoming the standard for alternating currents of high potentials. Indeed, it is doubtful whether any other type of switch is at all practicable for some of the heavier duties that may now be demanded of circuit-breaking devices. Their introduction gives a remarkable accruition to the powers and possibilities of high-tension switchgear, which is especially useful and opportune in view of the practical realisation of great power distribution schemes that is now in progress. Not a little of the successful materialisation of our ideals in this direction—some of them new, but many of them simply resuscitations from the days when the fascinations of alternating-current systems once before held our faith and imagination in thrall—will depend upon the adequacy and efficiency of the switchgear. It is therefore gratifying to note the steady development and perfecting of devices which will give us that absolute, safe, and workable control of which we may stand in need.

As usual, it is in America that the oil-break switch has been put most fully and thoroughly to the proof. Tests with rough apparatus at Niagara, on loads far in excess of any possible before or elsewhere, signally vindicated the soundness of the principles involved; and subsequent investigations have shown that not only is the application possessed of all the elements of practical success, but also that the circuit is broken in a manner which throws no abnormal strain on the insulation thereof. This is a highly satisfactory characteristic in view of the liability of severe resonance effects being originated by the flaring arc produced on the opening of an air-break switch or fuse; for beyond anything else must cable breakdowns be avoided. The mains will be the most costly and critical item of any power distribution scheme; and they must be most assiduously "nursed" and guarded from undue stresses. There is at this time cumulative evidence sufficient to

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entirely discredit the ordinary air-break switch in this connection, which leaves the field practically clear for some type of switch in which the break takes place under an insulating liquid.

The fault of the air-break switch for high potentials is that it is really dependent upon air convection to produce the final separation of the arc. Speed of break has no appreciable effect; length of break makes too much for cumbrousness to be utilised to any very effective extent. Moreover, as Dr. Garrard has shown, there is good reason to suppose that for every circuit in which there is a break bridged by an arc, there is a particular length of the arc at which high-potential oscillations are likely to occur in the circuit. It is important, therefore, that the arc be broken before it attains to that particular length. Simple air convection cannot ensure this: such mechanical devices as sliding shutters are clumsy and complicated, and surface leakage is apt to make them uncertain in action. The same disability attaches to fixed fenders arranged so that the arc may be broken against them by the up-draught; besides their presence hinders the draught. A forceful blast also involves too much complication to produce and apply, and a magnetic blow-out is not feasible, because of the small magnetic force of the currents dealt with and the impossibility of concentrating a field.

The conclusion becomes inevitable, therefore, that there is no very effective safeguard against these dangerous lengths of arc in air. The remedy must be found in surrounding the arc with a medium of very different properties. Now when submerged in oil it is in a medium of some 700 times the density of air. The buoyancy of the gaseous conducting arc is, therefore, roughly speaking, 700 times as great. The upward displacing force is that much more powerful, and the arc is drawn out and ruptured with corresponding rapidity. Moreover, the cooling influence of the new surroundings is greater than the old in much the same order. It is not surprising, therefore, that striking differences obtain between the arc lengths produced in air and oil respectively on breaking similar electric circuits. Arcs that draw out into feet in free air cannot attain to inches in oil. Definite measurements are not on record, but it has been roughly observed that the arc length in heavy mineral oil, on breaking heavy loads at 15,000 volts, does not appear to exceed ½in. Of course, the time duration is equally short, which is a very important consideration, for the heat generated is naturally in proportion to the time. It is probable that the heat dissipated by the long flaring arc in air would be sufficient to overheat and fire an oil-bath of the content capacity that has proved effective and sufficient in some types of oil-break switches. That the oil remains cool and uninjured in such circumstances is decided evidence of the extent to which arcing is suppressed.

In fact, the arc-quenching capacity of suitably selected oil is so great in comparison with the risk of firing the bath, that the margins of safety in any oil-break switch of good design are of very satisfactory character indeed. In the oil-break fuse the conditions are much more onerous. Here a certain amount of heat has to be generated, even in a mechanically-separated fuse, and one of low fusing temperature. It is impracticable to keep the fuse continuously submerged in the liquid, for heat is being constantly generated, and without some elaborate circulatory apparatus the oil would be dangerously heated under the normal working conditions. In the best of arrangements it is impossible to prevent some of this normal heating from being communicated to the oil. The only feasible designs must be based on the principle of drawing the parted ends under oil on the instant of fusing. The fuse link proper must stand above the surface, but metallic conduction will still convey much of the heat to the oil. It is obvious, therefore, that oil-break fuses of large size cannot be safely set to operate at near limits to the normal load. Thus it is better to treat them as safety circuit-breaking devices for the greater emergencies only.

It is essential that the fuse link be short—*i.e.*, the exposed portion of it—in order to keep down the possible arc length in air. It should have a very definite reduction in section at the desired point of breakage only, so that the heating and fusing will be a minimum, and located only at the immediate point of rupture. For it must be remembered that the whole of the heat of fusion has to be absorbed instantly by the limited mass of oil that comes into contact with the hot metal. And it is very undesirable to have a large arc playing on the surface of a substance like oil: the surface is, of course, the flashing site, and any floating dirt or ash will greatly conduce to such flashing.

Yet after making the very best of the design, it remains that such types of the oil-break fuse labour under great fundamental disadvantages as compared with the switch. In the latter, the work is done in the depths of the oil; in the former, it must be done at the surface. In the last, the constant normal heating effect may be inappreciable; in the first, it must essentially be of some significance, the more so as the fusing limit is set closer to the load. All this points strongly to the advisability of making the switch the only breaking device in the circuit. That is, of making the switch into an automatic circuit breaker by the addition of tripping gear, in the way we shall discuss presently, and so superseding the fuse altogether.

But there is one valuable feature in the fuse which it is a sacrifice to lose. It is an automatic circuit-breaking device with a natural time limit. Not a very controllable limit perhaps, but of great utility in that it discriminates, roughly but fairly, between momentary strong rushes of current and the dangerous prolonged overloads. Time limits on mechanical devices are a troublesome complication, although they bring in advantages of regulation. It is worth enquiring, therefore, whether the oil-break fuse cannot be improved, as no doubt it will be. There is one suggestion that may be made. It is to shunt a main air-break fuse with a separate and entirely submerged oil-break fuse in such a manner that the first quietly fuses and separates, and the other finally breaks the circuit. The air fuse must take the main proportion of the current, and should be of a material with a low temperature coefficient of resistance variation. Its fused ends should be sharply separated by mechanical means beyond the sparking distance before the oil-break fuse, which should have contrary properties, has time to open. By these means we ensure that there shall be little or no normal heating of the oil and no surface arcs on breaking.

It has been suggested that oil-break switches and fuses are lacking in engineering qualities; but why, was not stated. One has remarked that "as an engineer he preferred that switchboards should be dry." Such criticism is arrogant absurdity. Surely the engineer is not debarred from liquids when he can use them to such effect and purpose as is done here. And as for these dry and elegant switchboards, isn't it about time some real engineering were infused into *them*? It ought not to be long now before we complete our emanicipation from the tradition which makes us design our switchgear about some vague ideals of ornamentation, and lay it out in pretty panelled patterns of lacquer and enamel. When that is achieved, engineers who still have preferences for dry and polished elegance had better turn themselves to Maple's to design them something sweet in art furniture, which as an afterthought can be turned into a switchboard. But it is to be feared they won't be able to accommodate either the oil-break switch or the oil-break fuse.

Coming now to the detailed design of the oil-break switch, this works out along a number of divergent lines. In the first place, it should be observed that the normal duty is of little or of no importance in the design of high-tension switchgear in comparison with the emergency duty that it may be called upon to perform. In a central or sub-station the main switches or fuses may have to open emergency loads equal to the full power of the station. Moreover, the total ultimate capacity of the station must be considered in this connection, or the switchgear may prove of insufficient emergency capacity later on. On a short-circuit the switch or fuse must interrupt, with certainty and without damage to itself, a flux of power comparable with the total kilowatt capacity of the plant running, and as the short-circuit current of modern alternating-current generators is about three times their full-load current, a current upwards of three times the total ampere capacity of the running plant may likewise have to be dealt with. Of course, in the latter case the

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power behind these abnormally heavy currents is very considerably degraded by the great drop of voltage. Hence the maximum power to be broken will about correspond to the station capacity at the working voltage, and this will be the proper criterion on which to define the emergency duty of the switchgear.

The above assumes that the station is run in simple parallel. However, if the plant be arranged to run in independent sections when at full load, then the emergency duty is kept down to smaller and more definite limits. But a human equation comes into this case. If the attendants be neglectful in the matter of opening the interconnector switches, as soon as the additional units of plant are set running on the load, then we may again get emergency calls upon the circuit-breaking devices, which are beyond their capacity to deal with safely or satisfactorily. Still, in spite of this possibility, the arrangement is a valuable method of safeguarding the switchgear; and although it is to some extent less convenient and economical than simple parallel working of the plant, it should always be adopted when the switchgear is of doubtful emergency capacity, or is overcrowded or cut fine in dimensions or centres, or is otherwise at a disadvantage, considering the more abnormal conditions and risks to which it may be subject. For, we repeat, it is the abnormal conditions that are the true test of the efficiency of switchgear. The usual working conditions are in comparison not at all exigent, and they can be easily satisfied. Safety to operators and compactness of lay-out are not the only essentials. The former, of course, is all-important, but the latter is a decided snare. Engineers, knowing that they can get gear packed into a certain space, are strongly tempted to prescribe limits which absolutely cripple the design of the several items of apparatus. The imprudence of it is not discovered till a really serious accident comes along; then it is found that several units of switchgear become involved in the ruin, quite unnecessarily, simply because of their being too contiguous to the unit to which the accident happened. Spaciousness is, for this reason, a quality of good practical worth in a switchboard design, whereas compactness is simply a quality of cheapness and convenience.

Apart from the common considerations of conductor and contact density, and safe breaking distances and the like, there is one in particular which must obviously have some bearing on the capacity of an oil-break switch. This is the content of the oil-bath. The energy of the spark at break is the more effectively absorbed the greater the quantity of oil, not only because of the heat capacity, but more because of the free circulation. The arc is more completely enveloped, and the motions of the liquid are more powerful, so that the arc is swept aside by the rush of the fluid as well as carried upwards by its own buoyancy. It is possible, in fact, to arrange vanes on the contact bars in such a manner that on opening they will set up a strong flow athwart the arc, helping to break it with greater certainty and speed. The efficacy of all these "drowning-out" influences depends directly upon the amount of oil involved. Another point of great consequence to the continued reliability of the switch is the charring effect of the arcs on the oil. Every arc, of course, must burn and carbonise the oil which comes into immediate contact with it. Therefore by degrees the oil becomes foul, and its insulating quality seriously impaired. Before that, however, trouble is found in the deposit of carbon on the insulator surfaces. These circumstances call for periodical cleansings of the switch and renewal of the oil: and here, again, a large content of the oil-bath provides a greater margin of safety, and contributes largely to the permanence of the effective capacity of the switch.

Now, despite all these obvious advantages in favour of a large oil-bath, there is a strong division of design which aims actually at reducing the capacity of this bath to the smallest practicable amount. The reason—or rather, the intention—is to avoid the dangers of firing a large quantity of oil which, once alight, would burn for a considerable period and prove an uncontrollable nucleus of fire. It is considered that a small quantity will burn itself out without doing serious damage. But we are on very questionable ground here. It is very difficult to say, for instance, what is a dangerous amount of burning oil under given circumstances and what is not. On a compactly-built switchboard it would, indeed, seem that any quantity at all adequate for its purpose would prove dangerous when fired. On the other hand, it is very certain that the risk of igniting the bath depends very considerably upon its bulk; and the probability of deterioration follows the same inverse rule. Therefore in limiting the bulk we deliberately cut down the safe breaking capacity of the switch, and increase the risks of firing, for the sake of the possible impunity of the fire when it happens. Clearly, this is not a procedure to be decided upon lightly or without thorough investigation and experiment. The usual device is to break on auxiliary contacts contained in a small oil-bath, but it must not be forgotten that such contacts are extremely liable to become heated, and that they have to deal with the total energy dissipated on breaking the circuit. There is no virtue *per se* in auxiliary contacts, but they save the main contacts from damage and concentrate the arc in a convenient manner. The same conditions exist in breaking at the auxiliary contacts as in breaking at main contacts, so that we may easily get what is a formidable arc for the small auxiliary oil-bath, sufficient to blow out the oil and leave the switch in the dangerous state of an air-break switch with an altogether inadequate length of break.

However, on the other side of the question, we must not scorn the argument against the presence of a large store of combustible oil. The objection is reasonable, although the probability of igniting heavy masses of the description of oil employed is so very remote. It points to the advantage of isolating each switch in a cell or compartment, in situations sufficiently apart from the operating switchboard and each other, to prevent community in disaster. And, after all, this is one of the truest—if, indeed, it is not *the* truest—ideals in switchboard design. A complete catastrophe is the risk we court by following the dictates of space and convenience too far: and great is the gain of eliminating that risk The question is, how far "remote control" is practicable from each point of view—*i.e.*, mechanically and commercially. For the operation of the gear in an economical and feasible manner, demands that although the switchgear be scattered the control of it must be centralised.

Now, American practice has developed this idea, and although the methods followed are not yet ideal, some of them are decided advances in the right direction. In some respects these methods are crude and unrefined, as so usual with American work, which does not receive there the cautious criticism that is meted out to new notions here. Chiefly this in the development of the apparatus due to Yankee haste in standardising constructions on first suggestions without waiting for the best. Still, the main principle is firmly grasped, and, without doubt, most further development in switchboard design will take place along these lines.

The American type of oil-break switch for the usual run of work is contained in an iron tank, which is arranged to bolt under an iron frame carrying the switch mechanism, so that it can be lowered away from the switch contacts without disturbing any of the connections or mechanism. The contact bars or bridges are lifted into the clips by strong toggle joint contrivances above the tank. The contacts are carried in porcelain bushes projecting through the frame covering the tank, and the cable connections are sealed into these bushes. The whole makes a very substantial, if somewhat clumsy and rough arrangement, and it is admirably adapted for the purpose. The tank is lined with wood, and is of liberal dimensions to avoid risks of arcing to the sides. The frame and tank ought, of course, always to be earthed, although this precaution is usually neglected by American designers. These switches are, in general, a strong contrast to the too light constructions of highly finished metal and porcelain which characterise European practice, which somehow can seldom get entirely free from its clinging traditions of ornateness and polish. The latter types are, moreover, usually mounted in full view of the front of the board; the former types are invariably placed behind the panel and operated by hand levers on the front. For the less exacting conditions the oil switch frames are bolted direct to the

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back of the panel; then going up the scale of duty the principle of remote control is developed, and the switch is fixed on the wall behind, or on floors above or below the switchboard and connected thereto by systems of bell cranks and connecting rods. Following out the idea, the switches may be further isolated by fenders or partitions of brickwork, stone, or concrete slabs, or slate, or marble; or they may be entirely enclosed in cells of brick or other suitable constructions. There is thus scarcely any limit to the degree of isolation and protection attainable by such means, and at no excessive cost. The most onerous conditions are met by pneumatically or electrically operated switches, which can obviously be placed in any conveniently remote and guarded situations; and the lay-outs can be arranged to secure the maximum degree of immunity from wholesale disaster, now that the mechanical difficulties of operation are no longer in the way.

By means of a tripping coil controlling some point in the linkage of the operating mechanism, and designed to release or trip a locking device by which the switch is held closed, it is converted into an automatic circuit breaker. In the case of such a device intended to operate on maximum current, the tripping coil may be actuated by currents transformed from the primary circuit by a current or series transformer. Such secondary circuits can, of course, be earthed on one pole, and the potential differences will be low. Moreover, the secondary current strength can be standardised for a complete range of apparatus at one uniform figure of moderate dimensions, say four or five amperes, which serves all purposes, the variations being obtained on the primary side by varying the ratio and primary current capacity of the series transformer. The secondary current can be employed in the indicating and recording instruments being taken in series through the ammeter, wattmeter, power factor indicator, and such integrating or recording meters as may be employed. As potential transformers will, of necessity almost, be used for the pressure measurements and synchronising gear, it follows that the switchboard proper will be a low-pressure, small-current board pure and simple. Besides, there will be a perfect uniformity of capacity in the instruments, the only variable features in the combination apart from the main switches being the ratios of the transformers and the scaling of the indicating apparatus.

There should be immense advantage and convenience in this, particularly in respect of stock and quick deliveries. Extreme accuracy is, of course, only attainable by calibrating instruments and transformers together, but for all practical purposes sufficient uniformity can be secured in the transformers and instruments that the calibration of any one of the latter will hold good on any one of the transformers having the same ratio. The standardising of switchboard apparatus having such uniform and adaptable qualities is a thing very easy of accomplishment and very desirable.

A considerable further development in the direction of automatic control, becomes possible with the adoption of relays to control the tripping coils. The way is thus paved for more sensitive automatic features. Devices to operate on reverse currents can be introduced; and time limit attachments can be more readily applied. Preferably, the relays should be employed to close independent circuits through the tripping coils: by which method these coils can be made very powerful for their size, since the connection being momentary, very high current densities can be used.

The use of relays for switchgear has been much deprecated, but it is difficult to see fair ground of argument against them. Scarcely anyone at this time of day would quarrel with the use of circuit breakers on switchboards, yet it is a fact that the combination of a relay and a circuit breaker (fitted with a tripping coil, operated by a momentary independent current in place of the usual cumbrous main current coil) is the more reliable and adaptable device. The tripping action is made more sudden and sure, and in power it can be made almost what one will. The primary currents in the relay have so little to do, that the circuit-breaking device becomes far more amenable to treatment and adjustment for various conditions and requirements. In fact, the introduction of relays makes for perfection in automatics; and far from a relay being a superfluous and feeble limb, it forms a very acute and trustworthy brain, able to supplement and assist in a very efficient way the human brain of the switchboard operator.

The writer does not wish to be understood as saying that these relays and automatic devices are to be obtained at once in perfected forms, as it is to be hoped they soon will be. But they are commercially available from several quarters in more or less crude constructions. In fact, they are being rather thrown too carelessly on the market, but with a little solid intelligence put into their design and manufacture they should rapidly improve. Central-station engineers will at least find the subject worth following up, as the main developments in high-tension switchgear will continue along these lines.

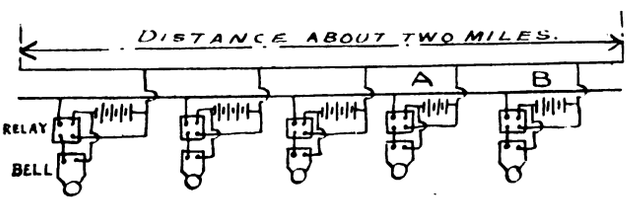
In conclusion, we summarise a few of what seem the best and logical developments of switchboard design, particularly for alternating currents of high potential: The abolition of ornament and the so-called artistic idea, as exemplified in excessive polish and lacquer and enamel; just as much of it as is conducive to cleanliness to be retained, and no more. The isolation of the sections in a sufficiently complete and effective manner to obviate all risks of community in disaster. The use of oil-break switches and circuit breakers with large oil-bath capacity, but arranged remote from the switchboard, each enclosed in a fireproof cell or compartment; the cells to be made with a cement floor, sloping well all round to a centre drain-pipe, made to drain quickly away all splashings of oil. The abolition of combustible insulation and insulated cable connections; the complete isolation of the latter into separate ducts. The reduction of the high-tension switchgear to a switch and a current transformer per single line, with selector or isolating plugs or switches where required. The enclosure of 'bus bars in cells or ducts of brickwork; the connections thereto to be similarly enclosed. It will be seen that there is a considerable amount of builders' work concerned in the lay-out of switchgear on these lines, and it is well for station and consulting engineers who contemplate use of the same to have full cognisance of this characteristic. For it throws the responsibility of the lay-out very much upon them, since the work being so largely structural, it is vain to trust to the building work being allowed for on a sufficiently liberal scale in the usual competitive schemes. It ought to be treated separately as a part of the building contract. It can be carried out more cheaply thus and in a more thorough and effective manner.

QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

QUESTIONS.

631. The diagram shows an underground signalling circuit with five bells in parallel. The line wires are galvanised iron wires on porcelain insulators. By putting together the two wires anywhere all five bells ring, which is necessary. It is desired to fix a telephone (wall pattern) at stations A and B, and to have a portable (watch pattern) to speak from any part of the line. Can this be



done with the present wires by placing switches at A and B, or, if not, what would be the best and cheapest means of getting the required communication?—PITMAN.

632. Is there any advantage in compounding a motor which is needed to be started up quickly on full load very frequently? The idea is that it can be started up as a series machine, the shunt being thrown in afterwards. The motor would be of 8 h.p., and work at 550 volts.—G. H.

ANSWERS.

Question No. 623.—What is to be said for and against putting wiremen on piecework: (1) on skeleton houses in Simplex conduit; (2) in houses already finished in casing or Simplex

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Best Answer to No. 623 (*awarded* 10*s.*).—There is a great deal to be said in favour of adopting piecework for outside labour, such as wiremen, but there are also very many difficulties which appear to have hitherto prevented the adoption of this course. The chief advantages may be briefly stated as follows: (1) Each man with his mate, who might be an improver, would be responsible for a definite job, and the weekly pay-sheets would soon show the smartest men. (2) Probably a very considerable amount of idling would be saved. (3) There would be an incentive to the workmen to get the jobs finished as quickly as possible, and this would be very satisfactory to the tenant or builder; the former always objects to having workmen in the house, and the latter generally makes out that the wiremen are delaying the plasterers, etc. (4) Time taken in getting to and from work and from one job to another would be largely saved or not paid for.

The apparent difficulties are many, however, and may be stated as follows: (1) The system could not be applied to large jobs with advantage, as in such cases it is necessary generally to employ a number of wiremen on the same job. (2) There would be a tendency on all jobs for the work to be scamped, and the inspection and test would have to be very thorough. Any time saved by the foreman in supervision would thus probably be expended in extra inspection duties. (3) There might be a difficulty in regard to the time taken in getting to and from the job. The men would probably expect an allowance for this. (4) A very great difficulty would be the delays which always take place before a job can be entirely finished. With skeleton work one cannot count on being able to go straight through the house, although this frequently can be done, but, of course, the fittings, switches, etc., cannot be fixed till later. Then if you pay piecework for the skeleton wiring only the tendency to scamp the work will be accentuated, as the wireman will think he can make good any deficiency when he is working on the time basis fixing fittings. While if you put another man on this work he is unfamiliar with the wiring and takes longer, therefore, to complete same, and you have all the evils and objections incident to divided responsibility. In the case of finished houses this necessity to break the work does not exist, but delays due to the idiosyncrasies of occupiers will be felt

All things considered, the writer does not think it will be found practicable to put wiremen on piecework to any large extent, but very great improvement might result from a properly worked out bonus scheme somewhat on the following lines. A careful record should be kept of the time and material spent on each job, the chargeman and others employed on same, etc., and, before starting any job, an estimate of the cost should be made by the electrician in charge of the work, and the men could be notified that the work would be done on the bonus system, which could provide that, say, 25 per cent. of any saving made on the estimate should be divided between the wiremen employed on the job and the foreman. The figure determined on as the probable cost of the job would not, of course, be the same as the quoted price, but would represent the prime cost, and would take into account *all* the conditions, possibilities of delays, etc., which in general vary considerably with the different jobs. It would probably be best not to let the wiremen know the figure decided on.—E. M.

Answer to No. 623 (*awarded* 5*s.*).—The question of day-work *versus* piecework is one of great interest to many who are engaged in industrial pursuits. An employer wishing to obtain the maximum output from his workmen, and desirous of introducing the piece system, will often find objections raised by the employés. The main reason given by workmen against piecework is that it leads to sweating and the general lowering of wages. It would appear that where great numbers of the same, or similar, articles are manufactured, piecework is advantageous to both employer and employed. In such cases there should be no difficulty in fixing fair prices for the work. It must be remembered, however, that, for piecework to be a success, careful inspection and constant supervision is absolutely necessary. Where, on the other hand, the work consists of varied items—such as repairs, alterations, etc.—and a detailed supervision is impracticable, piecework often leads to dissatisfaction on both sides.

A workman on piecework usually confines his attention solely to the particular operation for which he is paid. To anything beyond this he is completely indifferent. In an occupation such as wiring, where so much depends on good workmanship, the most fruitful cause of fires in electrical installations is generally considered to be faulty work by the wiremen, and, therefore, one would not anticipate the best results when piecework is in vogue. When wiremen are put on piecework a considerable increase in waste material may be looked for, and the scrap heap will probably show an abnormal growth in dimensions. The workman's one idea being to get his part done in the quickest and easist manner possible, he will have little time to give for the utilisation of material to the best advantage. It has already been mentioned that fires are often associated with bad workmanship. Suppose a wireman to be on piecework, would he, for instance, spend the necessary time in properly insulating joints? Joints are, perhaps, the weakest part in an installation, and given a finished joint there is little by which one can tell whether the operations of soldering and insulating have been efficiently performed. It is not all gold that glitters, and an elaborately varnished joint may cause the "insulation" to fall to zero. Generally it appears to be unsatisfactory to put wiremen on piecework except on special jobs, where there is a lot of similar work with constant supervision.

1. In this case so much depends on how the pipes are run, the care with which the "fish" wires are threaded, etc, that the question of piecework should be carefully considered before being introduced. When one set of workmen put the piping up on piecework and another gang draw the wires through on the same method of payment, anyone having had experience with the idiosyncrasies of the British workman will see trouble ahead. If the leads are put in as the pipes are fixed, the work must be carefully overlooked as to connections for fittings, etc.

2. Sending workmen into a finished house to "wire" it rarely gives the best results. Most engineers have experienced the difficulty in gauging the labour under such conditions, awkward corners have to be negotiated, walls to be got through, care taken of existing decorations, etc., so that it sometimes happens that a job is half done before one realises the extent of the work. A wireman put on such a job at what appeared to be a fair price, would no doubt be greatly tempted to scamp the work and rush it through anyhow. In any case, careless and scamped work leads to bad tests, and it may be found that the time and trouble expended in putting a faulty installation in a satisfactory condition for connecting on to the supply mains, will far outweigh any saving due to piecework.—M. M.

Answer to No. 623 (*awarded* 5*s.*). — On principle, in these two cases of wiring, or, indeed, any other, no! do not employ wiremen on piecework. On analysis the objects of piecework divide themselves under two heads—*i.e.*, cheapness of labour or fixed cost of labour. In the first case, the employer expects the workman to complete the job in a quicker time than if employed at a rate per hour; and in the second case, even if the cost of piecework came out the same, he would rest assured that should any unforeseen difficulty arise it would not increase the cost of his labour. In both of these conditions the transaction assumes the form of gamble. In piecework there is a much greater temptation to scamp work, especially if the wireman should be unexpectedly faced with any task which required special manipulation or delicate handling, and which was not allowed for at the time the price was fixed, as it is too much to expect of humanity to give the same attention to any obstruction when that attention means money out of pocket, than should it be paid for at an hourly rate. It should be borne in mind that the application of piecework on a wiring contract differs absolutely from piecework in a factory, as in the latter case a man is turning out much the same work week after week, whereas every fresh wiring contract presents new problems and difficulties, chiefly in connection with the mechanical or constructional portion. Of course, the great preventive of scamped work is proper and careful supervision and inspection, but it is a question

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whether that does not balance any saving due to piecework in the cost of the job.

Having thus gone into the objects of piecework and its general tendency, let us ascertain how they apply to the two cases in question, and see if either of them present any features to lead us to suppose that they present any exception to the above general rule. The first case appears to present itself as more adaptable to piecework than the second, owing to the fact that the job would be more straightforward, and that being so, there would be considerably less inducement to scamp than if the job was more involved in the execution of it; but, on the other hand, should any bad workmanship occur and escape detection, it would be built in and would cause more trouble eventually to repair. But on the whole, if the work were properly tested and inspected step by step before the builders' men started to cover it in, this case certainly appears more suitable for piecework than the second. Now, taking the case of a finished house, the great objection to piecework would lay in the more complex labour problem which this involves, as it must be remembered that the work would have to be carried out not only to satisfy a purely electrical point of view, but in accordance with that of the householder, and with the least disfigurement of the plaster, ceiling, paper, etc., and it is almost safe to conclude that the wireman would work at a greater rate when on piecework, and, therefore, with more danger to any decoration, etc., that might exist. In this case, though, any bad workmanship would in many cases be more easy to repair at a later date than if the work was done when the house was in a skeleton state.

To sum up, the more simple and straightforward a job is the more suitable it is for piecework, and, therefore, of the two cases mentioned in the question the first appears most applicable, but in reference to what was touched on in the beginning of the answer, it would certainly be better not to execute the work on the piecework system at all, but to employ men at an hourly rate, when there would not be any tendency for them to rush the job through in insufficient style for them to draw the money. Of course, it might be urged that piecework would enable the wiring contractor to give a lower price for the job, and the lower the price the more would electric lighting be utilised, with greater benefit to the whole trade. But no industry has certainly better foundations to recognition, although it may have slightly longer to wait, if the work was done in a manner that did not conduce to extreme cheapness, but rather that did not only lend itself to reproach but kept above suspicion; and a very good, if not conclusive, judgment on the question might be passed by taking the votes of a number of householders and the question put to them as to which they would consider safer or which they would prefer, that their houses had been wired on the piecework system or otherwise. It could be taken for a certainty that they would decide for the latter.—G. A.

Answer to No. 623 (*awarded* 5*s.*).—The employment of wiremen in piecework is no doubt conducive to economy in the cost of wiring, and in these days of competition and price-cutting the system will, no doubt, commend itself to the contractor who wishes to make a fair profit on his contract. The objections to piecework in case (1) are fairly apparent. In the first place, there is the difficulty of checking the work done by a wireman, as well as the manner in which the Simplex or other conduit has been put together. Unless the installation be a large one, it would not pay to keep a foreman or superintendent constantly on each house. The foreman, as a rule, has several other jobs under his charge, and very often when he comes round to check the work of a party of wiremen in an unfinished house, he finds a good deal of the runs already plastered up by the builders during his absence. He has, therefore, to trust to his wiremen for the integrity of the socket joints in the conduit. In many cases these joints would be found in anything but a satisfactory condition, and it would not be surprising if, in places, the conduit were sprung quite free of the sockets altogether, this being due to the undue haste of the piecework wireman to add another "point" to his day's achievements. A break of this nature in the conduit will admit the plaster, which will quickly destroy the rubber insulation of the wires, especially if the "threading" system of wiring be adopted—*i.e.*, threading the wires through each length of tube before the same is fixed. This trouble would not be so great if the work were done on the "draw-in" system, as, of course, in this method of wiring the conduit is first run throughout, and no wires drawn in until the tubing for the circuit is complete and plastered in, thus the plaster has an opportunity of drying before the wires can come in contact with any of it. There is, however, another feature of "jerry wiring" encouraged by the piecework system, and that is the tendency to neglect to file off the sharp "burrs" which are formed inside the tube after cutting it to the required length, and it is by no means uncommon to find the wires bereft of the major part of their insulation after being drawn round some bends armed with sharp edges left in this way. These objections raised against piecework in case (1) apply also in general to case (2), the difficulty being to properly inspect each man's work before passing it. In finished houses new wiring is generally run under floors, in false roofs, down hollow plaster partitions, and, as a rule, in places inaccessible for inspection, and, therefore, where good workmanship is not likely to be put in.

It seems to the writer that wiring is not by any means the class of work that lends itself to piecework, on account of the ease with which bad workmanship may be concealed. Further, in all wiring it is difficult and troublesome to establish a satisfactory system of rating the work done by a man, as it cannot fairly be paid for by any particular dimension, nor, of course, by weight, and not even by the number of "points" wired, inasmuch as all fittings have their own peculiar difficulties, and, therefore, cannot be rated on the same basis. This question of rating would be constantly creating friction between employer and employés, for even with such a standard system as the Simplex it would be very difficult of adjustment. On the other hand, of course, the workman paid by the hour will inevitably relax his energies when the foreman turns his back, and a good deal of time will be wasted. Unfortunately, however, every employer has to expect this sort of thing on outside work unless he can afford to keep a trustworthy foreman on almost every job.—D. J.

Question No. 624.—I wish to construct a transformer, the primary voltage of which is 2 000, and the secondary 25 volts, frequency 60. It is imperative that the secondary circuit consists of *one* turn only. Can this be done? Give particulars of design.

Best Answer to No. 624 (*awarded* 10*s.*).—Transformers have been built for welding purposes having the secondary consisting of but one turn. The output in special cases has been as high as 10,000 to 20,000 amperes, but at a very low voltage of about five volts. Incidentally, it may be mentioned that the Johnson Electric Traction Company, of America, employ special transformers for welding the joints of tramrails in position, the output of the transformer being 25,000 amperes at five to seven volts.

In all these special cases the transformers cannot be designed with anything approaching a fair efficiency, and the "specific" weight—*i.e.*, weight per kilowatt—is also excessive when compared with transformers for ordinary work. Before referring to formulæ, it will be well to consider the relations existing when a transformer is unloaded and when it is loaded. A transformer is analogous to a continuous-current shunt motor in operation. In a shunt motor, when running unloaded, the back E.M.F. generated in the armature is practically equal to the voltage of supply, and the small current taken by the armature can be divided into two portions—viz., one part being absorbed by the friction of the bearings and brushes, and the other part being absorbed in the armature core (called the "core loss" current). The energy absorbed by the core is made up of (1) the "eddy-current loss" and (2) the "hysteresis loss." When the motor is loaded the back E.M.F. falls, on account of the "drop" due to armature resistance, and a current is drawn in corresponding to the load. With a transformer the case is very similar. When the secondary is on open circuit the primary acts as a choking coil, and the back E.M.F. induced is practically equal to the supply volts, the small current taken by the transformer, called the "magnetising" current, under these conditions being required for carrying the iron through the magnetic cycles. This current is

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90deg. out of phase with the E.M.F., and performs no work, so that it is frequently called a "wattless" current. It will therefore be seen that the magnitude of this current is the function on which the "all-day" efficiency depends.

It will be convenient here to give the general formula connecting the E.M.F. with the flux, turns, and periodicity. A formula which the writer has found to be very convenient is the following:

$$E = 4 . f . T . N . M \times 10^{-8};$$

where E is the effective voltage generated (in volts);
T the number of turns;
N the periodicity in cycles per second;
M the flux simultaneously linked with each of the T turns; and
f a constant, called the "form factor."

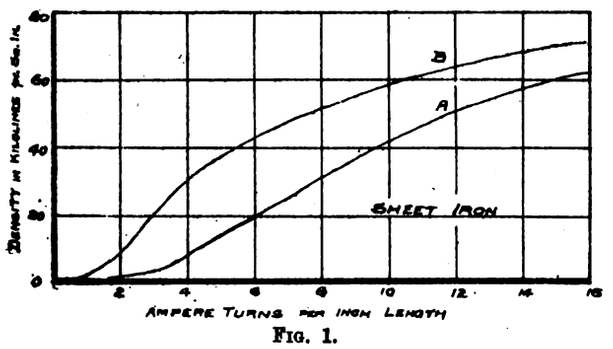

Fig. 1.

In transformers the relation between the voltage and flux is dependent on the wave-form of the applied E.M.F., and this involves the use of the term "form factor."* This may be defined to be the ratio of the square root of the mean of the squares of the equi-spaced ordinates of a curve to the true mean value of the equi-spaced ordinates; or,

$$\text{form factor } (f) = \frac{\text{R.M.S. (root mean square)}}{\text{T.M.}} \quad \frac{}{\text{(true mean)}}.$$

In the case of a rectangular wave the R.M.S. value, the T.M. value, and the maximum value are equal, and the form factor is unity. For a sine wave of E.M.F. the form factor is 1·11, and the value is higher for peaked waves. It will thus be seen that the form of the E.M.F. wave is of importance in transformer work. For practical purposes it is convenient to assume the sine wave for the E.M.F. curve, and the above formula thus becomes

$$E = 4{\cdot}44\ T\ N\ M \times 10^{-8}.$$

Applying this formula, we find that the E.M.F. generated by an alternating flux, M, having a periodicity of

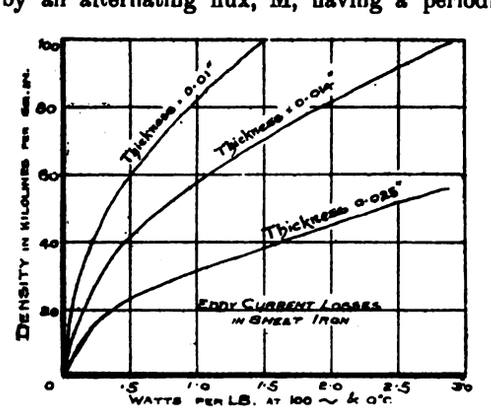

Fig. 2.

N cycles per second will be $E = 4{\cdot}44\ T\ N\ M \times 10^{-8}$ in the primary, and $E_1 = 4{\cdot}44\ T_1\ N\ M \times 10^{-8}$ in the secondary, since the same flux, M, is linked with both the primary and secondary turns (T = primary turns and T_1 = secondary turns). By dividing the former equation by the latter, we have $\frac{E}{E_1} = \frac{T}{T_1}$ = ratio of transformation. Thus the primary voltage is given at 2,000, the secondary at 25, and the secondary turns as 1, and hence the primary turns must equal 80. The flux to be generated in the core can now be determined. Inserting the values for E, T, and N, we have

$$2{,}000 = 4\ 44 \times 80 \times 60 \times M \times 10^{-8},$$

whence $$M = \frac{2{,}000 \times 10^8}{4{\cdot}44 \times 80 \times 60} = 9{\cdot}4 \text{ megalines.}$$

Reference may now be made to the curves given in Figs. 1, 2, 3, and 4. Fig. 1 gives the saturation curve for sheet iron plotted to suit the requirements of transformer calculations. Curve A was obtained after punching, and Curve B after subsequent annealing. In the calculations below Curve B will be used. Fig. 2 gives curves showing the eddy-current loss in sheet iron at different densities,

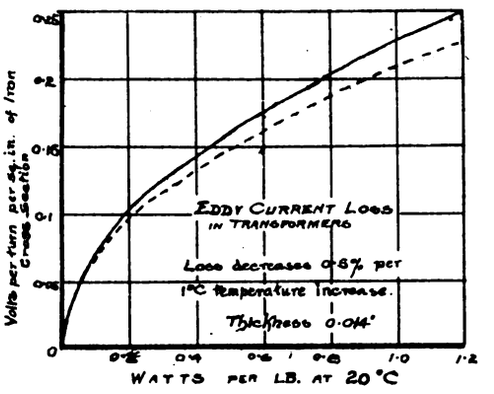

Fig. 3.

and shows clearly the effect of the thickness of the iron A thickness of 0·014in. is generally adopted for transformer work. The eddy-current losses can be calculated from the following formula:*

$$W = 1{\cdot}5 \times t^2 \times N^2 \times B^2 \times 10^{-10};$$

in which W = watts per pound at 0deg. C.;
t = thickness of sheet in inches;
N = periodicity in cycles per second;
B = density in lines per square inch.

The loss decreases ·5 per cent. per degree Centigrade increase of temperature. The formula holds for iron, having a weight of 0·282lb. per cubic inch and a specific resistance of 10 microhms per centimetre cube at 0deg. C. Fig. 3 is, however, to be preferred for transformer calculations, and corresponds to a thickness of 0·014in., such as is used for transformer work. In Fig. 4 is given a curve showing the hysteresis loss in transformer sheet iron at different densities. The curve is plotted for a periodicity of 100 cycles, but the loss at different cycles can easily be obtained, since it is directly proportional to the number of

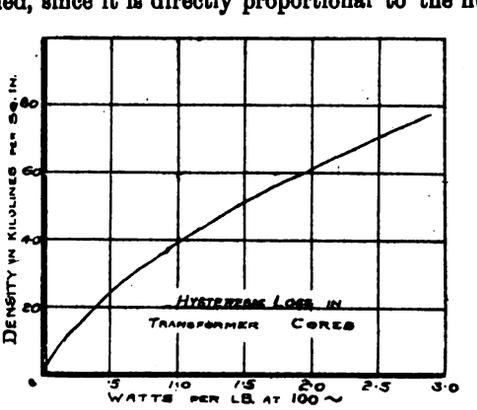

Fig. 4.

cycles per second such as occur in ordinary practice. The arrangement adopted in Fig. 1 of plotting the magnetising force in ampere-turns per inch of magnetic length has been found to be extremely convenient, as the ampere-turns required at a given density can be at once obtained by multiplying the value obtained from the curve by the length of magnetic path in inches. It will be seen from the curve that as the density is increased, not only does the magnetising force rapidly increase, but also the hysteresis and eddy-current losses.

* This term is due to Prof. J. A. Fleming. See "The Alternate-Current Transformer," vol. i., second edition, p. 583.

* For thicknesses greater than 0·025in. magnetic screening affects the result obtained by this formula.

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In Fig. 5 are given sketches showing a suggested arrangement of the core and coils, the writer preferring this arrangement on account of the better facilities for insulation. No mention is made in the question of the capacity of the transformer, and for an illustration of the methods of calculation given below we will consider a transformer of 20 kw. capacity. As stated above, 9·4 megalines have to be generated in the core. At a density of 30 kilolines per square inch the net section of iron required will be $\frac{9{\cdot}4 \times 10^6}{30 \times 10^3} = 313$ square inches; and at a density of 40 kilolines the net section required $= \frac{9{\cdot}4 \times 10^6}{40 \times 10^3} = 232$ square inches. It will be seen that, on account of the few turns in the primary, the amount of iron required is considerable. We will consider that the core of the present transformer is to be worked at a density of 40 kilolines per square inch, and that the net depth of the stampings is 30in. The gross length, *l*, will be about 10 per cent. in excess of this value—viz., 33in.—allowing for insulation between stampings. The thickness of the latter should be about 0·014in.

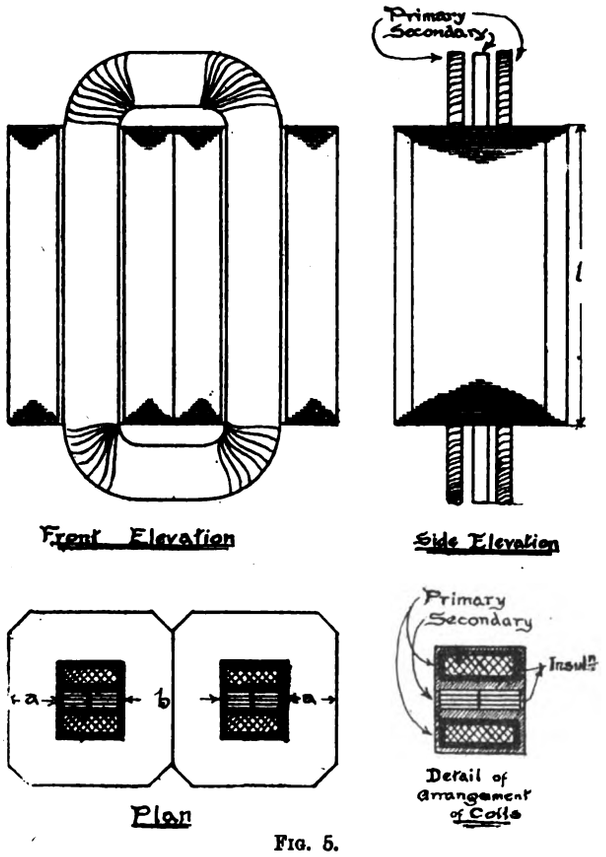

FIG. 5.

The width of iron required beyond the coils (*a*, Fig. 4) will be $\frac{232}{30 \times 2} = 3{\cdot}9$in. The openings for the coils may be 2½in. × 2½in., and the mean length of magnetic path will be $2\{2(2{\cdot}5 + 3{\cdot}9) + 2(2{\cdot}125 + 3{\cdot}9)\} = 49{\cdot}7$in. At a density of 40 kilolines per square inch, 5·5 ampere-turns of magnetomotive force are required per inch length of magnetic path.

$\therefore$ required ampere-turns $= 49{\cdot}7 \times 5{\cdot}5 = 218$.

There are 80 turns, and, therefore, a maximum current of $\frac{218}{80} = 2{\cdot}7$ amperes isrequired. The R.M.S value of this current $= \frac{2{\cdot}7}{\sqrt{2}} = 1{\cdot}93$ amperes. We will next estimate the core loss component of this "magnetising" current.

Weight of sheet iron $= 194 \times 30 \times {\cdot}282 = 1{,}640$lb.

(·282 being the weight in pounds of a cubic inch of sheet iron).

At 60 cycles and 40 kilolines the curve in Fig. 4 shows that there will be a hysteresis loss of $1 \times {\cdot}6 = {\cdot}6$ watts per pound of iron. For estimating the eddy-current loss Fig. 3 may be used. Volts per turn per square inch of iron cross-section $= \frac{2{,}000}{80 \times 232} = 0{\cdot}18$. From Fig. 3 the eddy-current loss corresponding to this value is 0 62 watt per pound. Consequently, hysteresis and eddy-current loss will be 0·6 + 0·62 = 1·22 watts per pound. Total iron loss = 1,640 × 1·22 = 2,000 watts. Core loss component of magnetising current $= \frac{2{,}000}{2{,}000} = {\cdot}71$ R.M.S. amperes. This current is 90deg. out of phase with the current for magnetising, and hence resultant "leakage" current $= \sqrt{(1{\cdot}93)^2 + (0{\cdot}71)^2} = 2{\cdot}05$ amperes. This is the current taken by the primary of the transformer on open circuit, and hence the name leakage current. The current density in the primary may be taken as 1,000 amperes per square inch, thus the section of wire = ·012 square inch, which corresponds to No. 10 S.W.G. The wire should have a triple cotton covering (the external diameter being ·144in.), and should be wound in two coils of 40 turns each, as shown in Fig. 5, being arranged in 10 layers, each of four turns. The wire should be treated with shellac, and at every second layer a strip of shellaced linen should be inserted. Each coil when wound should be served with tape of about ·007in. thick, half overlapped and dipped in varnish and baked, and the operation repeated The current density in the secondary may be 800 amperes per square inch, the section of copper required being about ·8 square inch (the output on the secondary being about 650 amperes at full load). The conductor should consist of copper strip of 1in. × ·1in. section, eight of these being in parallel, forming one turn (as shown in Fig. 5). This arrangement is to minimise the eddy-current loss in the conductors, which would be excessive otherwise. Each strip should be varnished and the whole served with one layer of tape, similar to the primary coils. The insulation between coils and core may consist of $\frac{1}{32}$in. fibre, and this may also be inserted between the primary and secondary coils. The low density in the conductors is to limit the temperature rise to ordinary values.

It will be seen that such a transformer is very weighty compared with ordinary transformers, and, further, the efficiency is also low—only about 75 to 80 per cent at full load. This is on account of the very few turns in the primary, due to the secondary consisting of but one turn. The above example is not intended to be taken as a practical case, but to illustrate the principles embodied in the calculations, and to bring out one great point in transformer work, that the greater the number of turns in the primary the more efficient the transformer can be designed.—A. D.

Answer to No. 624 (*awarded* 7*s.* 6*d.*).—The stipulation that the secondary winding shall consist of one turn only is one that will make the design quite unusual for transformers of small or moderate power, and one that will cause either high first cost or low efficiency or both, but it can be done, and the mere designing part is not at all difficult. We are given the voltage and the frequency, and since one turn of wire must have 25 volts generated in it, we can at once determine the total flux or magnetic induction that must be reached in the iron core from the formula,

$$e = \frac{\sqrt{2}\,\pi\, n\, \mathrm{N\,A}}{10^8}, \text{ or } \mathrm{N\,A} = \frac{e \cdot 10^8}{\sqrt{2}\,\pi\, n}.$$

In this formula a sine-shaped wave is assumed.

N = maximum flux or magnetic induction per square centimetre;

A = cross-section of iron core in square centimetres;

n = frequency;

e = E.M.F. per turn (virtual).

Hence $\mathrm{N\,A} = \frac{25 \cdot 10^8}{\sqrt{2} \cdot \pi \cdot 60} = 936 \times 10^4$.

If N has the normal value in transformer working of 5,000, the cross-section of the iron core must be not less than $\frac{9{,}360{,}000}{5{,}000} = 1{,}870$ square centimetres = 290 square inches, while if the working flux density is raised to the high value 10,000, the iron cross-section would still be 145 square inches.

So far we have not needed to consider the power of the transformer at all; the calculation above is quite independent of the power, and it is now seen why the expense and inefficiency are greater the smaller the power of the transformer. For unless the dimensions of the core differ

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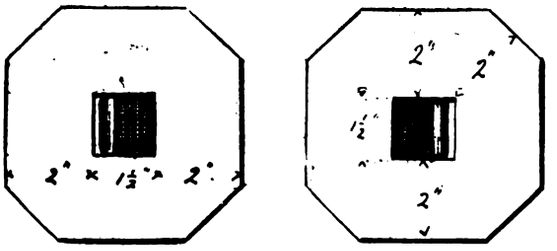
enormously from the ordinary, its weight will be excessive and the hysteresis loss very great. Of course the power for which the transformer is required must be known before proceeding further with the design, and as nothing is said about this in the question, we will assume it to be 10 kw. for our example, but will so consider the reasons for the points in our design as we proceed that they may form directions for the design of a transformer of any other power.

As we are quite in ignorance concerning the purpose for which the transformer is required, we are unable to judge of the relative importance of lowness of first cost and efficiency; we will assume that the efficiency is unimportant, so that a maximum induction value of 10,000 lines per square centimetre will not be too high, the iron cross-section being then 145 square inches, as stated above. The shell type of transformer will be the most suitable, as the iron needs a relatively large radiating surface in comparison with its mass, on account of the high induction and consequent large hysteresis loss. From consideration of the cooling capacity of the transformer, we see that the perimeter of the discs of the core should be large compared with the material in them, but the path of the magnetic lines must also be short, as this will both save iron and iron losses. We must then make the inside dimensions of the disc very small, and then keep down the outside dimensions as low as we can without making the length of the transformer too unwieldy.

Suppose we take wire of gauge 14 for the 200-volt winding, which has to carry five amperes when the input equals 10 kw., the area of cross-section of 80 of these wires is ·4 square inch, and allowing ·6 square inch for its insulation, which must be of good quality, we find that one square inch of space is sufficient for the primary winding. A similar allowance will be ample for the secondary, which will consist of a single turn of strip. A hole, therefore, 1½in. square will give sufficient room for the two windings and their insulation. Let us make the disc 5½in. square with the corners sheared off so as to give a minimum width of magnetic path of 2in.; the length of the transformer will be then $\frac{145}{2 \times 2}$ inches + 25 per cent., or 45in. The allowance of 25 per cent. is for insulation between the discs. The discs should be of the thinnest transformer iron procurable, as otherwise the eddy-current losses will be great



owing to the high induction. A sketch of the cross-section of the transformer is given herewith. If we know the magnetic quality of the iron as regards hysteresis and permeability, we may calculate the iron loss and the magnetising current as below. Area of each disc = 25 25 square inches. The volume of iron in the core equals twice this multiplied by the length (net iron) of the transformer = 50·5 × 36 = 1,820 cubic inches, and the weight in pounds = $\frac{1,820}{3·6} = 505$.

Suppose we know the hysteresis loss in watts per pound is ·5 for B maximum = 4,000, and frequency 100, then, by raising B from 4,000 to 10,000, we increase the hysteresis loss in the ratio of $\left(\frac{10,000}{4,000}\right)^{1·6} = (2·5)^{1·6}$, according to the well-known Steinmetz rule, and the decrease of frequency diminishes the loss in direct proportion, so that the total iron loss is

$$505 \times ·5 \times 2·5^{1·6} \times ·6 = 655 \text{ watts.}$$

To calculate the magnetising current we must know the magnetising force, H, required to produce a flux of B = 10,000. Suppose H must be six C.G.S. units.

Now $H = \frac{4\pi}{10}$ ampere-turns per centimetre.

The mean length of magnetic path is about 12in., or 30cm. Hence turns of primary per centimetre $= \frac{80}{30}$, and magnetising current is

$$H \times \frac{10}{4\pi} \times \frac{30}{80} = 1·8 \text{ amperes.}$$

In conclusion, let us emphasise the point that in a small-power transformer, where the turns are limited, the ratio of copper to iron may be rendered normal by making the copper circuit very long and the path of the magnetic lines very short. The mechanical design suffers, of course, accordingly.—SUPERHEAT.

Answer to No. 624 (*awarded* 5*s.*).—Theoretically a transformer could be constructed to comply with the particulars given in the above question, but in actual practice an excessive sectional area of iron would be required to carry the flux, as is shown later. Fig. 1 shows the general design of a transformer used for electric welding purposes, in which the secondary coil consists of one turn only of copper strip and arranged concentrically with the primary coil. Over the primary and secondary coils is wound a large number of soft iron wires, W, spaces being left at A and B to bring the ends of the coil out to the terminal board. This type of transformer is usually arranged for working on 600 to 1,200 volt mains at 60 to 100 cycles, the secondary giving out about 12,000 amperes and 1 volt, as for welding purposes very large currents are required at a low voltage. Now consider a transformer of this type working on 1,000-volt circuit at 100 cycles, and the secondary giving out 10,000 amperes at one volt. In this case the secondary consists of one turn, and consequently the primary of about

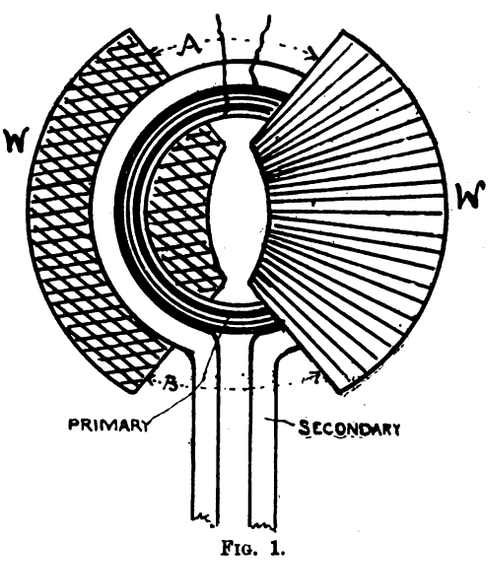


FIG. 1.

1,000 turns. Then the maximum flux can be obtained from the following formula:

$$\frac{\text{E.M.F.} \times 22 \times 10^6}{\text{Turns} \times \text{cycles}} = \text{C.G.S. units.}$$

Therefore, total flux equals 220,000 C.G.S. units, and to carry this flux six square inches sectional area of iron will be required in the core of the transformer (allowing for a density of 36,500 C.G.S. units per square inch).

In the transformer required by "J. G." the secondary consists of one turn only and the primary of 80 turns to suit the required voltages, and with the primary working on 2,000 volts at 60 cycles the flux will be 9,200,000 C.G.S. units by the above formula, and working at the same density in the iron as above, 250 square inches sectional area will be required in the core. From these figures it is quite evident without further proof that it is impossible to build a small transformer to suit the voltages required if only one turn is used for the secondary coil. On very large transformers of 400 kw. and above it would be possible, owing to the large quantity of iron required, as the primary and secondary coils would be of considerable size.—P.

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THE ELECTRICAL STANDARDS.

In our leading article for Sept. 4 this year we referred to the work which the electrical section of the Engineering Standards Committee had almost completed in connection with the fixing of definite standards for electric supply voltages and for the frequencies of alternate-current supply systems. In this issue we are able to give the conclusions of this committee, and also a statement of the procedure by which the committee arrived at these conclusions. The procedure is perhaps quite as important as the conclusions, in that it has given every opportunity for those whom the conclusion will affect to express their opinions on the matter. In the first place, the sub-committee of the electrical section dealing with generators, motors, and transformers is composed of fourteen gentlemen who collectively represent the bulk of the interests involved. Thus the War Office, the Admiralty, and the Crown Agents for the Colonies were all represented, and although there was no direct representative from the Incorporated Municipal Electrical Association, Mr. C. H Wordingham could be relied upon to give voice to the views of the central-station engineer. The sub-committee having made up its preliminary conclusions on the points before it, then circulated these throughout the country, so that all the leading manufacturers, consulting engineers, and users of motors had full opportunity of expressing their opinions on the proposed standards. It is gratifying to know that the replies received were unanimously in favour of the recommendation now before us. The full report of the sub-committee is yet to be published, but from the statement published in the present issue we gather that they considered the question before them on the general idea that the standards adopted should conform, as nearly as possible, to present conditions wherever possible, and that they should be selected with a view to enable manufacturers to meet most economically the demand for electrical accessories, such as motors, lamps, etc. In consequence, the conclusions of the committee as far as standard pressures for direct-current supply are concerned, are arrived at by taking approximately the means of the various pressures now in use. Thus we get, as standard pressures, 110, 220, and 440 volts. As the committee point out, electric motor "carcases built for these standard pressures could be utilised for pressures 10 per cent. above or below the suggested standards without any alteration whatever in the castings or mechanical components, by merely altering the windings and excitation.' In fact, it will be found that manufacturers have already gone even beyond the stage which the committee think is possible, and have made the same motors do for 10 per cent. variations of voltage without any alterations in the windings. In consequence, the engineer requiring a motor for, say, 200 or 240 volts, really gets, not the best motor for this voltage, but a 220-volt motor, and he has to put up in consequence with any inefficiencies involved by the change. In many instances the increase in the losses is very considerable, and satisfactory working is prejudiced. We know of one candid manufacturer of electrical motors who had done a considerable business with one supply company, and who received complaints as to the overheating of these motors. His reply to the complaint was that his motors were quite satisfactory for the voltage for which they were wound, and that the heating was due to the supply voltage being an abnormal one. He added that he could not give the very prompt deliveries demanded unless he could wind standard motors for stock. We trust that the standards now fixed will be adopted without exception for all new work undertaken, and that any consulting engineer who wishes to show his extreme care in detail by saving a

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few hundreds of pounds in his mains by using 240 volts instead of 220 will be restrained by the Board of Trade. In our leader of Sept. 4 we suggested that the Board of Trade had full power to do this, as the declared pressure of supply has under the Electric Lighting Acts to be submitted to them for approval. They hence can assist more largely than any other authority towards securing the adoption of these standard pressures in all new work. It is to be hoped that this will be done, especially as the Board of Trade has been consulted in the matter, and has approved of the standards fixed by the committee. Another point which should restrain engineers and contractors from departing for trivial reasons from these standards, is that they have been determined by an Engineering Standards Committee which is organised conjointly by all the engineering institutions in this country. If for a few years this course of keeping all new work to the standards is pursued, it will then be possible for electric plant manufacturers to assist in the matter. This assistance would come from the fact that they will be able, in consequence of the very large demand, to supply accessories for standard voltages and frequencies at considerably lower prices than they will be compelled to charge for non-standard articles.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

REVIEW OF "PRACTICAL NOTES ON ELECTRIC MAINS."

SIR,—As you have opened this matter for discussion, I am probably not out of place in having something to say thereon. Presuming that I am the author of this book reviewed in your last issue (I say "presuming," as I cannot claim the initial "B"), I should first of all like to tender my thanks to my reviewer for the praise he has given me.

Seeing that my reviewer has not stated his name, I cannot attempt to discuss his point technically, and even if he had given his name I would not promise to do so; but I can assure him that about some of the points he has raised there can be no "opinion," an opinion being at the best a very poor thing—merely a belief, and not something that one "knows" absolutely and finally; and that I do "know" that in many cases he is absolutely wrong, and I will leave others, who, perhaps, are not "experts," to tell him so.

Having read through his remarks, two questions came to my mind—viz., "What is an expert?" and "Is my reviewer an expert at electrical distribution or at reviewing?" I consulted a dictionary about the first, but to the second I have obtained no decided answer; yet he has written a good review. My mental remarks on reading his comments were such as: Oh! Indeed! Well, you would not serve my cables so! etc. And having had the aid of the dictionary, and seeing that I bring 18 years' experience to bear, I also will take the title of expert. I make these remarks, because when writing the MS. for this book I had the honest intention of helping those starting, and lest these should think that because my reviewer is an "expert," and says "this is so" and "that is so," his remarks are final and infallible.

My reviewer sums up the whole thing when he says "Mr. Lee is a man with opinions of his own, and is not afraid to tilt against the fetishes of standard practice." I have called myself an expert, but certainly not one to expound the rules of "standard practice." To what does "standard practice" lead us? To all sorts of curious things—for example, shorts, wet cable ends, cables which will not stand pressure tests, low I.R. figures, and, finally, new networks rotten in, say, five years. Allow me to implore young cable engineers to keep away from "standard practice" and "tomato cans"—such things lead England to contemplate "fiscal problems" and the like.

There is just one point on which I will remark, and that is the one bearing on the thickness of insulation wall necessary to withstand mechanical strains. This figure I thought I had given as $\frac{5}{32}$in. (few men outside a cable factory know anything about "mils"), and, of course, does not apply to cables for internal wiring. As far as I am concerned, this figure can remain at $\frac{5}{32}$in., in spite of the C.M.A.—possibly a most useful body—to itself.

In writing a book such as the one reviewed, the statements are apt to be misleading by their very baldness, simply because most readers—as evidently my reviewer—will not have the same attendant convoy of thoughts which the writer had. The reviewer is, however, quite right in his supposition that the book was written in odd moments. I may say it was written under great pressure, and some of it at times when the writer should have been in bed, and the proofs were looked through often while at meals. Thus there are sure to be errors, but I will here remark that if I have made a definite statement that is not an evident error, I have had ocular proof that such is the case, and I have been able to follow the cause through to a legitimate end.

As to my reviewer's suggestion that I should take to motorcar driving, I may tell him that since the M.S. was written I have done many hundreds of miles in motorcars, but even in this I so depart from rules of "general practice" that I do not admit accidents.

However, to conclude, let me again thank my reviewer, and ask the starters in our profession to steer clear of "general practice," but to think and know for themselves, and meanwhile, Sir, to adopt your suggestion to discuss these things.—Yours, etc., L. R. LEE.

Manchester, Oct. 26, 1903.

INDEPENDENT TELEPHONY.

SIR,—In reply to "R. M.'s" letter in your issue of the 23rd inst., we must say at the outset that our articles are being written from a practical point of view. What we cannot understand is why "R. M." did not make his imaginary exchange increase from 800 subscribers to eight millions. There is nothing like doing a thing well. We have never heard or known of an exchange rapidly increasing from 800 to 6,000 lines, and, therefore, from a practical point of view, cannot see the utility of imagining such a thing. "R. M." also points out that it is impossible to extend a board by fitting in multiple jacks unless they are wired, and wiring involves labour, and think it only fair this should be pointed out. To whom is he pointing it out? Surely he does not think that 2s. represents the price of a multiple jack alone, or £2 per strip of 20, or perhaps "R. M." is not acquainted with such practical facts as the price of jacks and cables. In conclusion, we should like to add that, considering the present state of the telephone question, we think genuine correspondents should have the courage to sign their names in full, and also the company they are employed by, so that we may have the pleasure of knowing to whom we are replying. In future we shall not trouble to reply to anonymous effusions.—Yours, etc.,

Southsea, Oct. 23, 1903. GARDNER AND HOLME.

WATER-LEVEL INDICATOR.

SIR,—Permit me to point out that the water-level indicator described and illustrated at p. 623 of your current issue is practically the same as that invented by me in 1878, and in that year submitted to the Admiralty.

The provisional specification, No. 1,748 of 1878, may be seen at the Patent Office Library.—Yours, etc.,

London, S.E., Oct. 28, 1903. C. E. KELWAY.

ELECTRICAL STANDARDS FOR DIRECT-CURRENT PRESSURES AND ALTERNATE-CURRENT FREQUENCIES.

The Engineering Standards Committee, organised jointly by the Institution of Civil Engineers, Institution of

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Mechanical Engineers, Institution of Naval Architects, Iron and Steel Institute, and Institution of Electrical Engineers, has recently considered a report from the Electrical Standards Sub-Committee on the above question. The importance of the decisions arrived at will depend on the spirit in which they are received by the electrical industry, and we trust that consulting engineers and manufacturers will unite together to make these standards the only ones to which they will work when laying down new installations. The report of the sub-committee reads as follows:

"The standardisation of electrical pressures and frequencies was the first portion of the important work entrusted to the sub-committee on generators, motors, and transformers by the Electrical Plant Committee. The sub-committee consists of the following gentlemen: Colonel R. E. Crompton, C.B., chairman; Colonel H. C. Holden, R.A., and Captain A. H. Dumaresq, R.E., representing the War Office; Commander G. L. Sclater, R.N., and L. J. Steele, Esq., representing the Admiralty; Llewellyn Preece, Esq., representing the Crown Agents for the Colonies; Dr. R. T. Glazebrook, representing the National Physical Laboratory; B. H. Antill, Esq., and W. B. Esson, Esq., nominated by the Electrical Engineers' Plant Manufacturers' Association; A. C. Eborall, Esq., S. Z. de Ferranti, Esq., Robert Hammond, Esq., Captain H. R. Sankey, C. H. Wordingham, Esq., Leslie S. Robertson, Esq., secretary; C. Le Maistre, Esq., electrical assistant secretary.

"At an early stage in their deliberations the sub-committee decided that the most advantageous metod of approaching this problem, beset at it is with so many difficulties, would be from the point of view of those most affected—namely, the users of lamps and of motors for power purposes. It was therefore agreed that the standard pressures to be suggested should be measured at the consumers' terminals as settled by Act of 1899. At the present time there exists many different pressures declared by the various lighting and power authorities. In view of the great desirability of obviating this unsatisfactory state of affairs, it was deemed advisable to suggest the minimum number of standard pressures which would best meet present commercial requirements, and at the same time utilise to the fullest extent the consumers' existing appliances. After careful consideration, it became evident to the sub-committee that the direct-current pressures of 110, 220, 440, and 500 volts would best meet the requirements, because carcases built for these standard pressures could be utilised for pressures 10 per cent. above or below the suggested standards without any alteration whatever in the castings or mechanical components, by merely altering the windings and excitation. It is to be hoped that now these direct-current pressures have been fixed as standards by the committee, they will in future be universally adopted by the engineers advising corporations and others distributing electrical energy. In course of time the benefits to the electrical industry at large, which will certainly follow the adoption of these standard pressures, must become more and more apparent.

"A circular was drafted embodying the suggestions of the sub-committee, and this was submitted, first to the manufacturers for their consideration, and secondly to the leading consulting engineers and users of motors. The information so courteously placed at the disposal of the sub-committee by the consulting engineers and manufacturers was most carefully weighed and considered by the sub-committee, and certain definite conclusions were arrived at, the circular being sent, in the first instance, to the manufacturers, as they were the people most directly interested. Replies were received from all the leading firms, who expressed themselves unanimously in favour of the recommendations of the sub-committee. The consulting engineers similarly gave their adherence to the proposals of the sub-committee. Before coming to their final decision, the sub-committee on generators, motors, and transformers conferred with the sub-committee on electrical tramways, of which A. P. Trotter, Esq., is chairman, and a joint meeting took place, with the result that the pressure of 500 volts, which most concerned the latter sub-committee, was agreed to, and in addition to the pressures already agreed to 600 volts was decided upon as the standard pressure for electrical railways.

"The question of the adoption of standard frequencies, although of equal importance with that of standard pressures, was not surrounded with the same difficulties. It was, however, deemed advisable to fix upon the standard frequencies at the earliest possible stage of the work, as no progress could be made in the standardisation of prime movers for driving alternate-current machinery until such time as the frequencies had been settled upon. On this question there appeared to be a great preponderance in favour of frequencies of 25 and 50. The only point upon which any serious difference of opinion appeared to exist was the advisability of the adoption of a third frequency of 40 or 42, to enable rotary converters to be used to the fullest advantage. All the arguments in favour of this third frequency were fully discussed, but after carefully weighing the *pros* and *cons.* the sub-committee decided not to recommend the adoption of more than two frequencies—namely, 25 and 50. The recommendations of the sub-committee were then submitted to the Electrical Plant Committee, the Publication Committee, the Main Committee, and the Board of Trade for their approval. This having been obtained, it was deemed advisable, in the interests of the electrical industry of the country, that the findings on the questions of direct-current pressures and frequencies should be published at an early date, without waiting for the completion of the entire report to be issued at a later date.

"The following are the resolutions on standard direct-current pressures and standard frequencies:

"1. That the standard direct-current pressures, measured at the consumers' terminals, be 110, 220, 440, 500 volts.

"2. That the standard direct-current pressures, measured at the terminals of the motors, be: for tramways, 500 volts; for railways, 600 volts.

"3. That 25 periods per second be the standard frequency for (*a*) systems involving conversion to direct current by means of rotary converters; (*b*) large power schemes over long distances; (*c*) three-phase railway work, where motor gearing and the inductive drop on the track rail have to be considered.

"4. That 50 periods per second be the standard frequency for (*a*) mixed power and lighting on town supply mains; (*b*) ordinary factory power plant; (*c*) all medium size power plant where rotary converters are not employed."

SOME NOTES ON STEAM TURBO-ELECTRIC GENERATING PLANTS.*

BY GEO. WILKINSON (MEMBER).

Almost since the first power station was established in this country, in 1889, under provisional order for the supply of electricity for lighting and power purposes, turbo-electric generating plants have been employed in the generating station. The share they have taken in the work of public electricity supply has not been large, but it has shown a steady and healthy growth. Until recent times an opinion prevailed in many quarters that generators of this class were to be tolerated only in places and under conditions where no other plant could be employed, that the capacity of steam-turbines in the way of steam consumption was unapproached by any other class of plant, and that with use they went from bad to worse in this respect; grave doubts were also entertained as to the mechanical and electrical stability of electric generators running at the high speeds which are inherent in the steam-turbine. How far these suppositions have been justified by past experience and practice it does not come within the province of this paper to show, but it is becoming generally recognised that where condensing water is available the steam turbo-generator has to-day established a record for reliability, efficiency, and durability, which constitute it a formidable rival to all generating plant in which reciprocating engines are employed, be they slow, medium, or high speed.

On April 23, 1884, the Hon. Charles A. Parsons filed his first applications for letters patent for turbine engines; one of these patents is entitled "Improvements in Rotary Motors actuated by Elastic Fluid Pressure, etc.," and the specification sets forth many of the essentia details to the construction of a successful and economical turbine engine, such as devices for reducing cost of construction, for preventing vibration, for drawing off leaking steam, and for providing efficient lubrication; this attention to details has always been a feature in the Parsons turbine, and has promoted in no small degree the immense success of the present-day turbo-generator. Mr. Parsons's original patent rights having expired, the way has been opened for the manufacture of steam-turbines by other engineers, and already such eminent firms as Messrs. Willans and Robinson, the Brush Engineering Company, the Westinghouse Company, and the British Thomson-Houston

* Paper read before the Leeds Local Section of the Institution of Electrical Engineers.

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Company, have commenced to manufacture steam turbo-electric generators, while Messrs. Greenwood and Batley, of this city, have for years made and supplied turbo-generators of the De Laval type.

To describe in detail the plants made by these firms is beyond the scope of this paper, and I purpose to note some of their leading characteristics only, devoting the remainder of the paper to remarks and suggestions based on my own experience, in the hope that they may be of service to some members of the Institution and form the basis for a useful and instructive discussion.

The De Laval Turbine.—About 1882 Dr. Gustav de Laval invented a reaction turbine originally constructed for direct driving of milk separators. The driving wheel was a pipe bent in S form, to which steam was admitted through a stuffing box in the centre, where the shaft was also fixed. The steam issued from the open ends of the pipe, thus driving the engine round. Steam-turbine engines of this simple type are, I believe, still working, but they are obviously crude and uneconomical. In the modern construction of the De Laval the steam is blown divergent from stationary nozzles, where expansion takes place, against vanes or buckets fixed in the circumference of a wheel, and the steam thus impinging on the vanes drives the wheel round and causes it to rotate at high velocity. There is only one row of buckets or vanes on the wheel upon which the steam delivers most of its energy, and is afterwards exhausted either to the atmosphere or to a condenser in the ordinary way. The steam-nozzles are placed in very close proximity to the vanes of the turbine wheel, the clearance being only 2mm., and consequently there is practically no loss of velocity between the steam jets leaving the nozzles, and entering the vanes of the turbine wheel. The peripheral velocity of the wheel in the largest De Laval turbines does not exceed 1,380ft. per second, while steam expanded from 150lb. pressure into a 28in. vacuum can attain a velocity of over 4,000ft. per second, thus the wheel falls far short of the theoretical economical speed. The turbine wheel is adapted by an ingenious construction and method of suspension to operate at a very high peripheral velocity, and the speed is reduced and made available for dynamo driving by very perfectly made spiral cut gears, which effect a 10 to 1 speed reduction. The dynamo armature is direct coupled to the gear-wheel shaft of the turbine. The larger sizes of turbine-dynamos have two armatures, so as to obtain a better distribution and balance in the turning effort. Two sets of field magnets are provided, and the armatures can be coupled either parallel or in series, or the machines can work direct on a three-wire system of distribution. The speed is maintained constant by an exceedingly ingenious and compact centrifugal governor mounted on the slower-running gear wheel, which controls a double-seated valve on the steam admission. The following table shows the high efficiency obtained with the De Laval generators. They are, however, made up to 300 h.p. only, which is too small a unit for most public electricity supply stations, and, so far as I am aware, only direct-current generators are supplied with these turbines.

TABLE I.—Results of Tests with De Laval Steam Turbo-Generators at Different Loads.

Turbine machine.	Pressure of admission steam. Lbs. per sq. in.	Vacuum inches of mercury.	No. of nozzles open.	Output in kw.	Lbs. of steam per kilowatt hour.	Remarks.
50-h.p. turbine-dynamo. The test made in April, 1895.	113·8	26·3	6	37·0	32·8	Work for condensing included.
	113·8	26·3	5	30·1	33·9	
	93.9	26·9	4	18·7	37·2	
	74·0	27·5	3	9·5	43·3	
				b.h.p.	Lbs. steam per b.h.p.	
150-h.p. turbine-dynamo. The trial made in Nov., 1897.	113·8	26 4	7	163·0	*17·6	Work for condensing not included.
	116·9	25·9	6	138 4	18·2	
	113·8	26·2	5	114·5	17·9	
	114·3	26·5	4	88·3	18·7	
	112·4	27·0	3	64·1	19·0	
	116·2	25 7	2	37·5	22·3	
300-h p. turbine-dynamo. The test made in June, 1900.	126·6	26·98	8	337·45	15·68	Work for condensing not included.
	126 4	26·99	7	293·7	15·76	
	125·0	27·24	6	249·1	15·92	
	125·0	27·62	4	162·7	16·25	
	125·0	27·91	3	118·9	16·70	
	125·0	28 16	2	73·5	18 00	
	125·0	28·25	1	30·4	21·77	

* To get approximate lbs. of steam per kilowatt-hour multiply by 10 and divide by 6.

The Parsons Turbine.—This turbine, which is by far the most important and extensively used at the present day, is of the parallel-flow type. The turbine motor consists of a cylindrical case with rings of inwardly projecting vanes, within which revolves a concentric shaft carrying rings of outwardly projecting vanes. The rings of vanes on the case nearly touch the shaft, and the rings of vanes on the revolving shaft lie between those on the case, and nearly touch the case. The steam passes first through a ring of fixed guide vanes, and is projected in a rotational direction upon the succeeding ring of moving vanes, imparting to them a rotational force; it is then thrown back upon the succeeding fixed ring of guide vanes, and the reaction upon the next ring of moving vanes increases the rotational force. The same process takes place at each of the successive rings of guide and moving vanes. The energy to give the steam its high rotational velocity each successive ring is supplied by the drop in pressure, and the steam expands gradually by small increments. In the earlier types the steam was taken in at the centre of the fixed cylinder, and operated on successive fixed and moving vanes, both right and left, exhausting at each end of the fixed cylindrical chamber, thus obtaining an approximate balance and little or no end thrust on the bearings; in the later designs the steam flows and operates upon fixed and moving vanes, in one direction only; the diameter of the fixed and revolving vanes are usually increased at least twice, and the three chambers thus formed are generally designated the high-pressure, intermediate, and low-pressure cylinders. To balance the end thrust imparted to the shaft by the steam operating upon the moving vanes, grooved pistons or dummies are used, which rotate within corresponding seatings; the diameters of these pistons correspond with the diameters of the working cylinders, and a passage connects each working cylinder to the back of its corresponding balancing piston, and thus the end thrust is neutralised. The balance pistons also act as a practically steam-tight joint, since the clearance between the grooves can be adjusted longitudinally by a thrust block in the end bearing. In order that the turbine shaft may set itself accurately in the centre of gravity, the bearing are constructed of a number of concentric loose-fitting sleeves immersed in oil in such a manner that any transverse movement of the shaft is resisted by the fluid friction of the thin films of oil which have to be squeezed from the parts where the tubes are pressed against each other; thus the flexibility of the bearings is sufficient to compensate for any slight variation between the centre of the revolving cylinder and its true centre of gravity. The armature of the electric generator is directly coupled to the turbo shaft by means of a steel sleeve; the shaft also carries a worm which drives a worm-wheel, which in turn operates the lubricating oil force pump, and also the steam admission governor, by means of an eccentric or cam. When necessary, the condenser, air, and circulating pumps are driven also from this slow-running worm-wheel. The governing of the machine is as follows: Steam is admitted to the turbine in a series of gusts by the periodic opening and closing of a double-beat valve. This valve is operated by means of a steam relay in mechanical connection with the turbine shaft. The duration of each gust is controlled by an electric solenoid, which is connected as a shunt to the field magnets. The core of the solenoid is hung from the end of a long lever. The fulcrum of this lever is periodically moved up and down by means of a link connecting it with the eccentric, which receives its motion from the worm on the sleeve coupling, the eccentric also serving to work the oil-pump. The short end of the lever controls the valve of the steam relay. Each periodic movement causes a gust of steam to be admitted to the turbine, the duration of the gust depending on the height of the distant end of the long lever. With alternating-current generators an ordinary centrifugal governor takes the place of and fulfils the functions performed by the before-mentioned solenoid; a second centrifugal governor is also provided which comes into action should the generator through any cause obtain an excessive and dangerous speed, when a trip gear is operated thereby and the steam automatically cut off from the plant. One important factor which in the early times prevented the use of the Parsons turbine in alternating-current stations was that the makers were unable to guarantee satisfactory parallel running of the plants. About the year 1894 this difficulty was surmounted by modifying the governing in such a manner that the steam admissions were increased in frequency and shortened in duration, thus obtaining a more even angular velocity. The first single-phase turbo-alternator to be successfully run in parallel with slow-speed generators was one of the radial-flow type of 150 kw. output, installed in the Portsmouth Corporation works in 1894. Mr. Quin shortly afterwards succeeded in operating parallel-flow single-phase plants in phase with slow-speed plant at Blackpool, and to-day the successful operation of the plants in parallel with each other and with plant of other types is common practice. The first Parsons steam-turbine and generator was built in 1884. It developed 10 h.p. at 18,000 revolutions per minute. It ran for several years in Gateshead-on-Tyne, supplying current for the manufacture of incandescent lamps. It is now in the South Kensington Museum. It consisted of two groups of 15 turbines each, the steam entering between them and passing in opposite directions through each group. In 1889 the radial flow type of steam-turbine was introduced, and in 1892 a 100-kw. set running at 4,000 revolutions per minute was tested with a steam pressure of 100lb., slightly superheated, and a vacuum of 28in., when the consumption was found to be 25lb. per kilowatt hour. About two years later the parallel-flow type of turbine was again adopted, in which were introduced the modifications already described. Various improvements were also made in the design and construction of the vanes, which resulted in a considerably greater economy of steam. About this time several turbines of the non-condensing type were put down in the Manchester-square station of the Metropolitan Electric Supply Company, of London, where an injunction had been obtained against the company on account of the vibration caused by the reciprocating engines already installed. These turbo-alternators were of 350-kw. capacity, and gave complete satisfaction. Since that date the size of turbines has gradually increased, units of 500 kw. being put down in Newcastle, Scarborough, Cambridge, London, and other places. In 1900 two alternators, each of 1,250 kw. capacity, were made for the city of Elberfeld, Germany. The turbines were of the tandem type, consisting of high and low pressure cylinders, and ran at 1,500 revolutions per minute. The dynamos were four-pole, and supplied single-phase current at 4,000 volts and 50 periods. The steam consumption with slight superheat was 18·8lb. per kilowatt-hour at full load, or 11·9lb. per indicated horse-power, including the power required to drive the condenser pumps. These dynamos run perfectly in parallel with the 1,500-h.p. Sulzer engines which are coupled to 1,000-kw. Brown-Boveri alternators running at 83 revolutions per minute. In fact, the turbines steady the reciprocating engines, even when the latter are running on traction load. During the last few years new designs have been brought out in which the consumption obtained has been further reduced, giving, especially in the larger

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sizes, some very remarkable results. A few examples of the amount of steam used by various sizes of turbines are given below.

50-kw. Steam Alternator for the Blackpool Corporation.

Pressure of steam above atmosphere at stop valve.	Superheat at stop valve.	Vacuum in the turbine cylinder bar = 30in.	Revolutions per min.	Load.	Steam used.	Steam used.
Lbs. per sq. in.	F.O.	Inches of mercury.		kw.	Lbs. per hour.	Lbs. per kw.-hour
126	0	28·0	5,044	52·7	1,480	28·0
132	0	28·5	4,880	0	320	—

300-kw. Three-Phase Alternator for De Beers Mines, South Africa.

Lbs. per sq. in.	F.O.	Inches of mercury.		kw.	Lbs. per hour.	Lbs. per kw.-hour
150·0	53·3	27·8	3,000	312·1	6,260	20·06
153·0	50·0	27·8	3,000	231·8	4,960	21·45
150·5	40·2	27·9	3,000	154·5	3,670	23·75

500 kw. Single-Phase Alternator (2,200 Volts) for Hastings.

Lbs. per sq. in.	F.O.	Inches of mercury.		kw.	Lbs. per hour.	Lbs. per kw.-hour
145	93	27·4	3,000	501·9	9,776	19·47
148	90	28·1	3,000	255·1	5,612	22·00

A disadvantage in the Parsons plant is its great length, and there appears to be no good reason why it should not be shortened, the discs carrying the vanes being made larger in diameter to compensate. A convenient arrangement would be to place the plant thus shortened vertically, instead of horizontally, and I venture the opinion that the vertical type of turbo-electric generator will eventually displace the horizontal type. Returns published by Messrs. C. A. Parsons and Co. in May, 1903, show that the firm have supplied 50 turbines to corporations, ranging from 50 kw. to 1,800 kw., and aggregating 20,900 kw.; also 73 turbines to electric supply companies, ranging from 50 kw. to 3,500 kw., and amounting to 31 880 kw. in the aggregate.

Westinghouse-Parsons Steam-Turbine.—This steam-turbine built by the Westinghouse Company is practically the same as the Parsons type, with the exception that the governor is placed between the turbo and the electric generator. A fly-ball type of governor is made use of, which has several features conducive to good regulation. The ball levers are swung on knife-edges in lieu of pins. The governor works both ways—that is to say, the mid-position of the levers is admitting a full head of steam to the turbine. A movement from this in either direction is tending to cut off the supply. This serves a useful purpose in the event of a very excessive load coming on the turbine, such as a short-circuit, which has the effect of bringing down the speed more than the percentage variation permitted by the adjustment of the spring, when the steam immediately becomes shut off. Again, in such an event as some of the governor driving mechanism becoming broken, and the governor balls slowing up independently of the turbine, the steam is shut off before any damage could take place. It may be of interest to note that the Westinghouse Company have on order, and are building, about 85,000 b.h.p. nominal capacity of turbines for use in this country. These include, among others, three 3,500-kw. turbo-alternators for the Metropolitan Railway of London, and eight 5,500-kw. turbo-alternators for the Underground Electric Railway Company of London. In addition, large sets are being built for the Corporations of Brighton and Liverpool. The guaranteed maximum steam consumption of the 5,500-kw. plants at 165lb. steam pressure and 27in. vacuum per kilowatt hour is as follows: full load, 20·81b. saturated steam, 17·7lb. with 150deg. F. superheat; half load, 25lb. saturated steam, 21·2lb. with 150deg. F. superheat. The plants are also designed to take an overload of 50 per cent. In these large turbines a departure is made from the regulation practice, inasmuch as steam is admitted at the centre of the casing and exhausts at both ends; a balance is thus obtained upon the duplicate sets of revolving vanes, and no steam balancing dummies are used.

Willans and Robinson Steam-Turbine.—This is practically a Parsons turbine with the following modifications: While efficiency in the Parsons turbine depends upon the small clearances between the outer ends of the turbo vanes and the cylinder casing, and also between the ends of the fixed vanes and the revolving cylinder, in the Willans these peripheral clearances are disregarded and reliance for efficiency is had upon the small clearances on the sides of the vanes at their outer ends. The rotating rings of vanes (and also the fixed ones) are enclosed by a double hoop of thin metal which moves with the vanes; the edge of this ring comes fairly close to the continuous collar which forms the root of the next fixed ring of vanes. The clearance is very small, and it is claimed that if the hoop touches the fixed collar it will do no harm, but will almost immediately wear itself into the proper position. There are other minor details in connection with the governors, bearings, and casing, introduced with a view to simplification, and the makers are prepared to guarantee, with high-pressure superheated steam and a good vacuum, a steam consumption not exceeding 17lb. to 18lb. per kilowatt-hour on a 1,000-kw. turbine coupled to an alternating-current generator.

Brush-Parsons Turbo-Generator.—So far as the steam portion of this plant is concerned, it is built to the Parsons designs with one or two detail modifications in connection with the oil circulation and cooling; the alternator is of the fixed armature type with revolving field magnets. Although the Brush Company have only recently taken up the manufacture of this class of plant, an examination of the various parts during construction convinces me that the Brush Company's production will prove itself to be one of the best and most reliable of turbo-generators.

The Curtis Steam-Turbine.—The shaft in this turbine is vertical, the lower end carrying discs of large diameter within the steam casing on the periphery of which the steam-vanes are carried, the stationary rings or vanes being fixed to the cylinder casing. On the upper end of the shaft the revolving field magnets are mounted, and the stationary single or polyphase armature coils are located in grooves formed in the laminated iron discs surrounding field magnets, the whole being protected by a metal casing in the shape of an inverted basin. At the extreme upper end of the shaft the centrifugal governor is located, which controls the plant in the novel manner described later. The Curtis generator is of recent development, and retains some of the features of both the De Laval and Parsons types; also a number of novel and practical innovations are introduced which make the plant specially interesting at the present time, and which the manufacturers claim make possible a lower speed, less weight, fewer and simpler parts, high economy, less cost in manufacture, and other important advantages. Velocity is imparted to the steam in an expanding nozzle or nozzles, so designed as to efficiently convert into velocity nearly all the expansive force of the steam between the pressure limits used. After leaving the nozzles, the steam passes successively through two or more lines of vanes on the moving element, which are placed alternately with reversed vanes on the stationary element. In passing successively through these moving and stationary elements, the velocity acquired in the nozzle is abstracted, and largely given up to the moving element. Thus the steam is first thrown against the first set of vanes of the moving element, and then rebounds alternately from moving to stationary vanes until it is brought nearly to rest. By this means and by virtue of the large diameter of the discs carrying the vanes a high steam velocity is made to efficiently impart motion to a comparatively slowly moving shaft. The steam inlet area is made up of a number of expanding nozzles adjacent to each other, so that the steam passes to the wheels in a broad belt when all the nozzle sections are in flow. This process of expansion in nozzles and subsequent abstraction of velocity by successive impacts with wheel vanes is repeated two or more times, the devices for each repetition being designated as a stage. The number of stages and the number of lines of vanes in a stage are governed by the degree of expansion, the peripheral velocity which is desirable or practicable, and by various conditions of mechanical expediency. Generally speaking, lower peripheral speeds entail more stages, more lines of vane per stage, or both. The general practice is to so divide up the steam expansion that all stages handle about equal parts of the total power of the steam. The governing is effected by the successive opening or closing of the high-pressure set of steam nozzles and consequent widening or narrowing of the active steam belt. The first expansion nozzle is controlled by a throttling device operated by the governor, and the remaining nozzles are opened or closed electrically by a small electric controller which is moved round by the governor. The downward thrust due to the pressure of steam against the vanes is not balanced by steam pistons or dummies, as in the Parsons type, but the whole revolving mass is floated up on a thin film of oil which is forced up beneath the footstep bearing by an oil force pump. High efficiencies are obtained with this plant, and with 125lb. steam pressure superheat of 100deg. F. and 28in. vacuum, the makers guarantee maximum steam consumption per kilowatt-hour, exclusive of the power required for operating the condenser pumps and driving the exciter, as follows:

Size of plant.	Full load.	Half load.	Quarter load.
kw.	lbs.	lbs.	lbs.
750	19·9	20·9	24·0
1,500	19·3	20·2	23·2

Under the same conditions, but with 140lb. steam pressure and 28½in. vacuum, a 600-kw. Curtis generator at 1,500 revolutions per minute gave on test a consumption of 19½lb. of steam per kilowatt output on full load, 19½lb. on 25 per cent. overload, 20¾lb. on half, and 22½lb. on a quarter load. The following are some of the distinctive features of the Curtis turbo-generator: (*a*) the short vertical height occupied by the steam portion of the plant, as compared with the horizontal length of the steam portion of the Parsons type generator, and the strength and substantial section of the steel turbine vanes; (*b*) the extremely small floor space occupied by reason of the electric generator being built vertically over the turbine; (*c*) the excellent ventilation obtained in the alternator owing to its being built vertically over the turbine; (*d*) the uniform turning movement obtained by the continuous supply of steam to the turbine and speed regulation by varying the volume thereof. Possible disadvantages are that the generator carries no exciter, and the condenser pumps cannot be driven direct from the turbo shaft. It is probable that the reciprocating steam-engine will still maintain its superiority over the steam-turbine for driving direct-current generators of large size, inasmuch as at the high speeds necessary with turbines there is difficulty in constructing a satisfactory direct-current revolving armature; the armature reaction necessitates either a special compensating winding or the shifting of the brushes for changes in load, and the excessive peripheral velocity and vibration of the commutator precludes the use of carbon brushes, which would probably soon become red hot. Hitherto most of the high-tension alternating-current turbo-generators have been constructed with revolving armatures, a practice which is to be condemned, inasmuch as with the excessive centrifugal strains and vibration due to high velocity it is difficult to maintain good insulation of the high-pressure generating coils; also the excessive velocity of the collecting rings causes cutting of both the rings and the collecting brushes. A considerable amount of metal dust is thrown off at the point of contact, and in long continuous runs this metal dust

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is apt to collect and break down the insulation of the high-pressure collecting rings or brushes. In the writer's experience both these causes have produced breakdowns in turbo-generators with revolving armatures. The ideal arrangement is a fixed armature with the field magnets revolving within same, and this is now becoming standard practice in single and polyphase turbo-generators. The result is an absolutely reliable plant, which in point of first cost, economy of operation, and steam consumption, is in advance of the best practice with slower speed generators driven by reciprocating engines.

Economy of Space and Buildings.—This may be readily set forth by comparing the 3,500-kw. Sulzer-Kolben two-phase generators at the Willesden works of the Metropolitan Electric Supply Company, with turbo-generators of equal output. The Sulzer-Kolben plant weighs, with condensers, approximately 585 tons. The space occupied by the foundations is 60ft. 2in. in length by 21ft. 6in. in width, with a vertical height above the engine-room floor to the top of the piston tail rods of 33ft. 4½in. A Parsons turbo-generator of the same output weighs approximately 148 tons, and the space occupied does not exceed 37ft. 1in. in length by 8ft. in width and 14ft. 6in. in height, plus about an equal depth for the condenser-room beneath. A Curtis turbo-generator of 5,000 kw. output weighs approximately 175 tons, and the space occupied does not exceed 20ft. by 15ft., with a vertical height not exceeding 30ft. In this size the condenser, turbine, and generator are arranged vertically, the condenser forming the base of the plant.

(To be continued.)

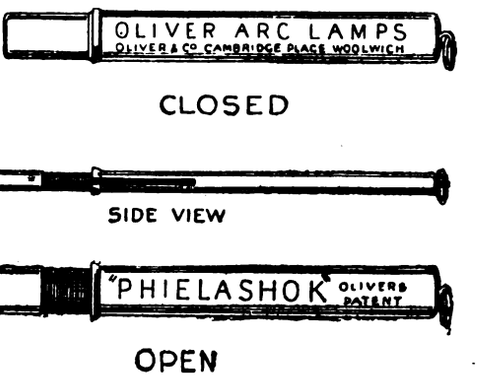
TRADE NOTICES AND NOVELTIES.

Continuous Concrete Conduit.

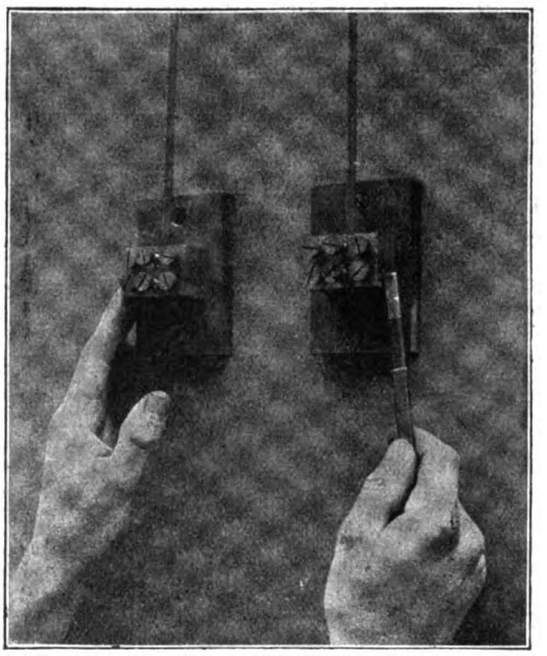
On Wednesday last we were invited by Messrs. Berry, Skinner, and Co., of 78, Upper Thames-street, E.C., to inspect a new system of constructing underground conduits into which cables can be drawn. The system is being used at the Neasden power-house of the Metropolitan Railway for conveying cables from the generating machines to the switchboard. For this purpose 4in. diameter ducts are required, and these are constructed in concrete in the following way. Iron pipes about 3⅞in. in diameter are used as formers. These pipes at Neasden are about 4ft. long, and they are jointed by an internal screwed coupling, so that the outside surface is continuous after the pipes have been screwed together. Each pipe is first dipped several times into a hot composition of paraffin wax and graphite, until the thickness of the same on the pipe is over ⅛in. The pipes are then screwed together, and laid on wood distance pieces, and concrete is packed in all round them. After two or three days have elapsed, in order that the concrete may be firmly set, the iron pipes are withdrawn. In order that this may be done steam is passed through them, which melts the above composition, and hence releases the pipes from the concrete bed. The result is a concrete conduit without joint, the inner surface of which is coated with a thin layer of paraffin and graphite, which acts as a lubricant when the cables are being drawn in. The advantages which are claimed for the system by its inventors and by Messrs. Berry, Skinner, and Co. are the following: (1) absolute continuity, and the seamless nature of the duct between manholes; (2) the whole of the work is constructed on site, so that no stock of troughing is required to be kept at any time; (3) a great saving in cost as compared with any other known draw-in systems. In reply to queries on the question of cost, we were told that 4in. diameter conduits could be made in this way at prices ranging from 1s to 1s. 3d. per yard run of single duct. This price applies to contracts where there are a number of ducts required side by side. It was also stated that 60 yards of pipe could be drawn out, which would allow for 120 yards between the boxes. The chief difficulty which seems likely to be found with the system is that it requires absolutely straight runs between draw boxes, as otherwise the iron formers could not be withdrawn from the concrete. For tramway working this could be obtained, especially in outlying districts. We understand that the system is being used in Germany, both by the Allgemeine Elektricitäts-Gesellschaft and by the Government Post Office Department.

"The Phielashok."

Messrs. Oliver and Co., the arc lamp manufacturers, have introduced a new electrical instrument or appliance in the form of an ordinary flat pocket pencil case, which they appropriately call a "Phielashok" (Oliver's patent). The use of this instrument is for testing electric wires and apparatus to ascertain whether they are alive or have current on them, and it owes its introduction to the general high pressure of electric supply now so generally prevailing in this country. Previous to the introduction of the "Phielashok," a conductor or part of an apparatus could be tested for electrification by placing the body directly across the part in question, and the supposed other pole of the circuit when a shock of either 230 or 460 volts, as the case may be, might be expected. This method is by no means a personally pleasant one even to those who boast that they are quite seasoned in this respect. The alternative is to obtain an incandescent lamp, pole finder, or galvanometer, and to make the test which in any case will involve a loss of time. On account of its compact and small size the "Phielashok" is carried in the pocket, and is at all times at hand to make a test. It consists of two parts—an outer metal case and an inner sliding portion specially prepared of very low electrical conductivity, which is capped with metal.



In making a test it is necessary to hold the metal case in one hand with the slide drawn out a certain distance, to place the other hand to one pole of the circuit, and to touch the supposed other pole with the metallic end of the slider. Thus the body will be placed in series with the low-conductivity slider, probably directly across the supply voltage, and if so, a very slight shock only will be experienced, giving an indication to the user that the wire or part be alive. A greater or less shock may be taken by diminishing or increasing the length of the high-resistance strip in series with the body, which may be drawn out of or passed further into the case. "Phielashok" may be used on any circuits up to 1,000 volts and even higher, but for higher voltages these are specially prepared and made. Standard instruments are, however, for use on ordinary supply pressures from, say, 200 or less up to 500 volts, but even these vary with the individual user. Instruments for alternating current are



marked "A," and those for continuous current "C." The applications in practical use for the "Phielashok" are innumerable.

Catalogues, Pamphlets, etc., Received.

Steam Plant Specialities (Illustrated). Holden and Brooke, Limited, Manchester.—In the preface the firm say that this catalogue, C, of their manufactures will be found to contain all essential particulars together with much new information, including some important modification in prices and preliminary notices of several new specialities for steam-power plants. We understand that any of our readers may obtain a copy upon application, and it would interest steam users to do so.

Lundberg Electric Light Accessories (Illustrated). A. P. Lundberg, Pioneer Electrical Works, 477-487, Liverpool-road, N.—Amongst the specialities mentioned we note "Pivot" and "Century" tumbler types, "Improved Pioneer," "Impulse," "Bowspring" switches, distribution boards, and various fittings

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suited to high-voltage requirements. The firm have the following agencies: Scotland—Messrs. W. C. Yuille and Co., 17 and 19, West-street, Tradeston, Glasgow; Lancashire—Mr. E. Unsworth, 145, Shrewsbury-street, Manchester.

MOTORS FOR PRINTING MACHINES (the Holmes-Clatworthy system). J. H. Holmes and Co., sole owners of the British patents for the Lundell continuous-current electric motors, Newcastle-on-Tyne, and 17, Soho-square, London, W.—This is a supplementary list to a list of 1,300 motors driving printing machines supplied by the firm, and already referred to by us.

PSYCHILOID (ILLUSTRATED). Psychiloid, Limited, Love-street, Sheffield.—Contains particulars of sheets, tubing, insulating handles, bobbins, formers, commutator rings, rollers, etc., of this insulating material, which has the advantage that it can be tapped and bored, and for which it is claimed that it is absolutely insoluble in all ordinary solvents, that it has been immersed for one month in water and sulphuric acid (3 1) without the slightest effect, and that it is practically non-absorbent. A number of tests made by various electrical engineers, including Mr. Capper, of the University College, Sheffield, are appended. The latter found on trying to pierce a sample at a pressure of 2,500 volts that no effect was produced, although it had been soaked in water for over 24 hours. Another firm found a sample to give an insulation test of 7·5 megohms.

TELEPHONE INSTALLATIONS FOR ELECTRIC TRACTION SYSTEMS (ILLUSTRATED). Western Electric Company, North Woolwich, and 171, Queen Victoria-street, E.C.—The telephone apparatus described in this list has been specially designed to meet the requirements of tramway service. Amongst the advantages claimed for this system are: (1) Simplicity of operation. To call the central station one has only to press the key in a microtelephone connected to a street box; or, in the case of a sub-station, to remove the microtelephone from the hook. (2) Minimum amount of apparatus at the street boxes, there being neither batteries, induction coils, nor any other accessory. (3) Any number of points may be joined up to one line. (4) Small battery power required at the central station; in most cases six or eight cells. The firm recommends users to adhere, if possible, to standard apparatus, thereby ensuring low cost and quick delivery.

APPOINTMENTS VACANT.

Clerk of Works, Shoreditch Borough Council's Electricity Department. Salary, £3. 3s. per week (working hours same as contractor), Oct. 31. Also King's Norton and Northfield Urban District Council, Nov. 2.

Engineering Assistant in a borough engineer's office in the vicinity of London, with experience in the construction and maintenance of electrical tramways. Salary, £160 per annum, with annual increments of £10 to a maximum of £200. Applications to be addressed to Box W 14, *Contract Journal* Office, 139-140, Salisbury-court, Fleet-street, E.C

Correspondence Clerk, Woolwich Borough Council, £90 per annum, Nov. 2.

Improvers at high-tension alternating station, London. See advertisement in last issue.

Advertisement Assistant, London County Council. Applications, by 10 a.m. on Nov. 16, to County Hall, Spring-gardens, S.W.

Engineering Assistants (2), London County Council, with good experience in the design and construction of the permanent way and general arrangement of electric tramways on the conduit system (if possible) and on the overhead system. Salaries up to £7 a week. Applications to Clerk of the Council, County Hall, Spring-gardens, S.W., by 10 a.m. on Nov. 10.

Representative, conversant with municipal authorities, and with practical knowledge of tramway construction, and surveying for first-class firm of tramway engineers and manufacturers. Apply to A 21, *Contract Journal* Office, 139-140, Salisbury-court, Fleet-street, E.C.

Improver, Perth Corporation Electricity Works. Commencing wages, 12s. per week. See advertisement.

Jointer, Erith Corporation, £2. 5s. per week. Also Mr. C. Turnbull, Tynemouth Electricity Works, North Shields. See advertisement.

PERSONAL.

The Scarborough Works Committee have recommended that Mr. Robert Atkinson, of Shipley, should be appointed clerk of works in connection with the laying of the tramways, his salary of £3. 10s. per week being paid by the tramways company.

Mr. Herbert E. Sharp, from the Bristol electrical works, has been appointed assistant electrical engineer at Taunton.

The control of the permanent way of the Reading Corporation tramways has been transferred from the borough engineer to Mr. W. Binns, the engineer and manager of the tramways department.

Mr. R. G. Mercer, A.M.I.E.E., who has been with the British Insulated and Helsby Cables, Limited, Prescot, for the last five years as outdoor superintendent, has been appointed as manager in Messrs. Psychiloid, Limited, Electrical Insulating Works, Sheffield.

FORTHCOMING EVENTS.

SATURDAY, OCT. 31.

Glasgow Scientific Society.—At 7.30 p.m., ordinary meeting. Paper: "The Evolution of a Technical College," by Emeritus Professor Alexander MacLay.

MONDAY, NOV. 2.

Royal Institution.—At 5 p.m., general monthly meeting.

TUESDAY, NOV. 3.

Institution of Civil Engineers.—At 8 p.m., ordinary meeting. Inaugural address of Sir Wm H. White, K.C.B., F.R.S., etc.

London Electrical Contractors' Association.—At 8 p.m., ordinary meeting, Restaurant Frascati, Oxford-street. Paper: "A Model Specification for Contractors' Use," by Mr. W. R. Rawlings.

WEDNESDAY, NOV. 4.

Institution of Electrical Engineers (Glasgow Section).—At 7 p.m., second annual dinner, Grand Hotel, Glasgow.

Liverpool Engineering Society.—At 8 p.m., ordinary meeting. Inaugural address of Mr. Thomas L. Miller.

THURSDAY, NOV. 5.

Chemical Society.—At 8 p.m., ordinary meeting.

Rontgen Society.—At 8 30 p.m., ordinary meeting. Inaugural address of the Right Hon. Lord Blythswood, LL.D., F.R.A.S.

LEGAL INTELLIGENCE.

SOUTH LONDON TRAMWAY RECONSTRUCTION.

Before Mr. Justice Bigham and a special jury in the King's Bench Division on Monday the case of Olley *v.* White and Co., Limited, was heard. It was an action brought by Miss Lila Olley against Messrs. White and Co., Limited, contractors, to recover damages for personal injuries alleged to have been sustained through the negligence of the defendants. The defendants denied negligence or liability.

It appeared that in August of last year the defendants were under contract with the London County Council to electrify their tramway system between Westminster and Tooting, and on the 28th of that month plaintiff entered one of the London County Council's horse cars at Westminster Bridge. While the car was proceeding along Kennington-road, near Kennington Cross, where the defendants had dug a trench, it left the line and partly overturned.

Plaintiff said that she was riding on the top of the car, and that in consequence of its leaving the line, owing to the points not being properly fixed, she was thrown violently against the rail of the car, sustaining injuries to her side and a severe shock to her nervous system. Plaintiff suffered from functional disturbance of the heart, giddiness, and sleeplessness, and she was unable to follow her employment for three or four months. The defendants denied negligence, and contended that if the plaintiff was entitled to recover the London County Council were liable.

Mr. **Justice Bigham** said in this case there seemed to be a fight between the defendants and the London County Council. He did not think the plaintiff ought to suffer in consequence of that dispute, and, therefore, he suggested that the London County Council should be brought in, and that it should be left to him to decide whether the defendants or the London County Council were liable to pay, assuming that there was negligence.

Eventually it was agreed that the London County Council should be brought in as parties to the action.

GEORGE F. MILNES AND CO., LIMITED.

In the Chancery Division of the High Court on Tuesday Mr. Justice Buckley heard the petition of John Lysaght, Limited, for the winding up of the above-named company. The nominal capital was £250,000, of which £122,990 has been paid up.

Mr. W. F. Hamilton, K.C., for the petitioner, a judgment creditor, said there was a voluntary winding up, Mr. Max Meyer being the liquidator. Counsel objected to his acting, on the ground that he was a director of companies in Berlin and a German subject, though temporarily domiciled in England. Counsel asked for a supervision order and that somebody should be appointed liquidator instead of Mr. Meyer.

After hearing Mr. Preston on the same side, Mr. Willis for creditors, Mr. Nepean for the debenture holders, and Mr. Bramwell-Davis, K.C., for the company, his Lordship made a supervision order, and appointed the receiver appointed in the debenture holders' action to act jointly with Mr. Meyer.

A WIRING CONTRACT.

At Croydon County Court, Messrs. Wenham and Waters, electrical engineers, of Croydon, sued Dr. P. F. O'Hagan for £8. 6s. 6d., balance of account for wiring defendant's house and supplying fittings.

Mr. Robinson, for the plaintiffs, stated that the work was done as long ago as December, 1901. The original price of the contract was £11. 2s., but with the addition of several small items this was increased to £20. 6s. 6d. Defendant had paid two sums of £5 and

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one of £2 on account, and this had reduced the amount to the sum claimed.

Mr. Clark, for the defendant, said that the defence was that the price agreed upon was 15s. per point and that the price was excessive. They were quite willing to have the matter go before an electrical engineer and abide by his decision.

The **Judge** said it was too late for a defence that the price was excessive to be raised. There would be judgment for the plaintiffs.

URBAN ELECTRIC SUPPLY COMPANY.

In the Chancery Division on Monday, **Mr. Maugham** said that in the case of John Pickering and Son *v.* the Urban Electric Supply Company, Limited, an order had been agreed between them which put an end to the action. It was a motion for an injunction in regard to the right to lay a cable. The parties were *sui juris*.

His Lordship sanctioned the arrangement.

CENTRAL LONDON RAILWAY SUED FOR FALSE IMPRISONMENT.

A remarkable action was brought against the Central London Railway Company at the Clerkenwell County Court on Thursday last week by a man named Thomas Hayes, who claimed to recover £10 damages for false imprisonment.

The action arose in this way. According to **Mr. May,** counsel for the plaintiff, his client, on Dec. 22, was travelling home from work on the Central Railway. He got in at Bond-street and was going to the Post Office, but owing to a breakdown all the passengers were ordered to alight at the British Museum Station. On leaving the station each passenger was given a complimentary ticket entitling him or her to travel one journey on a future occasion. On the following morning, at six o'clock, plaintiff, for the purpose of going to his work, proceeded to the Post Office Station, and instead of purchasing a ticket, put his complimentary pass into the box and stepped on to the lift. Almost immediately he was seized by one of the officials, who accused him of not having put a ticket in the box. Plaintiff explained that he had dropped in a complimentary ticket, but the official declined to believe him and dragged him out of the lift, saying, "We must make an example of you men," but adding that if he liked to take a ticket he could go. Refusing to do this, plaintiff was detained for 1½ hours until the station-master arrived. The ticket-box was then searched and the complimentary ticket found, whereupon the station-master apologised to plaintiff for the detention and asked him to say no more about it. Plaintiff replied that he certainly should not let the matter rest there. He proceeded to his work, but was told by the foreman that he could not have men coming there late. A short time afterwards, on the ground that work was falling off, he was discharged.

For the defence, **William Henry White,** conductor on the Central London Railway, said the occurrence took place on Dec. 30, and instead of being six o'clock it was nearer eight, because he was only acting as collector that morning from 7.30 till 8. He saw plaintiff enter the station, but as he passed the box without dropping any ticket in the box he went after him, and told him he must take a ticket before travelling. Plaintiff's reply was that he had dropped a complimentary ticket in the box and declined to take another one, although he (witness) assured him that if the ticket was found he would have his money returned if he gave his name and address. The station-master arrived in a few minutes, and several complimentary tickets being found in the box plaintiff was told he could travel.

The **Judge** said he could not give a verdict in plaintiff's favour in the face of the evidence adduced by the other side. Judgment would be for defendants, with costs.

LARGE TUBE CLAIM.

At the Sheriff's Court in Red Lion-square on Wednesday, Mr. Under-Sheriff Burchell and a special jury heard a claim for £10,282 from the Great Northern Railway Company, on behalf of the trustees of the late Mr. Arnold, of Seven Sisters-road, N.

The claim was in respect of 233, 235, 237, and 239, Seven Sisters-road. The latter three, which are shops, have been taken by the railway company, under parliamentary powers, for purposes in connection with the building of the Great Northern and City Tube. The cowhouse and dairy premises at No. 233 had, said Mr. Freeman for the claimants, suffered depreciation to the extent of 25 per cent. through the action of the company.

After hearing expert evidence on both sides, the jury found for the claimants in the sum of £7,200.

COMPANIES' MEETINGS AND REPORTS.

BRITISH ALUMINIUM.

An extraordinary general meeting of this Company has been called for Nov. 4 to consider and, if thought fit, pass the following resolution—namely: "That the capital be reduced from £400,000, divided into 10,000 A cumulative preference shares of £10 each, 20,000 preference shares of £10 each and 10,000 ordinary shares of £10 each, to £310,000, divided into 10,000 A cumulative preference shares of £10 each, 20,000 preference shares of £10 each, and 10,000 ordinary shares of £1 each, and that such reduction be effected by cancelling capital (which has been lost or is unrepresented by available assets) to the extent of £9 per share upon each of the 10,000 ordinary shares which have been issued and are outstanding." Should the above resolution be passed by the required majority, it will be submitted for confirmation at a second extraordinary meeting which will be convened subsequently.

NORWICH ELECTRIC TRAMWAYS.

The annual general meeting of the shareholders in this Company was held at 20, Bishopsgate-street Within, E.C., on Wednesday. The report stated that the gross earnings of the Company for the year ended June 30, 1903, amounted to £33,833. 8s. 7d., and the working expenses to £24,204. 14s. 1d., leaving a gross profit amounting to £9,628. 14s. 6d. To this have to be added the amount brought forward from last year of £824. 3s 5d., after having paid 1 per cent. on Oct. 22, 1902, or £4,840, and placing to reserve account £974. 10s. 9d., and £1,209. 16s. 7d. interest received from the Corporation in final settlement of account, making a total of £11,662. 14s. 6d. Deducting from this the sum of £2,640, being 4 per cent. interest on the Company's outstanding mortgage debenture to June 30, 1903, there remains a profit of £9,022. 14s. 6d. The directors recommend that a dividend of 2½ per cent. be paid on the Company's shares for the year ended June 30, 1903, which would absorb £6,600, and that a sum of £1,209. 16s. 7d. be placed to reserve account, the balance of £1,212. 17s. 11d. being carried forward. The reserve account will then be increased to £2,184. 7s. 4d. A comparison between the gross receipts for 11 months to June 30, and the receipts for the same period ended June 30, 1902, shows that there was an increase of £497. 15s. 4d. The working expenses for the same period show an increase of £699. 2s. 9d. The average cost per car mile was 5·43d. The average receipts per car mile were 7·76d. The number of car miles was 1,045,901. And the number of passengers carried 7,173,420. The report was adopted.

MAY-OATWAY FIRE APPLIANCES.

The annual general meeting of this Company was held on Friday, when the second annual report of the directors was presented. The figures showed that for the first time the sales have met the expenditure. During the period covered by the report some large installations have been completed, and they are working with satisfaction to their owners and the brigades with which they are in direct connection. Direct connection by the Company's system has now been made, or is authorised, by the headquarters of the fire brigades at Glasgow, Liverpool, Manchester, Birmingham, Leeds, Sheffield, Dundee, Bolton, and a number of other boroughs and towns.

EDISON AND SWAN UNITED ELECTRIC.

The report of the directors for the year ended June 30 last states that the net revenue account shows that £30,835 has been brought forward. Interest on debenture stocks has absorbed £18,761; £5,690 has been set aside as depreciation on freehold and leasehold property, plant, and machinery; £6,174 has been applied in writing down values of stocks; and £1,168 has been reserved on account of bad and doubtful debts. In pursuance of the policy inaugurated last year a sum of £1,000 has been added to the reserve for future stock depreciation. The result, as shown by the balance-sheet, increases the debit balance by £1,959. The cost of establishing the business, goodwill etc., £443,451, has been brought forward at the figures standing in the last balance-sheet. The freehold and leasehold property, plant, machinery, and tools have also been brought forward at the value stated in the last balance-sheet, with the addition of the amount expended to June 30, 1903, less depreciation charged in net revenue account. The shares of the Altrincham Electric Supply, Limited, have been taken at par, as in previous years. The indebtedness of this company has been reduced by £152. There has been expended on capital during the year £2,770. The directors will continue to exercise a strict watchfulness on capital outlay.

WESTERN TELEGRAPH.

The report of the directors for the half-year ended June 30 last states that the revenue for this period amounted to £229,090 and the working expenses to £94,791. After providing £13,578 for debenture stock and debenture interest and sinking fund, and £3,239 for income tax, there remains £117,480; to this is added the £5,331 brought forward, making a total of £122,811. A quarterly interim dividend, amounting to £31,189, has been paid, £35,000 transferred to the general reserve fund, and £2,000 to the maintenance ships' reserve fund. The revenue includes £14,790 dividends upon the Company's investments in other telegraph companies. The directors now recommend the declaration of a final dividend of 3s. per share, making, with the interim dividends, a total dividend of 6 per cent. for the year, and also the payment of a bonus of 2s. per share, which together will amount to £51,982, leaving a balance of £2,639 to be carried forward.

NEW COMPANIES REGISTERED.

West Surrey Light Railway Company, Limited.—Capital, £1,000. Objects: to provide and work a light railway or railways, tramway or tramways, in Surrey. Registered office: 27, Chancery-lane, W.C.

Incandescent Lighting and Electric Fittings Company, Limited.—Capital, £2,000. Objects: to carry on in Glasgow or elsewhere the business of manufacturers of and dealers in gas and electrical fittings and furnishings of all kinds.

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CONTRACTS FOR ELECTRICAL SUPPLIES.

Bermondsey.—The Borough Council invite tenders for cables, arc lamp standards, and accessories, by Nov. 9.

Caraminal (Spain).—The Municipality require tenders for installation and working of the village for 20 years. Tenders by Nov. 3.

Hornsey.—The District Council invite tenders for one 300-kw. steam dynamo to be delivered in October, 1904, and another in March, 1905.

Dudley.—The Guardians invite tenders for the supply and fixing of the various appliances for the electric installation to the laundry and boiler house.

Windsor.—The Town Council invite tenders for the supply of electricity or gas for the purpose of public lighting throughout the district for a period of five years.

Swansea.—The Corporation invite tenders for the supply, delivery, fixing, and connecting of ducts, troughs, cables, wires, street boxes, etc. Tenders by Oct. 31. See advertisement in last issue.

Rangoon.—The Municipal Committee have decided to call for amended tenders for the electric lighting of the town on a continuous-current system. Five tenders were received for the first call.

Wisby (Sweden).—Tenders are invited for a private and public electricity supply estimated to cost 180,000 kroner. Particulars may be obtained from the Director of the Draetselkammaren at the above place.

Wakefield.—The City Council invite tenders for the supply and erection of one 400-kw. two-phase generator, comprising engine, alternator, exciter, and accessories. Tenders by Nov. 7. See advertisement.

Brussels.—The Belgian Government Railways invite tenders for material and appliances to be used for lighting passenger trains. Specification No. 996 may be obtained from the above authority. Tenders by Nov. 4.

Blackpool.—The Electricity and Tramways Committee invite offers for various plant. Particulars can be obtained from the borough electrical and tramway engineer, Mr. Charles Furness, West Caroline-street, Blackpool. See advertisement.

Glasgow.—The Scottish Office of the May-Oatway Fire Appliances, Limited, invite tenders for the wiring of various installations. Full particulars from the Managing Director, 49, Queen-street, Glasgow. Tenders by Nov. 7. See advertisement.

Kilmarnock.—The Corporation invite tenders for the supply, delivery, and erection of three Lancashire boilers, engines and dynamos, overhead hand travelling crane, storage battery, and switchboard, by Nov. 18. See advertisement in last issue.

Shanghai.—The French Colony propose to instal motor-propelled tramways. Tenders may be sent by Oct. 31, 1903, to Secrétariat de la Municipalité Française de Shanghai. Particulars may be obtained from l'Office National du Commerce Extérieur, Rue Feydeau, 3, Paris.

Barrow-in-Furness.—The Corporation invite tenders for the completion of the electric lighting installation at Hawcoat and Walney police stations and the pig slaughtering hall and lairage at the public abattoirs. Further particulars may be obtained from the Borough Engineer.

Russia.—The Russian Minister of the Interior has sanctioned a plan for the reconstruction of three lines of municipal tramways—namely, those in Newsky, Sadovaia, and Wassiliostrow districts. Each car is to provide for two classes of travellers, and will accommodate 52 persons.

West Ham.—The London County Council invite tenders for the supply and erection of (a) engine, dynamo, switchboard, etc., and (b) electrical wiring, mains, and fittings required in connection with the installation of electric light at the Abbey Mills pumping station. Tenders by Nov. 3.

Todmorden.—The Corporation invite tenders for one Lancashire boiler, two steam dynamos and balancer booster, two feed pumps and one injector, economiser, surface or jet condenser, switchboard and instruments, storage battery, cable work, and overhead hand crane. See advertisement in last issue.

Culiacan (Mexico).—Tenders are invited for lighting the town by electricity; 60 arc lamps of 1,200 c.p and 110 incandescents of 50, 30, and 16 c.p. will be required. Propositions will be received by letter until Dec. 31 in the Secretaria del Ayuntamiento, Culiacan, where further information may be obtained.

Manchester.—The Paving, Sewering, and Highways Committee invite tenders for laying underground telephone pipes (Contract 8), with other appurtenant works. Drawings may be seen and specification, etc., obtained on application at the City Surveyor's Office, Town Hall, Manchester. Tenders by 10 a.m. on Nov. 5.

Blackpool.—The Electricity and Tramways Committee invite tenders for one new 450-kw. traction set (vertical triple-expansion engine and multipolar generator). Specification may be obtained from Mr. Charles Furness, borough electrical and tramways engineer, Electricity Works, Blackpool. Tenders by Nov. 14.

Beckenham.—The Urban District Council invite tenders for the electric wiring of houses in their district under a free wiring scheme. Specifications, etc., may be obtained from the consulting engineer, Mr. Reginald P. Wilson, 66, Victoria-street, Westminster, or Mr. John A. Angell, surveyor, Council Offices, Beckenham. Tenders by 4 p.m. on Nov. 9. See advertisement in last issue.

Swindon.—The Corporation invite tenders for the supply, delivery, and erection of steel poles, overhead line section boxes, arc lamps, and accessories. Specifications, etc., may be obtained from Messrs. Lacey and Sillar, 78, King-street, Manchester, and 2, Queen Anne's-gate, Westminster. Tenders by Nov. 16. See advertisement.

Chichester.—Tenders are invited for the installation of a system of electrical water-level indicators and recorder and telephones. Specifications may be seen and bills of quantities obtained at the office of the city surveyor and waterworks engineer, Mr. I. Pym-Jones, Lion-street, Chichester. Tenders by Nov. 6. See advertisement.

Radcliffe.—The Council invite tenders for the supply and completion of (Contract No. 12) lighting and traction switchboard and accessories; (14) rail bonds. Specifications may be obtained from Messrs. Lacey and Sillar, 2, Queen Anne's-gate, Westminster, and 78, King-street, Manchester. Tenders by Nov. 14. See advertisement.

Radcliffe (Lancs.).—The Urban District Council invite tenders for the supply of the pitch and oil required in the construction of the tramways in the district. Specifications, etc., may be obtained on application to Mr. W. L. Rothwell, engineer, at the Council Offices. Tenders to Mr. S. Mills, clerk, Council's Offices, Radcliffe, by Nov. 14.

Sydney (New South Wales).—Tenders will be received at the office of the Deputy Postmaster-General, Sydney, New South Wales, up to 2.30 p.m. on Dec. 30, for the supply and delivery at the departmental stores, Sydney, of telegraph, telephone, and electric light material. Specifications, etc., may be seen and tender forms obtained at the General Post Offices, Sydney, Melbourne, Brisbane, Adelaide, Hobart, and Perth.

Wednesbury.—The Corporation invite tenders for the electric wiring and fittings for the following public buildings: town hall, municipal offices, art gallery, public baths, public library, and electricity sub-station. Specification, etc., may be obtained between 2 and 5 p.m. on and after the 23rd inst. at the offices of Mr. F. J. Warden-Stevens, A.M.I.M.E., A.M.I.E.E., consulting engineer, 34, Victoria-street, Westminster. Tenders by 12 noon on Nov. 20.

Manchester.—The Commissioners of H.M. Works and Public Buildings invite tenders for erection of a telephone exchange and engineer's office and store at Quay-street, Manchester. Specifications, etc., may be seen at H.M. Office of Works, New Bridge-street, Manchester. Forms of tender may be obtained at H M. Office of Works, etc., Storey's-gate, S W. Tenders before 12 noon on Nov. 11 to the Secretary, H.M. Office of Works, etc., Storey's-gate, London, S.W.

Harrismith (South Africa).—The Town Council invite tenders for the supply, f.o.b. British port, of the galvanised iron buildings required for a small electricity generating station. Drawings, specifications, etc., may be seen at the offices of, or obtained from, the Council's consulting engineers, Messrs. Mordey and Dawbarn, 82, Victoria-street, Westminster, S.W. Tenders to Messrs. Webster, Steel, and Co, 5, East India-avenue, Leadenhall-street, E.C., by noon on Nov. 9.

Derby.—The Directors of the Midland Railway Company invite tenders for the supply of stores for 12 months from Jan. 1, 1904, including telegraph instruments, telegraph stay rods, bolts, insulators, etc., telegraph and signal wire. Samples may be seen at the General Stores Department, Derby, on and after Nov. 2, between the hours of 10 a.m. and 4 p.m. (Saturday, 10 a.m. and 1 p.m.) Forms of tender on application to Mr. Alfred Derry, stores superintendent, Derby. Tenders to the General Stores Committee, Midland Railway, Derby, by 9 a.m. on Tuesday, Nov. 10.

RESULTS OF TENDERS.

Bristol.—The tender of Mr. McNaughten for the supply of carbons to the new arc lamps has been provisionally accepted.

Blackpool.—The Corporation have accepted the tender of Crompton and Co., Arc Works, Chelmsford, for the supply of arc lamp carbons for the ensuing year.

St. Olave (Southwark).—The Salisbury Electrical Engineering Company, of Lee, have obtained the contract for providing 370 lights and 188 switches at the workhouse at £365.

Aberdeen.—The Corporation have accepted the tender of Mr. P. Tawse, amounting to £9,798. 14s. 4d. for the extension of the cable subway from Crown-street along Langstane-place, to Holburn-street.

Southend.—The tender of Messrs. Crompton and Co., Limited, Chelmsford, at prices amounting to £163, has been recommended for acceptance for the supply of ten 300 wattmeters, ten 300 ampere brakers, and 120ft. copper strip.

Southampton.—The Corporation have accepted the tender of Pearson, Huggins, and Co., Limited, 51, Scrutton-street, Finsbury, London, E C., for the supply of 20 overcoats for employés of the tramway department, at £25. 17s. 9d.

Preston.—The Tramways Committee have resolved to recommend the Council to accept the tenders of Messrs. Dick, Kerr, and Co., Limited, for the supply of 30 electric cars for the sum of £472 per car, and for permanent-way construction and overhead equipment (with the Lorain Company's special work) for the sum of £80,592.

Swindon.—The Corporation have accepted the following tenders: A. J. Colborne, Newport-street, Swindon, for erection at Swindon, Wilts, of car depot stores, repair shops, etc., £3,233. 17s.; Reason Manufacturing Company, Brighton, for the supply of maximum demand indicators for 12 months; Cable Accessories Company, Birmingham, for the supply of fuse boxes for 12 months.

London.—Messrs. Rowland Carr and Co. report orders as sub-contractors to Messrs. Crompton and Co., Limited, for 40 arc lamp columns and accessories for Hackney. They have also secured the contract for the steel troughing in connection with the electrification of the Underground Railways, and a further order from the New Century Arc Lamp Company for 40 arc lamp columns required for Stepney.

Brighton.—The tender of Messrs. Dick, Kerr, and Co., of Preston, to supply 20 tramcars at £10,200 is recommended for acceptance.

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The closeness of the tendering is shown by the fact that the tender of the Brush Electrical Engineering Company was only £10 more. The Tramways Committee also propose to accept a tender of £5,962 for the supply of 800 tons of tramrails. This tender varies from £300 to £800 above five other offers. These latter were, however, for Belgian rails, and being advised that the life of British rails was 20 per cent. longer than that of the foreign article, the committee decided to give the contract to the home product at the higher price.

Steam-Turbines.—The British Westinghouse Electric and Manufacturing Company have in hand turbo-generators aggregating 78,300 kw., or nearly 115,000 h.p., at Trafford Park Works. The largest sets, eight of which will furnish current from its Chelsea power station for the Underground Electric Railways of London, will normally develop 5,500 kw., or about 8,000 h.p., but be equal to 11,000 h.p. on overload; they are the largest single-cylinder engines which have yet been constructed. The Brighton and Liverpool Corporations respectively claim 5,400 kw. and 3,200 kw. of the total orders in hand, Clyde Valley Power Company 12,000 kw., and Metropolitan Railway 10,500 kw.

London, N.E.—The Bethnal Green Borough Council have received the following tenders for clearing the site of proposed electricity works: Amount of offer—C. Griffiths, Ben Jonson-road, Stepney, £100 (accepted); S. E. Bonsall, 8, Queen's-road, Peckham, £105. 11s.; Smith, Wilkinson, and Sons, 10, Tottenham-lane, Hornsey, £102; J. Ashton, sen., 8, Stanley-road, Wood Green, N., £100; A. Myer, 180, Morning-lane, Homerton, £96. 10s.; J. M. Hinton, Park House, Alexandra-terrace, East Ham, £95; W. Butler, 61, The Grange, Bermondsey, £75; J. W. Moore, 88 and 90, South-street, Walworth, £55. 10s.; J. C. Base, 131, High-street, Stratford, £35; W. Downton and Co., Neville Yard, West Kilburn, £35. Amount to be paid to contractor—S. Eddiard, 15, Green-lanes, Stoke Newington, £50; J. Ashton, 106, Mare-street, Hackney, £60; W. Marshall, jun., 1, Clifton-square, Peckham, £140.

Paisley.—The British Schuckert Electric Company, Limited, report the following recent orders, among others: For Paisley Corporation, extensions to tramway switchboard, consisting of nine panels, with the necessary instruments and switchgear; also a negative booster set of 27 kw. capacity to work in conjunction with the return-current feeders. For the Dunlop Rubber Company, Limited, Aston, through Messrs. Willians and Robinson, who are supplying the engine, a 275-kw. direct-current generator, 250 volts, 340 r.p.m. This machine will operate in conjunction with the existing plant of the Dunlop Rubber Company, the whole of which, including generators, motors, etc., was installed by the British Schuckert Electric Company, Limited. For the Lurgan Weaving Company, Belfast, a 88½-kw. combined direct-current generator, 220 volts, and Allen steam-engine, together with ejector condensing plant complete.

Wolverhampton.—The Corporation have received the following tenders for the supply, delivery, and erection of surface condensing plant and oil separators, to deal with 15 000lb. of steam an hour:

Allen, Son, and Co., Bedford	£1,339	0	0
Belliss and Morcom, Limited, Birmingham	1,431	0	0
Ditto (alternative tender)	1,402	0	0
Blake, Knowles, and Co., London	1,094	2	0
J. Evans and Sons, Wolverhampton	1,292	17	6
Klein Engineering Company, Manchester	1,492	0	0
Mirrlees, Watson, and Co., Glasgow	1,305	5	0
Ditto (alternative tender)	1,310	5	0
Ditto (alternative tender)	1,320	5	0
Ditto (alternative tender)	1,364	5	0
Thornton and Crebbin, Bradford	1,337	0	0
Ditto (alternative tender)	1,207	0	0
Wheeler Condenser Company, London	1,191	0	0
Worthington Pump Company, London	1,361	0	0

Devonport.—The Corporation have received the following tenders for a negative booster:

Walker and Hodgetts, Limited, (guaranteed efficiency 80 per cent.)	£310
British Electric Plant Company, Limited (70 per cent.)	310
Crompton and Co., Limited (73 per cent.)	313
Brush Electrical Engineering Company (82 per cent., accepted)	327
Siemens Bros. and Co., Limited (72.25 per cent.)	332
Industrial Engineering Company, Limited (72 per cent.)	338
Bruce Peebles and Co., Limited (79 per cent.)	341
Keighley Engineering Company, Limited (80·5 per cent.)	347
Johnson and Phillips (81 per cent.)	375
Rhodes Electrical Company (77 per cent.)	390
Mavor and Coulson, Limited (79 per cent.)	391
Thomas Parker, Limited (77·5 per cent.)	393
British Westinghouse Company, Limited (79 per cent.)	397
Lancashire Dynamo and Motor Company, Limited (78 per cent.)	410
Laurence, Scott, and Co., Limited (75 per cent.)	420
Mather and Platt, Limited (75 per cent.)	425
Lister Electric Manufacturing Company, Limited (76 per cent.)	433
British Schuckert Electric Company, Limited (76 per cent.)	455
Electric Construction Company, Limited (80 per cent.)	465

Wandsworth.—The Borough Council will hold a special meeting to consider whether or not the Council shall agree to make a contribution of £65,000 towards the cost of the widening of Streatham High-road for the extension of the London County Council tramway from the present terminus at the Tate Library, Streatham, to the county boundary at Norbury. The Borough Council has on a previous occasion refused to make any contribution, but it is now proposed that the resolution embodying that refusal shall be rescinded, in view of the advantage that would accrue to ratepayers in the Streatham Ward if the proposed extension was carried out.

BUSINESS NOTES.

TRACTION.

Dover.—The Board of Trade have confirmed the Dover and River light railway order.

Calverley.—A tramways provisional order is to be applied for on behalf of the District Council.

Birkenhead.—It has been resolved that top deck covers be fitted to two of the Corporation's trams.

Burton.—The Burton and Ashby light railway order has been confirmed by the Board of Trade.

Heywood.—Terms have been arranged for the leasing of the tramways to the Rochdale Corporation.

Airdrie.—It is probable that the first sections of the electric tramways will be opened for traffic in February.

Barking.—The Board of Trade's inspection of the new electric tramways to Beckton took place on Tuesday.

Burnley.—It is has been decided to fit two of the Manchester-road cars with mechanical slipper brakes at a cost of £60.

Leicester.—One of the Lancashire boilers for the tramway power-house has been delivered. It was supplied by Messrs. Yates and Thom, Blackburn.

Redruth.—It was stated at this week's meeting of the Council that from Nov. 7, 1902, to Sept. 30 of this year the trams had carried 1,000,000 passengers.

Colchester.—The laying down of a system of electric tramways in the town was formally marked by a fitting ceremonial performed by the Mayor on Thursday last week.

Huddersfield.—Bicycles will in future be carried upon the tramcars at owner's risk in all respects at the same rate as passengers, but not more than two will be carried upon one car at a time.

Brighton.—The tramways engineer has been instructed to prepare specifications and detailed drawing for a public shelter and tramway room at the Old-steine terminus of the tramway system.

South Hams Light Railway.—The Light Railway Commissioners will hold a public enquiry at Kingsbridge on Nov. 3 as to the expediency of granting an order to authorise the South Hams Light Railway.

Twickenham.—With reference to the London United Tramways Bill, 1903, the District Council have decided to agree to the tramway company's amendments in the agreement between them and the Council.

Calne.—The Light Railway Commissioners will hold an enquiry soon in regard to the application of the promoters of the Wilts Central Light Railway to construct a light railway between Calne and Marlborough.

Middlesex.—The County Council are opposing the application of the London United Tramways Company to the Board of Trade for an extension of time for the completion of the extension of their Ealing line to Uxbridge.

Halifax.—The Corporation Tramways Committee have received an offer of £2,000 per annum for the privilege of occupying spaces on the Corporation tramcars with advertisements. This is equivalent to a rate of 1¼d. in the £.

Wolverhampton.—At a special meeting of the Town Council to be held on Friday, the members will be asked to consider the question of promoting a Bill in Parliament for the extension of the tramway system to Wednesfield.

Kirkcaldy.—In connection with the tramway scheme, in respect of which parliamentary powers are to be applied for to double the lines where necessary, and to lay double line to Dysart, it has been decided to divide the existing route into six ½d. stages, or 2½d. for the complete route.

New Zealand.—At a recent meeting of the board of directors of the Waipori Falls Electric Power Company it was intimated that the electrical supervising engineer was expected to arrive this month, and he would at once commence operations on the intended electrical tram service work.

Hastings.—Mr. W. M. Murphy has informed the Town Council that the tramway works will be commenced in February, and he hopes to complete the principal lines before the end of next year. The time for completion authorised by the original Act and order has yet nearly two years to run.

Dublin.—The Judicial Committee of the Privy Council have heard an application on behalf of the Dublin United Tramways Company for an extension of time limited for the completion of certain works in connection with their system. The committee granted an extension of two years from the present time.

Spain.—A proposal has been made by the "Tranvia del Este" Company of Madrid for a new electric tramway line, and until Nov. 13 other proposals on more favourable terms, duly guaranteed, may be made. An application has also been made for the concession for an electric tramway in the Canaries from the port of La Luz to that of Sardina.

Handsworth.—It having been agreed by the District Council to pay the South Staffordshire Tramways Company £5,250 for the purchase of that portion of their undertaking which is in the Council's district, the electrical engineer has been instructed to proceed with the preparation of plans for the conversion of the lines to electrical working.

Scarborough.—The joint committee of the Water Committee and Streets Sub-Committee have met to consider the question with regard to the tramways company and the laying of water-mains. It was decided to appoint a deputation along with the two engineers

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(Mr. Millhouse and Mr. H. W. Smith) to interview the tramways company.

Swansea.—Over 30 tenders have been received for the proposed tramway extensions. The specified date of completion is 12 months, with the exception of certain portions, which must be completed in six months. The penalty for late completion is 1 per cent. of the total price of each contract for each day's delay. The tenders must be all in by the 31st inst.

Bankfoot.—The Board of Trade have confirmed the Bankfoot Light Railway (Extension of Time) Order, 1903, reviving the powers granted and extending the period limited by the Bankfoot Light Railway Order, 1898, for the compulsory purchase of lands and extending the period limited by that order for the completion of the railway and works by that order authorised.

Norwich.—The gross earnings of the Norwich Electric Tramways Company for the year ended June 30 amounted to £33,833. 8s. 7d., and the working expenses to £24,204. 14s. 1d. The directors recommend a dividend of 2½ per cent., £1,209. 16s. 7d. going to the reserve account, and the balance, £1,212. 17s. 11d., to be carried forward. Seven million passengers were carried during the year.

Paris Underground.—A Reuter's telegram from Paris of Saturday's date says: "In consequence of a short-circuit in the power cable another fire broke out on the Metropolitan Railway at about five o'clock this morning. Dense smoke filled the tunnel between the Champs Elysees and the Etoile Stations. No trains have been running up to the present, but the fire has been got under. No one was injured."

Finchley.—At the last meeting of the Urban District Council the surveyor reported that there was still considerable delay in finishing the portion of the track already laid. He understood, however, from the county engineer and the contractors that the necessary material was now coming to hand, and more dispatch would be possible. High-tension mains had been laid from Barnet boundary to Whetstone.

Altrincham.—The poll taken on the tramways question was declared on Saturday. Voting cards had been sent round to the ratepayers asking the following question: "Are you in favour of the Altrincham Urban District Council applying to obtain a provisional order for the construction of tramways in Altrincham?" 1,311 voted for and 1,098 against the application, giving a majority of 213. Nearly 200 did not vote.

Derby.—On Tuesday, after a long discussion, a special meeting of the Town Council passed the following resolution: "That the portion of the resolution of the Council passed on May 6, 1903, approving of the routes presented by the Tramways Committee be rescinded so far as it refers to the tramways on the Burton-road at a point on the road opposite Vicarage-avenue and the borough boundary adjoining the parish of Littleover."

Greenock.—The decision of the arbitrator in the dispute between the Town Council and the tramways company (referred to in our issue of the 16th inst.) has now been made public. The arbitrator has fixed the price to be paid by the company for electric energy in excess of 500,000 units per annum at ⅛d. per unit, and decided that the company shall pay the Council £125 per annum for the use of the cables as from May 1, 1901.

New York.—The *Electrical World* supplies details of an addition to the subway power-house now building on the Hudson River. This addition will make the plant the largest and most expensive in the world. The total estimated cost of the whole scheme is £1,400,000, and the plant will be capable of generating 132,000 h.p. The boiler plant at first will consist of 72 boilers, each of 500 h.p. The chimneys will reach to a height of 265ft.

Lewisham.—The Borough Council have received a letter from the London County Council stating that if they will consent to contribute one-third of the cost of the necessary street widenings upon the introduction of electric trams, the London County Council will proceed with the application to Parliament. At a previous meeting the Lewisham Council agreed to contribute one-sixth, and they have now promised to reconsider the matter.

Erdington.—A meeting of the Tramways Committee of the Urban District Council has considered and approved the detailed specification and drawings for the construction of the first portion (about six miles in length) of a complete scheme of electric tramways for the district, prepared by Messrs. Robert Green and H. Humphries, the joint engineers, who were instructed to forthwith obtain the approval of the Board of Trade to them and to advertise for tenders.

Quarry Bank.—Last week Sir Herbert Jekyll heard objections to the Quarry Bank, Brierley Hill, and Rowley Regis light railway order. The following clause was inserted in the order: "Nothing in this order shall authorise the Councils to alter or interfere with any of the tramways or light railways of the Dudley, Stourbridge, and District Electric Traction Company, Limited, without the consent, in writing, of the company, or without like consent to construct certain other lines."

Buenos Ayres.—Electric traction is making great headway at this place. All the lines of the Anglo-Argentine Tramway Company have now been converted to electrical working, and La Nueva Tramway Company has obtained permission to convert their line to the same method of traction. The concession is for 55 years, and the company agrees to give free lighting *en route* to 200 16-c.p. lamps per kilometre. Various extensions of the electric lines in Belgrano and Flores are to be carried out by the Buenos Ayres Electric Tramway Company.

Newcastle.—A special meeting of the Tramways Committee has been held to decide which route from Chillingham-road to Heaton-road it would be best to put in the Bill to be brought before Parliament. The committee decided that the trams should go one way by St John's-terrace and Tenth-avenue and return by Ninth-avenue and St. John's-road. The committee's recommendation (entailing an expenditure of £6,800) came up at the Council meeting on Wednesday, but was referred back after a long debate, which was characterised by some unruly scenes.

Sheffield.—The Tramways Committee have recommended to the Corporation that they should cease to insure against claims for compensation by third parties, and undertake themselves to meet these risks, but they suggest, with a view to limit the liability, that notice be given that from Dec. 5 next, as passengers are being carried at less than the maximum authorised charges, they will only be carried on the express condition that the liability of the Corporation is limited to an amount not exceeding £25 for any accident to any one person. The electric cars are about to be equipped with the "National" life-guard.

Southend.—Financial statements with reference to the electric lighting fund and the light railways fund were submitted at the last meeting of the Town Council. With regard to the former, the estimated expenditure for the year was shown as £8,725, and the estimated income as £8,400. The expenditure for the six months ended Sept. 30 was £4,485, and the income £4,459. Under the light railways heading, the year's estimated expenditure was put down as £14,841, and the estimated income as £15,000. The expenditure for the six months ended Sept. 30 was £8,852, and the income £10,394.

Rotherham —Dr. Kennedy has reported on the proposed tramway routes, and the Tramways Committee recommend that clauses be inserted in the Bill to be promoted for the following extensions: (*a*) Effingham-square, Frederick-street, Bridge-street, College-road, to Bradgate; (*b*) Wellgate, Badsley Moor-lane, and Middle-lane; (*c*) Moorgate-road to Whiston; (*d*) Effingham-street, Greasborough-road, to Greasborough boundary; (*e*) Fitzwilliam-road to bottom of Whinney-hill; (*f*) Canklow-road to Whiston Bar; (*g*) Domine Well-lane in Market-place; (*h*) existing extensions at Kimberworth and Canklow.

Llanelly.—A meeting of the Estates Committee of the Borough Council was held on Monday, when the deadlock in connection with the traction and lighting scheme was again considered. Mr. D. Randell, solicitor to the Council, was present, and repeated the advice he had already given, that the Council should go to Parliament to secure a Bill to compel the Insulated Wire Company to carry out their agreement. Mr. Randell said that he was backed up in that view by the opinion of Mr. Vesey Knox, of the Parliamentary Bar, who said that it was the only course that the Council could pursue. The matter was then fully discussed, and by four votes to three it was decided to adopt the advice of the solicitor and take parliamentary proceedings.

Additional Traffic Returns.—Anglo-Argentine, £2,113 increase; Barcelona Ensanche y Gracia, £136 increase; Barcelona, £59 decrease; Brisbane, £123 decrease (month of August, £11,736, increase £294), British Columbia Electric (month of March), gross earnings £10,352, net income £2,659; Buenos Ayres and Belgrano Electric, £129 increase (month of September, £13,793, increase £1,317); Calcutta, £425 increase; Cape Town (month of September), receipts £15,174, expenditure £8,503; Isle of Thanet Electric, £50 decrease; Lisbon Electric (month of September), receipts 89,636 milreis, expenses 51,231 milreis; Mexico Electric (month of August), receipts £48,600, expenses £27,900; Perth Electric, £268 increase; Port Elizabeth (month of September), receipts £3,730, expenditure £2,767.

Islington —At the last meeting of the Borough Council the Works Committee reported consideration of a letter from the London County Council giving at length the reasons (among them being that the conduit system would necessitate the reconstruction of numerous bridges) which had induced them to suggest that the overhead trolley system should be adopted for certain of their northern tramways, and expressing the hope that the Borough Council would, in view of the difficulties, agree to the proposal that certain of the tramways in the borough should be worked on the overhead system of electrical traction. The meeting resolved that representatives from each borough affected by the proposed reconstruction of the London County Council's northern tramways for electrical traction, together with their respective town clerks and borough engineers, be invited to attend a conference to consider the question with a view to united action being taken in the matter.

Speed of Tramcars.—In connection with the prosecution of four motormen of the London United Tramways for driving their cars at a higher speed than the authorised limit, some official trials were made on Wednesday in order to decide whether the contention of the company that their cars were unable to run at a greater speed than 10 miles an hour was correct. The *Times* correspondent, who watched the trials, says the prosecutor, Mr. Moffat Ford, and his expert, Colonel Crompton, C.B., were not admitted. He gives the result of one trial as follows: "Car No. 75 was timed carefully over 220 yards twice. It consumed on one occasion 35⅗ seconds, on another 37 seconds. Since 45 seconds is the time which ought to be consumed in covering a furlong, it is abundantly clear that yesterday car No. 75 exceeded the legal limit twice—that is to say, on the only occasions when it was timed." The official results will probably be made known when the adjourned summonses come before the West London police magistrate.

Cheltenham.—A deadlock has arisen between the Corporation and the light railway company in regard to the proposed extensions of the present light railway along High-street to Charlton Kings, and along Both-road to Leckhampton. The Corporation stipulate that along the High-street jarrah wood blocks should be used on either side of the track, but the company insist that the material shall be creosoted deal blocks. The difference in the life of the two blocks is said to be considerable, but so also is the cost, jarrah wood entailing a larger expenditure by £600 per mile as compared with creosoted deal blocks, and on this basis the extra cost to the company would amount to between £3,000 and £4,000. It is stated that Mr. Nevins, chairman of the company, has sent what practically amounts to an ultimatum

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to the Corporation—viz., that he adheres to the cheaper material; that he is anxious to proceed with the extension without further delay, but that he will make no further concessions to the Corporation on the point mentioned.

Chatham.—The Chatham and District Light Railways Company have found it impossible to get through their scheme (estimated to cost about £6,000) for doubling the track on Chatham-hill with the celerity they had anticipated, and the work has not yet been commenced. The requirements of the Chatham and Gillingham Councils necessitated prolonged negotiations, but eventually matters were satisfactorily adjusted with the first-named authority. The company, however, declined to agree to carry out all the works stipulated for by the Gillingham Council with regard to the part of the road in that parish, and appealed to the Board of Trade to decide the points of difference between them. Lieut.-Colonel P. G. von Donop, R.E., accordingly held an enquiry into the matter, and met representatives of the company and the Council on Chatham-hill. The Board of Trade have now given their decision. They have determined the matter in accordance with Lieut.-Colonel von Donop's report, which is in favour of the light railways company.

Cardiff.—There was another discussion at the meeting of the Tramways Committee on Friday last with reference to permitting the use of cars for advertising. Mr. Ellis (engineer) expressed the opinion that the prospective revenue was more than counterbalanced by the present sightliness of the cars and their attractiveness to passengers. If the inviting appearance of the trams were altered, he believed there would be a falling off in traffic. The committee were practically unanimous in deciding not to entertain the advertising idea. According to a Cardiff electrical engineer, the illuminated tramcar experiment which has been tried at Cardiff is a costly luxury. Mr. W. S. Crossman informed the committee that the gentleman in question had told him that the cost per hour was no less than £3. Mr. Ellis replied that the actual cost was only 3s. 4d. per hour, and that the tramway receipts on the day on which the car was run went up £50. Mr. Ellis reported that up to the 16th inst. the increased receipts over last year totalled £16,973. There were now 79 cars regularly running, as against 66 at the corresponding date of last year. The committee expressed satisfaction with the increase.

Portsmouth.—The Corporation are recommended to extend the tramways to connect with the proposed Portsmouth-Hayling Island Light Railway at the borough boundary. The estimated cost of the scheme is £10,000. The Light Railway Commissioners will hold an enquiry into the proposed light railway next month. From the tramways accounts for the past 12 months it seems that the sum of £83,563. 12s. 5d. was expended in the year on the capital account, making a total expenditure of £620,239. 8s. 8d. The income was £83,950, against £50,643; whilst the expenditure was £36,961, against £29,871, leaving a gross profit of £46,988. This, after paying off the adverse balance of the previous year, and providing the interest and sinking fund charges, leaves a balance of £6,918. 10s. 8d., which the committee have decided shall form the nucleus of a reserve fund. The total amount redeemed and accumulated in the loans fund in respect of the undertaking now amounts to £31,066. Application is to be made for loans as follows: laying a double junction at Bradford-road, Southsea, £556. 10s. 10d.; laying a cross-over in Commercial-road. £150; and purchase of a motorcar and track sweeper and sprinkler, £655.

Local Authorities and By-Laws.—On Tuesday Sir Herbert Jekyll presided over a conference of local authorities of West Middlesex relative to the adoption of a set of by-laws giving them power to control the service of the London United Electric Tramways. Twickenham, Chiswick, Brentford, Hanwell, Teddington, Hampton, and Hampton Wick districts were represented. The President said that some districts wanted the electric cars to run at speeds above the Board of Trade standard, some below. The Board recognised that the code, as it applied to old horse tramways, was quite inoperative in the altered condition of electric traction, and they were considering the question of speeds; but there would have to be uniformity. With regard to the distance between travelling cars, all the authorities agreed to 50 yards, with the exception of Chiswick, which wanted 150. The Brentford Council asked for a speed indicator to be on each car, but that was quite impracticable, and would have to be dropped. The suggestion of the same Council that every car should be disinfected once a month to the satisfaction of the local authority was *ultra vires*. Mr. Clifton Robinson, for the company, said they would welcome the invention of a reliable speed indicator, and would give a bonus of £500 for one.

Belfast.—An application came before the Judicial Committee of the Privy Council in Dublin on Friday on behalf of the Cavehill and Whitewell Tramway Company, Belfast, for power to increase the capital of the company. Mr. Ronan, K.C., for the company, said the application was not opposed now, although opposition had been threatened by the British Electric Traction Company. The Cavehill and Whitewell Tramway Company in 1881 and at different times had obtained further capital and borrowing powers by amendment orders. The tramway was a little over three miles in length, and ran from Chichester Park, Antrim-road, out to the suburbs of the city. The line was worked by horse power, and it was sought to reconstruct the line and work it by electric power. In the parliamentary session of 1901-2 the company, in conjunction with the British Electric Traction Company, promoted a Bill which authorised the capital to be increased by £33,000, and the borrowing powers by £11,000. The entire capital then amounted to £45,000, which was more than sufficient to have the work carried out according to the estimate, which placed the cost at £40,000. Subsequently, however, the estimate was increased to £57,000, and they wanted power in order to meet this to increase the capital by the issue of 22,500 new ordinary shares, and to increase their borrowing powers by £7,500. The Act of 1901 did not provide for the additional capital, but this was purely an oversight. The Lord Chancellor, in giving the decision of the committee, said they would not remark on the merits of the case, but they could not accede to the application on the question of jurisdiction.

Bradford.—In their annual report for the past 12 months, the Tramways Committee of the Corporation state that the route length of the tramways worked by the Corporation has increased from 39 to 45 miles. The car mileage has increased by 1,719,898 miles, and the receipts show an increase of £68,984. There are 206 cars, fully equipped, 187 of which are now in service. The lowering of certain fares from 3d. to 2d. and the alteration made in regard to workmen's fares have been attended with satisfactory results. The receipts for the year ending Aug. 31 last amounted to £183,648, as compared with £114,664 last year, the average per car mile being 10·12d. The number of accidents for the year ended Aug. 31 last is 1,168. It is with pleasure the committee note that out of this number there have been no fatal accidents. Forty-four million passengers have been carried on the cars during the 12 months. The wages and working conditions of drivers and conductors have not been varied from last year. The "class" system of working and the payment by the hour have been found to work very satisfactorily, and now that the men have been thoroughly trained the committee believe they have an excellent staff of employés, who know their work thoroughly and do it well. The total staff numbers 901, against 826 last year, and 215 in 1901.

Ramsgate.—The Board of Trade has issued Lieutenant-Colonel von Donop's report on the accident which occurred at Ramsgate on Aug. 12. While an electric tramcar travelling from Margate to Ramsgate was descending Bellevue-road the driver lost control of it, and it came into collision with another car travelling in the opposite direction. Over 30 passengers were injured, two seriously. Lieutenant-Colonel von Donop says that the driver, by his account, manipulated his brakes in a most unskilful way, and it was to his want of skill that the accident must be to a great extent attributed. He had had considerable training at the work, but both his action and his evidence showed that he did not understand the working of the rheostatic brake. It was, however, specially with the view of preventing drivers losing control of cars that Major Pringle, in his report of Oct. 12, 1901, recommended the provision of slipper brakes, so that these might be applied before commencing to descend steep gradients. The 40 four-wheel cars belonging to the company had, it was stated, all been equipped with slipper brakes, and since there had been no cases of runaways with those cars. But the brakes fitted to the 20 eight-wheel cars could not be so applied, and it was to this defect that this accident must also be attributed. Until the company fitted these eight-wheel cars with slipper brakes, which could be applied before the car started to descend a steep gradient, he did not consider that Major Pringle's recommendation had been properly carried out. The company pointed out that the provision of such brakes was a matter of great difficulty on account of the arrangement of the wheels on these eight-wheel cars. This might be so, but the problem must be faced or the use of these cars be discontinued.

Electrification of Steam Railways.—In its annual report recently issued the Massachussetts Railroad Commission gives a useful account of the experimental steps which have been taken by various railway companies in America towards the substitution of electricity for steam. While looking favourably upon such movements, the Commission thinks that the steam railroad is not likely to give way to the electric railroads in the immediate future, and says "it is idle to suppose that the end can be hastened by legislation." In dealing with the entire railroad system, the report remarks, there is the frequent and infrequent passenger and the frequent and infrequent freight service, the light and the heavy trainload, the short and the long distance haul, the traffic with many and the traffic with few stops, and the complicated freight and passenger terminals. It is evident that these conditions present serious questions affecting both safety and expense in considering an electric equipment. The use of a single motor, carrying its own fuel, distinguishes steam transportation; while the peculiar feature of the electric system is the fact that the power is generated at one or more central stations and transmitted for considerable distances. The principal economy in the use of electricity is in the opportunity to generate power in large units under the most favourable conditions; its waste is in distribution at expense and loss. The greatest electrical economy is secured when the load upon the line consists of a large number of small units—small trains at short distances apart—equally distributed; the least favourable condition is when the load upon the line consists of a small number of large units at long distances apart. As the development of the passenger business, through increased frequency of the short-distance services, has been in the direction of the greatest electrical economy, while the development of the freight business, through the increase in the weight and decrease in the number of trains, has been in the direction of the least electrical economy, it is clear that the most favourable field for the introduction of electricity is in the passenger traffic. It is almost wholly in this field that the possibilities of an electric service upon railways are exhibited in different places in this and other countries with varying degrees of success. The service is found upon certain branch or suburban lines, where increased facilities for transportation combined with reduction of fare have brought a large increase in the volume of traffic. Whether a given enterprise has proved profitable it is often difficult to determine, but it is safe to lay down the general rule that a field for the development of a very large traffic with frequent train service has been shown to be essential to satisfactory results. Upon every hand it is apparent that agencies are at work to develop the application of electricity so as to permit more and more its substitution for steam in the general operation of railroads. No incitement to pushing forward these undertakings can be more effective than the stimulus of self-interest on the part of those anxious to instal the electric in the place of the steam plant, and on the part of those eager in the handling of transportation

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to make use of every real advance in methods. It is idle to suppose that the end can be hastened by legislation in the effort to compel capital to follow experiment more closely than business prudence dictates.

New South Wales Tramways.—The report of the Railway and Tramway Commissioners of New South Wales for the year ended June 30 last has just reached us. We gather that on that date there were 124½ miles of tramways open for traffic, the capital expenditure on which amounted to £3,371,587. The earnings during the year amounted to £752,034, being an increase of £120,277 over previous year, and the working expenses, which include over £20,000 to meet the reduction of the working hours of the running staff, to £654,165, being an increase of £112,181. The interest on the capital invested on lines open for traffic, calculated at 3·552 per cent.—the average interest paid on the State debt—calls for £117,265, and the balance, after paying all working expenses, amounts to £97,869, the result being a deficit of £19,396. The permanent way, the Commissioners state, has, as well as the rolling-stock, machinery, electric plant, and buildings, been efficiently maintained during the year. Owing to the conversion from steam to electric traction, a larger amount of relaying has been necessary. Seven miles 23½ chains of 42lb. rails were relaid with 60lb. T-rails, and 1 mile 68 chains with 83lb. girder rails, and the cost has been charged to working expenses. 26,000 tons of metal have been used in maintaining the lines, as compared with 18,816 tons the previous year. During the 12 months 24 electric cars, paid for out of working expenses, replaced 24 steam cars and three steam motors. The total amount of steam stock replaced to June 30 this year by electric cars is 111 cars and 26 motors, at a cost of £82,677. The cost of the old stock was £82,458. 160 electric four-wheel motorcars and five service trucks have been added to the stock during the year and charged to capital. 130,405,402 passengers were carried, as compared with 108,135,111 in the previous year—an increase of 22,270,291. The conversion of eight steam lines to electric traction during the year necessitated a large increase in the amount of electric power generated at the main power-house at Ultimo. An extensive addition to the plant has been completed, and the output has advanced from 1,235,455 to 2,826,126 Board of Trade units. In this connection the three-phase power transmission system, with five sub-stations for distribution of the required electrical energy to the various sections at Sydney, Newtown, Randwick, Waverley, and North Sydney, has been brought into operation. A further extension of the power-house has been put in hand, a considerable portion of the steel structural work having been erected and made ready for the reception of the new plant to be installed. Attached we are able to give a comparison of the figures for the years 1903, 1902, and 1888 respectively. Amount expended on construction and equipment—1903, £3,371,587; 1902, £2,829,363; 1888, £877.244; cost per mile open, including workshops and rolling-stock, £27,090, £27,220, and £22,786 respectively; miles open for traffic, 124½, 104, 38½; average miles open for the year, 116½, 96½, 38; earnings, £752 034, £631,757, £236,519; working expenses, £654,165, £541,984, £219,196; balance (after paying working expenses), £92.869, £89,773, £17,323; percentage of profit to capital invested, 86·99, 85·79, 92·67; earnings per average mile open, £6,455, £6,546, £6 224; working expenses per average mile open, £5,615, £5,616, £5.768; return per average mile open (after paying working expenses), £840, £930, £456; earnings per tram mile, 1s. 1¼d., 1s. 4¼d. 3s. 4¾d.; working expenses per tram mile, 11½d., 1s. 2d., 3s. 1¾d.; return per tram mile (after paying working expenses), 1¾d., 2¼d., 3d.; number of passengers carried, 130.405,402, 108,135,111, not obtainable; tram mileage run, 13,695,630, 9,344,164, and 1,388,786. For the quarter ended Sept. 30 last the revenue amounted to £185,840, as against £166,900 in the corresponding quarter last year; and the expenditure to £159,239, as compared with £143,528.

London County Council.—Since the London County Council have withdrawn the electric cars from the cable section between Kennington and the Streatham terminus, passengers desiring to journey through to the London termini, or *vice versâ*, by tramcar have to change cars at the junction of the electric and cable systems. This, we regret to hear, has given rise to much inconvenience and loss of time to passengers, especially to those who avail themselves of the tram service to reach their places of business in the City. We are informed, and believe it to be quite within the facts of the case, that often passengers coming from the Brixton and Streatham districts have to wait 10, 15, and 20 minutes at the Kennington junction before they are able to proceed on their journey townwards in the electric cars. The reason for this is not that the number of cars running is insufficient, but that the service is most irregular. For instance, it is no uncommon sight to see four, five, or six "Westminster" cars running in succession and leaving Kennington on the return journey comparatively empty, while large numbers are awaiting the arrival of a "Blackfriars" car to carry them to their various destinations lying in that direction. When at length it does come there is an unseemly rush for seats. Sometimes it is the other way about, and passengers wanting to get to Westminster have to wait an equal length of time before their car arrives. Necessarily a change of cars must entail delay, but we think that if the connections were managed better the inconvenience would not be unduly resented by the public. As it is, there is much grumbling, and not without good cause. It is stated that the electric cars will commence to run from the London termini as far as New Cross on Jan. 1. At the usual weekly meeting of the Council on Tuesday the Highways Committee had on the agenda various reports referring to the tramway undertaking. These showed that arrangements are being made for the provision of car-shed accommodation at New Cross and Wandsworth. In the first case the committee asked for authority to spend £850, in addition to the £11,500 already sanctioned, for the acquisition of property for the purposes mentioned, while in the second a Bill is to be promoted next session for the compulsory purchase of certain property in Jews'-row, Wandsworth, with the same object. The following report was presented with reference to the tramway reconstruction in South London: "Certain preliminary expenditure will have to be incurred in making surveys, preparing plans, etc., in connection with the various tramway works which are in immediate contemplation. These include the reconstruction of the Streatham cable tramways, a work which it is imperative, in the interests both of the general and of the tramway traffic, should be carried out with as little delay as possible, and the extension of the tramways from the present terminus in Tooting High-street a short distance along Defoe-road, in order to provide a fresh terminus, which is urgently needed, for the Tooting tramways. Some small expenditure will also be required for making surveys, etc., in connection with tramways south of the Thames which the Council have given notice to purchase, and in prosecuting enquiries with regard to undertakings which they will shortly be in a position to purchase should it be so decided. To cover the expenditure necessary to provide the staff with all that will be required to make the surveys, etc., referred to, and to cover other expenses of a preliminary character, the committee suggest that a vote of £2,500 should be passed. This course was adopted previously to the work of the reconstruction of the New Cross and Greenwich sections of the tramways being put in hand, and was found to be a convenient one. Ultimately the various items of expenditure proposed to be incurred will be charged proportionately to the respective works to which they properly relate." The committee had sent to the Finance Committee an estimate of the amount named, and recommended that the estimate of £2,500 submitted by the Finance Committee be approved, and that the Highways Committee be authorised to incur that expenditure on capital account up to that amount. The committee also brought forward a report with regard to alteration of mains in Tower Bridge-road. It stated that in connection with the construction of the tramway in Tower Bridge-road, authorised by the Council, which is at present being carried out, it will be necessary to arrange for the removal or alteration of certain pipes, wires, etc., under the carriageway. Certain of these mains are those belonging to the Bermondsey Borough Council as part of its electric lighting undertaking, and the Borough Council have received notice from the contractors, Messrs. W. Griffiths and Co., to remove the mains referred to, in order to provide sufficient depth in the carriageway for the construction of the electric conduits for the tramways. The Borough Council suggests that the mains to be removed should be placed as far as possible in the Tower Bridge-road subway and its laterals, but the committee think that the best and least expensive course to adopt would be to carry the mains by the shortest route through the arch of the subway. The cost of the work will have to be borne by the Council as part of the cost of the construction of the tramways. The committee accordingly recommended that permission be given to the Council of the metropolitan borough of Bermondsey to carry out the necessary alteration of the positions of their electric lighting mains in Tower Bridge-road in consequence of the construction by the London County Council of tramways along that thoroughfare, such permission being subject to the mains being laid by the shortest route through the arch of the subway and to the work being carried out in all respects to the satisfaction of the Council's chief engineer.

LIGHTING AND GENERAL.

Falkirk.—The Town Council are about to make a few extensions of electric light mains.

Luton.—The Guardians have decided to substitute electricity for gas at the workhouse.

Hammersmith.—The public lamps in Great Church-lane are to be supplied with electricity in place of gas.

Cardiff.—The Corporation have obtained permission from the Marquis of Bute to lay a cable through his estate.

Hanwell.—The District Council having decided to obtain an electric lighting provisional order, the draft of same has been approved.

Penrith.—A scheme for the electric lighting of the town at a cost of £7,500 is under consideration by the Urban District Council.

Melksham.—An agreement relating to the license of Messrs. Tilke and Smith to lay electric mains in the urban area is under consideration.

Huddersfield.—The Electricity Committee in their last report state that the number of consumers is now 1,835, and lamps connected 127,690.

Tobercurry.—The District Council have granted permission to the Tobercurry Lighting Committee to erect poles and wires necessary for the lighting of the town.

Benfieldside.—An offer from the electric supply company to tender for the lighting of the district for the season 1904 and 1905 is before the Lighting Committee.

Salford.—The Council propose to apply for sanction to borrow £10,000 to cover the cost of the purchase of motors to be hired out to the public, as authorised by the Corporation.

Bradford.—It is expected that the Sunbridge-road dust destructor, now being erected by the Horsfall Destructor Company, will have 500 h.p. available for electric lighting purposes.

East Ham.—From Jan. 1 next current will be supplied to private consumers at 4½d., and to places of public worship at 4d. per unit, which is a reduction of 1d. per unit on each rate.

Lowestoft.—We understand that the next report of the Electric Lighting Committee will deal with the question of free wiring and a flat-rate system of charging as against the present maximum demand method.

Rosario Electric Co.—In their report for the period to June 30 last the directors recommend a dividend on the preference shares at the rate of 6 per cent. per annum, calculated from the due dates of instalments to June 30 last.

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Ladysmith.—We referred to the opening of the Corporation's electric light works in our issue of Sept. 25, and now learn that already the engineer, Mr. J. Stanley White, is putting down an additional set equal to the two at present running.

Thornbury.—Steps are being taken by a syndicate to secure a Bill for the sole supply of electric power in that part of the Rural District Council's district not already allotted. The Council have, however, decided to obtain these powers themselves.

Gillingham.—The Parish Council have instructed Messrs. Parry, Ross, and Richards to make a preliminary canvass and survey of the parish, and to submit a report with estimates of the cost of electric lighting for the further consideration of the Council.

Wrexham.—On Tuesday the electrical engineer presented a scheme for the extension of the electric light cables, the approximate cost of which will be £4,500. The question of applying for sanction to the borrowing of £4,500 has been referred to the Finance Committee.

Ludlow.—An enquiry has been held into an application of the Town Council for sanction to borrow £8,250 for purposes of electric lighting and the provision of a refuse destructor. The Council were represented by Mr. J. H. Williams (town clerk) and Mr. Parker, C.E., Hereford.

Wisbech.—The Town Council have decided that an expert be consulted with regard to offers from several electric lighting companies to provide an installation for the town. His selection and the fixing of his remuneration in the first instance is to be left to the Electric Lighting Committee.

Sheffield.—The senior students of the technical engineering class of the Owler-lane Evening School on Monday, by the permission of Mr. S. E. Fedden, C.E., visited the electric light and power station. Mr. A. Cuthill (station superintendent) and Mr. F. T. Callis (senior engineer) acted as guides.

Cheetham.—The Urban District Council have asked Mr. A. Slatter to attend a Council meeting on behalf of the electric light company in order to discuss the provision of electric power at the waterworks. The electric light company propose to commence laying the cables as soon as the rain stops, whenever that may be.

Mansfield.—An electrical exhibition was opened on Tuesday afternoon at the town hall by the mayor (Mr. J. Crampton). The exhibition is held in connection with the Corporation electricity department, under the supervision of Mr. W. J. Chadburn (chairman of the committee) and Mr. Hewlett (the engineer).

Calne.—The town clerk has been instructed to reply to the Southern District Electricity Corporation that the Council could not withhold or give their consent to the company's application to supply Calne with electricity, as they were at present considering whether they should not make a similar application to the Board of Trade.

Elland.—During the weeks passed since the opening of the electricity works, the consumption of current in the town has reached for each night an equivalent of 800 8-c.p. lamps We understand that during the week everything has gone satisfactorily at the station. The Council intend to offer current at 3d. per unit for lighting places of public worship.

Pitlochry.—A project for introducing the electric light is again under consideration, and the details of the scheme are said to be now very fully arranged. It is understood that Mr. John Leonard, architect, is one of a number of local gentlemen who have interested themselves in the matter. The motive power will be derived from the River Tummel.

Finchley.—The supply of electricity to North Finchley commenced on the 29th ult., and a supply from dusk to 12.30 a.m. was maintained until the 8th inst. Since that date the supply has been uninterrupted. East Finchley has been permanently supplied since the 9th inst., and Church End since the 12th inst. Sections of the mains in each of the three districts are being connected.

Glengarnock.—At a meeting of the ratepayers last week it was decided to form a lighting district co-extensive with the water district, which will extend from the new railway, Kilbirnie, to Langbar. The Glengarnock Iron and Steel Company are willing to supply electric light at 5d. per unit, and it is estimated that the cost of the installation and lamps will not exceed 2½d. per £1 on owners and the same on occupiers.

Paddington.—The Metropolitan Electric Supply Company are laying electric mains along Maida-vale. At the last Council meeting the Joint Works and Electric, Gas and Water Committee submitted a report on the whole question of the lighting of the borough, and recommended that no action be taken at present with a view to lighting any of the streets of the borough with electricity. This was agreed to without discussion.

Bermondsey.—The Electric Lighting Committee's recommendation that it be an instruction to the Baths Committee to adopt the report of Messrs. Kincaid, Waller, and Manville, in conjunction with the borough treasurer's report thereon, for the heating of the Bermondsey baths by exhaust steam, came before the Council last week. The expense would be £2,020, and the matter will come before the new Baths Committee next month.

Stock Exchange.—The Stock Exchange Committee have appointed Nov. 5 a special settling day for Peebles (Bruce) and Co.'s 20,000 6 per cent. cumulative preference shares of £5 each fully paid, Nos. 20,001 to 40,000. The committee has ordered the said securities to be quoted in the official list. The committee have also been asked to allow Eastern Telegraph Company's further issue of £44,435 3½ per cent. preference stock to be quoted in the official list.

Aston.—The sub-committee appointed by the Council as a deputation to visit and inspect the combined electricity station and dust destructor at Wrexham last week reported that, as the members present could not agree upon a unanimous decision, it resolved to prepare two separate reports. It was decided to take these reports at the same time as the reports of Mr. W. H. Trentham and Messrs. J. and J. S. Enright, adjourned from the special meeting of the Council held in May.

Dundee.—Following the example of the North British Railway Company, the Caledonian authorities have completed arrangements for the introduction of the electric light at Dundee West Station. In addition to the passenger platforms, the goods department and the busier sidings will be equipped with the new illuminant. The arrangement, like that at Tay Bridge, provides for the supply of current from the Corporation works, the installation being carried out by the company's engineers.

Stirling.—The last report of Mr. A. C. Hanson, electrical engineer, shows that for the four weeks ending Oct. 3 15,768 units were generated, as compared with 14,165 for the same period in 1902. The total number of equivalent 8-c.p. lamps connected to date was 11,145 against 9,710 at the same period last year. A new distributing cable has been laid. Several Nernst lamps have been erected in place of gas lamps; others are being converted. A number of new applications for motors and lighting supply were recorded at last week's meeting.

Arbroath.—The special committee of the Council appointed to deal with the proposals from several electric lighting companies, and to ascertain the best terms upon which any one of these would be prepared to take over the order and carry out the work, have agreed to recommend that the proposals of the Empire Electric Light and Power Company, Limited, London, should be accepted. The company will take over the order at a price which will not involve the town in any loss, and will complete the installation within 12 months.

Whitby.—The following interesting particulars have been ascertained by the committee of the Whitby Conservative Club in connection with the respective costs of electricity *v.* gas, the former of which illuminant was recently installed in the club premises on Marine-parade. During the past quarter 146 units—38 of which were charged for at the rate of 8d. per unit and 108 at 2d.—were consumed, making a total charge of £2. 4s. 10d. for the quarter. The cost of gas for the corresponding quarter of last year was £3. 1s. 5d. The introduction of electric light has, therefore, effected a saving of 16s. 7d. on £3, which is considered very good business.

Long-Distance Telephones.—Communication is now practicable between Cardiff and Brussels and neighbourhood, but not with any other town in Belgium. The charge is 8s. for each period of three minutes' communication, and the service is only open to Post Office subscribers making use of the Post Office call offices. Conversations by subscription are allowed by night at half rates for a period of not less than six minutes. Formal sanction by the French Administration having been given to the arrangements, communication will now be practicable between Cardiff and Paris (including the suburbs), Orleans, and Rouen. The charge for communication is the same as that for Belgium.

East Molesey.—Edmundson's Electric Light Corporation have offered to insert the following clauses in the proposed provisional order: (1) to give the Council the right to purchase the undertaking at a valuation as a going concern at the end of 7, 14, or 21 years; (2) to supply electricity to private consumers at the following rates, 7d. per unit for the first hour per day at the maximum demand, or its equivalent, and 3d. per unit for any further quantity. Furthermore, as it cannot be a clause in the order, they would be prepared to enter into an agreement to supply electricity for public lighting at a price not exceeding 2½d. per unit. The Council have abandoned their own proposal for obtaining an order, and have decided to consent to the above clauses.

St. Pancras.—The London County Council have informed the Council, with reference to the application for a loan of £30,000 for electric lighting purposes, subject to the Borough Council agreeing by resolution to provide out of a sinking fund established for that purpose or from maintenance account, for all renewals and replacements during the currency of the loan of any of the plant and machinery provided with the proceeds thereof, they are prepared to advance £23,960 of that sum upon the terms that it is taken up at once and repaid with interest at the rate of £3. 15s. per cent. per annum, calculated quarterly, by equal half-yearly instalments of principal and interest combined, within 42 years from the date of the advance, and that the Borough Council pay the cost of the loan.

Worthing.—The borough surveyor estimates the cost of the proposed refuse destructor, including the engines, boilers, and other plant, tenders for which have already been provisionally accepted, at £5,600, and the Council will apply for sanction to borrow this sum. The destructor building will be sufficient to admit of the destructor being extended to double the capacity of the plant now proposed to be put down. The Council have decided that the fixed charge for lighting purposes to private consumers remain at the present rate of 6d. per unit, but that from and after the commencement of the new year the table of discounts allowed in respect to current supplied for lighting purposes should be as follows: 1,000 up to and including 5,000 units used per annum, 5 per cent.; and over 5,000, 10 per cent.

Camberwell.—At the last meeting of the Council the application of the County of London and Brush Provincial Electric Lighting Company, Limited, to place a transformer box in Burbage-road, near the corner of Half Moon-lane, was granted, subject to any disturbance of the footway or roadway being made good to the satisfaction of the borough engineer, and subject to an undertaking by the company that should the site or any portion thereof or the works connected therewith be required for public purposes, the company will pay the cost of removal or of any alterations. A letter has now been received from the company stating that they cannot possibly accept the condition the Council has made, and that there is no alternative but to submit the matter to the Board of Trade unless the condition be withdrawn.

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St. Olave (Southwark).—The workhouse is to be lighted by electricity instead of gas. The total cost of gas for the workhouse for the year ending Lady Day last was £483, of which it was assumed one-fourth was required for cooking purposes. Upon an average two-thirds of the lights—370—will burn three hours daily, and consume 45 units of electricity, the cost of which at 3½d. per unit amounts to 13s. 1d. per day, or, say, £240 per annum. The difference between the cost of gas (£365) and electricity (£240) is, therefore, £125. The Salisbury Electrical Engineering Company, of Lee, have obtained a contract for £365—providing 370 lights and 188 switches. The current is to be taken from the Borough Council.

Share Market.—More attention is given to electric lighting shares just now, and many cheap securities are obtainable, yielding from 3¾ to 4¾ per cent. on the money invested at present quotations South London Electric shares have been favoured during the last few days owing to a remarkable increase in the amount of current sold by this company, which in its early days had many troubles to overcome, and still suffers from original over-capitalisation. One reason for the increase in consumption is that the South London Corporation has secured a useful temporary customer in the London County Council. During the time occupied by the building of the Council's own power-house, the South London Company supplies the energy to the London County Council's trams. The arrangement lasts for some 18 months yet.

Dumfries.—Messrs. Frank Suter and Co., Limited, London, acting in co-operation with three other manufacturing firms, have offered to the Town Council to carry out an electric light installation for the town on the following terms: that the Council provide the capital, amounting to £16,300; that the company carry on the undertaking, and pay to the Council the full interest on capital and sinking fund charges, and shall also pay over annually half of the profits, but under reservation of a right to charge a loss incurred at any time against the profits of subsequent years; that the company and the firms associated with them enter into an agreement guaranteeing the Council against any loss; and that the Council be entitled to take over the works at any time without payment of any premium on giving 12 months' notice. It is proposed to employ the Dowson power gas in generating the electricity.

Fulham.—The electrical engineer to the Borough Council has reported that as a result of his investigations he had come to the conclusion that it was necessary to at once put in hand the construction of two new sub-stations, one in West Kensington and the other in Fulham-road at its junction with Munster-road. It was also necessary to add to the present high-tension feeders supplying Jerdan-place. The total cost of these works would be £2,050. It was agreed by the Council to put the work in hand. At the present moment constructional and other works involving capital expenditure are practically suspended owing to the fact that the triennial elections for the borough councils take place next Monday, and also because the County Council have urged upon the local councils the necessity of suspending, as far as possible, further works out of capital expenditure until the money market is in a more satisfactory condition for the Council to borrow.

Erith.—The Electric Lighting Committee recommend the erection of a number of ¼ and ½ ampere lamps, and the necessary extensions of the public lighting cables. With regard to a supply of current to Crossness outfall works the committee have considered a letter from the superintendent, Mr. E. J. Beal, enquiring upon what terms the Council would be willing to supply electricity to those works for the day load, and recommend that the Council agree to supply current for the day load at 5d. per unit, or for both the day and night loads, estimated at 140,000 units per annum, at 4d. per unit, provided in each case that the London County Council will guarantee the payment of the minimum sum of £200 per annum for the period of three years. The committee have directed the resident electrical engineer to obtain badges to be fixed to the coats of the staff engaged in the fixing or examination of wires, fittings, meters, etc., upon the premises of private consumers, also to provide oilskins for the outside workmen.

East Barnet.—Progress is being made with the framing of an electric lighting scheme for the district. The Electric Lighting Committee of the Urban District Council have obtained a report of Mr. Warden-Stevens, in which he agrees with Mr. Adams in advising the Council not to allow the electric lighting order to lapse, but he takes a different view from Mr. Adams as to the best way of carrying out the order. Mr. Adams advised the Council to generate and distribute their own light, and to introduce a dust destructor, while Mr. Stevens advises the Council to obtain a supply in bulk, and undertake distribution through their own mains. He thinks that works established in the district would be successful eventually, but recommends the purchase of energy in bulk in the meantime. He does not believe in confining the mains in the first instance to a few of the best roads, and thinks that the means of supply should be given to all within reasonable limits. If the Council undertook the distribution they would see that the interests of the ratepayers were fully safeguarded. The scheme will involve an expenditure of £14,821.

Birmingham.—The Birmingham Tame and Rea District Drainage Board decided on the 27th inst. to apply for sanction to borrow £14 000 for the purpose of erecting a boiler-house, electric generating station, high-tension power transmission line, motors, pumps, transformer stations, etc. In the last session of Parliament authority was given to the Board to sell two acres of land to the city of Birmingham for the purpose of constructing a refuse destructor thereon. In payment for this land the Birmingham City Council agree to generate steam, day and night, capable of actuating one high-speed engine, calculated to give off 175 b.h.p. With this power the Drainage Board, on the advice of their engineer (Mr. J. D. Watson), resolved to lay down an electrical power transmission plant for the purpose of driving motors for farm purposes at Saltley, Tyburn, and Park Hall; and motors for driving five centrifugal pumps, capable of lifting seven million gallons per day, situated at various places along the line of the 8ft. main sewer in the valley of the Tame. Three motors will also be erected at Tyburn for driving machinery in the mechanics' and joiners' workshops. Provision will also be made to drive four rotary sewage distributors at Minworth Greaves. In addition to this there will be provision for lighting at the Board's more important buildings at Saltley, Tyburn, etc. The contract for the provision of the electrical transmission plant has been secured by the British Thomson-Houston Company, Limited, of Rugby, and amounts to the sum of £7,977. 5s.

Accidents.—The electrical engineer of Swansea (Mr. Prusmann), as reported in the *Daily Post*, said the cause of Sunday's failure of the electric light was due to a short-circuit in one of the boxes near the hospital corner. He found on examination it was impossible to tell what was the cause, as all the fittings in the box were entirely burnt up, and there was nothing left upon which to base a conclusion as to cause. The street arc lamps, which have separate cables, were only out for five or ten minutes. Three churches which use the current were in darkness, together with private consumers, for something like an hour and a half. The Empire though, where a sacred concert was held, was reconnected in sufficient time, so that no inconvenience was caused to the concert. This was due to the fact that one of the feeder cables is connected direct into the basement of the Empire. Shortly after eight o'clock (the lights having been out since 6.35), the private lighting was resumed, with the exception of a short length on which the fault actually happened, affecting two or three consumers. There was no delay in the report of the fault. Directly it happened the automatic circuit breaker operated at the station and threw the whole works into darkness. The engines continued to work, and within half an hour the whole staff were either at the station or at the scene of the fault. There was not the slightest confusion, and each of the staff did exactly the right thing. North Shields was last week plunged into darkness through the electric power station being flooded. Local failures were also reported at Jarrow. The resident engineer of Worthing, in his report on the recent failure of certain arc lamps, states that the chief cause of default was due to the dampness of the atmosphere, the effect being to corrode the brasswork and small moving parts of the lamp mechanism, so that the "feed" of the lamp is impeded. On Saturday evening the electric light supply failed at Leicester owing to a short circuit on the switchboard. The main cable conveying the electric light current fused, the switchboard broke down, and the station had to be shut down. Supply was resumed on the following evening. The cellar containing the switchboard is fireproof, so that there was practically no danger. As soon as the man in charge of the board found the "sparking" in connection with the switchboard he telephoned to the generating station at Aylestone, and the machinery was stopped at once. This station has been running now for over nine years, and the mishaps experienced have been quite insignificant.

Manchester.—A good deal has been published about the resignation of Mr. Metzger at Manchester. We have refrained from details till now, and give herewith the report of the discussion in the Manchester Council respecting the same. Mr. Howarth moved the adoption of the Electricity Committee's minutes, with the deletion of the following words from the clause which announced the resignation of the chief engineer: "On the ground of his inability to work in unison with the deputy chairman." Outlining the incidents leading to the resignation, Mr. Howarth said that in January of this year the Electricity Committee of Halifax wrote to the town clerk asking if he would allow the engineer to advise in connection with certain works in progress in that town. This letter was laid before the committee, who found that Mr. Metzger was appointed subject to a condition that he should devote his whole time to the duties of the position. The town clerk of Halifax was informed that Mr. Metzger could not advise his Corporation. He did not see any need to consult Mr. Metzger on the matter, but he subsequently explained to Mr. Metzger that the Corporation could not allow its officials to do outside work. Then the Burslem Town Council approached the chief engineer personally, without consulting the town clerk, and he undertook the revision of their schemes and received for his work 50 guineas. When Mr. Metzger was asked for an explanation by the committee he said he had received the sanction of the chairman. This, Mr. Howarth said, was not the case. Mr. Metzger did write to him, and the impression left on his mind was that someone merely wished to consult him on a technical point, and he did not feel justified in refusing permission for that. If he had known that Mr. Metzger was seeking to augment his salary by outside work, he should have put his veto on the proposal. It appeared that Mr. Metzger had accepted the task of arbitrating between the Trafford Park Power Supply Company and the Electrical Company of Berlin. As the Electric Company were doing a large amount of work for the Manchester Electricity Committee, this action of the chief engineer placed him and the committee in a very invidious position. The matter was discussed by the committee, and a good deal of personal feeling was manifested. Ultimately Mr. Metzger tendered his resignation. It was accepted by the committee, and the words which he asked to be deleted were inadvertently inserted in the minutes. Mr. Howarth concluded by saying that Mr. Metzger had been in the service of the electricity department for two years and nine months. During that period Mr. Metzger had applied himself to the work very earnestly and very successfully. Mr. Burgon seconded the resolution, which was passed without further discussion.

Dalkeith.—The erection of the generating station in Croft-street has been nearly completed, and the streets are being opened for the purpose of laying the electric cables. The contractors, Messrs. Crompton and Co., are at present also introducing electric light installations into Jedburgh, Melrose, and Dollar. The plant will consist of two Crompton 55-kw. belt-driven shunt-wound dynamos, driven by two 80-h.p. high-speed electric light gas-engines by Crossley. The supply of gas to these engines will be provided by two 80-b.h.p. gas-producers, suitable for using anthracite coal. The battery consists of 360 cells,

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The switchboard is of black and white marble. A hand-driven travelling crane by Chatteris, capable of lifting 12 tons, is to be put up as a permanent fixture. There will be one motor and two boosters for charging the battery, all direct-coupled together on one bed, and there will also be one balancer. The supply will be a low-pressure continuous current on the three-wire system, the voltage across the outers being 460. The cables are being laid by Messrs. Callender on the solid system. There will be about 22 arc lamps for public lighting. Consumers will have the option of adopting free wiring.

Bristol.—The Electrical Committee have adopted a report of the Wiring Sub-Committee as to the terms on which the Corporation should undertake free wiring, wiring on hire-purchase terms, and as to the hire of motors. The wiring is to be carried out through local contractors. In the case of free wiring, a percentage on the cost of the installation will be charged as rental, but the amount cannot be fixed until the Local Government Board have sanctioned the raising of the necessary loan. In the case of hire purchase, the committee are prepared to extend the payments over any period up to five years. The consumer will be required to pay 10 per cent. of the cost of the work on signing the agreement, and in the case of a three years' term, 12 quarterly payments, each equal to 8½ per cent. of the cost, with interest quarterly at the rate of 4 per cent. per annum on the principal from time to time outstanding. In both cases the hirer will be at liberty to redeem the fittings at any time on equitable terms. The rates for the simple hire of motors will be reduced at the expiration of the current quarter. The sale of motors on the hire-purchase system will not be undertaken by the committee, because there are manufacturers always willing to sell on those terms. Some months ago the Town Council sanctioned considerable extensions of electric street-lighting, the streets to be so illuminated being chiefly the main thoroughfares leading to the city. The scheme involved the erection of about 300 arc lamps. Some sections have been completed and on Tuesday many of the new lamps were given a trial, evidently with perfect success.

Portsmouth.—The auditors in their last report state that there is a considerable improvement in the system of book-keeping of the electric light department. The revenue account shows an increase in the sale of current of £3,250, whilst the rentals have increased by £200. The gross revenue amounted to £35,282, as compared with £32,295. The expenditure under various headings generally showed increase, the profit on the undertaking being £14,079, as compared with £14,695. The form of the balance-sheet of the undertaking the auditors do not approve. They query certain items in the balance-sheet. As to repayment of loans, while the auditors are satisfied that at the present time the annual instalment of loans raised by issue of stock are correctly charged, and will with their accumulations suffice to meet the principal amounts due at the end of the number of years for which the loans were sanctioned, they are not satisfied that the same is the case in regard to the loans from the bank and to the advances by the treasurer through the capital cash account. They do not consider that interest has been fully charged each year against the revenue of the undertaking, and that owing to this omission the balance on the net revenue account is made to appear at a sum of at least £1,200 in excess of the true figure. Dealing with the figure in the accounts for depreciation, the auditors submit a basis for calculation. As they truly point out, the accuracy of the balance-sheet depends on the actual depreciation being provided for in the accounts. They also discuss certain items which have been charged to capital expenditure. To put the accounts of the undertaking upon a really proper basis, the auditors consider that one correction is essential, and a second is very desirable. First, the amount of interest charged since the commencement should be looked into, and to the extent that the undertaking has not been charged with full interest, its so-called reserve fund should be applied to correct the errors that have taken place. Secondly, the figures for a depreciation fund should be submitted to an expert, who should advise the Corporation what alterations, if any, should be made therein, and, if necessary, make a valuation of the machinery and plant. The result of his decision should be thereupon included in the accounts, so that it may be clearly seen what is the true position of the undertaking, and whether it is, in fact, paying its way or otherwise. On the electric lighting account a further sum of £16,384 on capital account was expended during the year, making a total expenditure of £218,446. The total in the loans fund for the extinction of debt now stands at £24,369, and £12,177 has been repaid. The income of the revenue account was £35,282, as against £32,295 The expenditure was £21,203, as against £17,589. Mr. Bone considers this does not compare favourably with the previous working, when the increase of revenue was over 18 per cent., while the expenditure showed a slight decrease. The increase in the expenditure is mainly under the heads of generation of electricity and repairs.

Aberdeen.—The plans of the new subway, the accepted tender for which is mentioned in another column, have been prepared in the burgh surveyor's department under the personal supervision of Mr. Dyack, burgh surveyor, and his assistant, Mr. Conway, both of whom have had practical experience of this work. The *Aberdeen Daily Journal* says: Near the top of Crown-street there will be a spacious distributing chamber, lined with white glazed brick. From this chamber, cables may be taken in any direction required. The subway itself is to be of a horseshoe shape, 6ft. 6in. in height by 4ft. 6in. across, so that it will scarcely be so big as the one from the electricity works up Crown-street. It will be built of concrete, lined with red brick, and protected from damp by means of bitumen sheeting, as in the existing subway. Its total length will be some 700 yards. In the construction of this tunnel several difficulties will have to be contended with, as, for instance, dealing with and diverting sewers, etc., which come in the way, one of them being the main sewer, which will have to be lifted and relaid. On the other hand, the difficulties will be much less formidable than were encountered in laying the Crown-street tunnel, for then part of the new main sewer, which is to have its outfall at Girdleness, had to be constructed at the same time beneath the electric cable subway; and having a comparatively level piece of ground to deal with from Crown-street to Holborn-street, the contractor, Mr. Tawse, should be able to make a very satisfactory job, as he did under more difficult circumstances with the Crown-street subway. Along the route there will be, among several new features, connecting chambers at Bon-Accord-street and Bon-Accord-terrace, provided so that cables may be taken towards Union-street or elsewhere for future extension. Another new feature is that, instead of the subway being entered from the centre of the street, entrances are to be provided from the footpaths so that on having a cover opened there anyone may get into the subway by a short passage. Near the top of Holburn-street there will be another distributing chamber from which cables may be taken either up or down Holburn-street to Albyn-place, etc. This chamber also will be lined with glazed white bricks. Here a ventilating fan, electrically worked, will be erected, so that the tunnel will be kept well ventilated. There will also be plenty of light from the electric lights which will be placed throughout the tunnel in a manner similar to those in the existing subway. The cables will be carried on a cable rack rather different in design from the present one in Crown-street. This rack will be prepared by the Corporation electric department. The subway will hold 52 cables, but will be so arranged that a dozen or more may be added without any difficulty should necessity arise for them. In the subway they will be safe from damp or other damage, while if anything should go wrong, the workmen walking through the subway could give it their attention. The work, which will be commenced almost immediately, will probably be carried on in two or more sections at one time, so that operations may be completed in an expeditious manner.

Barnstaple.—The charge for public lighting is to be 6d. per unit up to the end of the current year. The Council are producing electric current at 2·1d. This does not include interest and sinking fund, but the difference between 2d. and 6d. will be more than ample to provide for it. The Mayor submitted the following address at the last Council meeting: "Gentlemen,—As so many misstatements have been made concerning the financial position of the borough, it is my duty and privilege to place before you and the ratepayers a statement thereon, particularly with regard to the electric lighting undertaking. I find that on April 26, 1901, estimates were prepared by your engineer for lighting what is termed the compulsory area, and such estimates amounted to £21,450, which included contingencies such as engineer's fees, costs of the provisional order, and legal expenses; £21 600 was borrowed. The contracts for the work amounted to £14,657. 7s. 6d.—viz: Bryant and Thorne, for building, £3,789; Babcock and Wilcox, for boilers, £3,012; Newton Electrical Company, for engines and dynamos, £4,235. 6s.; St. Helens Cable Company, for mains, £2,001. 11s. 6d.; Ashmore, Benson, and Co., for accumulators, £1,031. 10s.; Chatteris Engineering Company, for crane £115; Tucker, for laying water-pipes, etc., £448; Johnson and Phillips, in lieu of contract for well, £25—total, £14,657. 7s. 6d. To this there are extras on the various contracts, which I propose dealing with in detail. The first is that on buildings. These extras amounted to £1,574. 16s., and are arrived at thus: increased expenditure on foundations, caused by extra excavation in some parts to a depth of 15ft. at least, £482; substitution of white for red bricks for facing of building, and for increased height of walls, £57. 17s. 9d.; construction of condensing pit, in consequence of the substitution of surface condenser in lieu of ejector condenser provided for, £46. 0s. 5d.; increased strength of roof principals, £53; additional 3ft. on boiler-house, £60; new side walls, owing to dilapidated condition of old walls, £420. 0s. 6d.; sundry work in connection with engineers, £68 4s. 8d.; substitution of brick for stone for walls of boiler-house, £81. 13s. 1d.; felting for roof and improvements in engine-room, £68. 16s.; pumps in boiler-house and other sundries, £237. 3s. 7d. — total, £1,574. 16s. I ought here to say that these extras appear somewhat heavy, but I am informed that they are according to the scheduled prices mentioned in the contract and specifications, and that careful and accurate measurements were made by a competent quantity surveyor acting for the Council, and there can be no doubt full value for money has been received. Boilers, £709. 1s. 4d.; extra for surface condenser in lieu of ejector condenser, £550; donkey pump, £14. 13s.; stanchions under tank, £17. 10s.; extending exhaust piping to end of building to avoid alterations when new engine required, and sundries, £126. 18s. 4d.; engines and dynamos, £214. 8s. 2d.; recording voltmeter, £15. 12s.; motor for economiser, £26. 13s.; meters, £70; extra length of cables and sundries for connecting dynamos to switchboard, £102. 3s. 2d.; mains, £1,295. 8s. 11d.; laying cables each side of High-street, Joy-street, and Cross-street, to avoid repeated interference with wood paving by crossing, £426 4s. 8d.; house services, £269. 19s. 1d.; cable through North Walk, £47. 7s. 7d.; two extra arc lamps and sundry cable work, £551. 17s. 7d.; accumulators, £29. 17s. 3d.; for cable to connect regulating switches on switchboard instead of on wall in battery-room; crane—extra length of rail, £17. 10s. The foregoing extras, it will be observed, could not be foreseen, but as the works proceeded it was considered desirable, for the better management and equipment of the station, that they should be carried out, there being a surplus available. There are other items expended which had nothing whatever to do with the contracts, but which must be placed to the capital of the undertaking. They are: clerk of works, etc., £91. 19s. 9d.; cost of trials of machinery, £40. 3s. 2d; switchboards for meters, £16. 9s.; fuse-box services on mains, £26 4s. 1d.; Board of Trade fees, costs of provisional order, mortgagor and mortgagee's costs on loan, official advertisements, Mr. Adams's and Mr. F. W. Chanter's fees for preliminary reports, first cargo of coal for drying and testing purposes, etc., £597. 19s. 2d.; engineer's fees and expenses, £1,125; instruments for station, £48. 14s. 4d.; service lines, meter fixing, and miscellaneous, £43 7s. 5d.—total, £1,989. 16s. 11d. The total amount, therefore, charge

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able to capital is £20,488. 6s. 1d.—viz.: contracts, £14,657. 7s. 6d.; extras on buildings, £1,574. 16s.; extras on boilers, £709. 1s. 4d.; extras on engines and dynamos, £214. 8s. 2d.; extras on mains, £1,295. 8s. 11d.; extras on accumulators, £29. 17s. 3d.; extras on cranes, £17. 10s.; extras on miscellaneous items outside contracts, but chargeable to capital, £1,989. 16s. 11d.—total extras, £5,830. 18s. 7d. It will be seen that the total amount of the contracts, extras, and incidentals properly chargeable to capital is below the engineer's estimate, and below the amount you were authorised to borrow. A far better station than was at first intended has been erected. Experts say it is one of the best in England. You have a better building, improved condensing plant, cables laid on both sides of High-street, Joy-street, and Cross-street, and extra public lamps. The Council is accused of frittering away thousands of pounds of the ratepayers' money in this undertaking. Now what is the result? As I have before stated, the original estimates amounted to £21,450. To this should be added the cost of work which was not intended to be executed at the time the estimates were made, but, in consequence of the careful management by the engineer and the Council, whereby favourable contracts were entered into, these extra works have been carried out at a cost of £2.218. 18s. 5d., that being the extra amounts to Babcock and Wilcox, the Newton Electrical Company, and the St. Helens Cable Company, without seeking further borrowing powers. Further, there is the difference between the cost of well and Tucker's contract, amounting to £209. Notwithstanding the two latter amounts being charged to capital, there is a balance of £1,111. 13s. 11d. to the credit of capital account not expended as originally contemplated, so that instead of exceeding the amount borrowed a saving of £3,379. 12s. 4d. has been actually effected on the undertaking, as follows: to amount of estimates, £21,450; add works not contemplated—to Babcock and Wilcox, £709. 1s. 4d.; to Newton Electrical Company, £204. 8s. 2d.; to St. Helens Cable Company, £1,295. 8s. 11d.; difference on well and Tucker's contract, £209—total, £23,867. 18s. 5d. Amount actually expended, £20,488. 6s. 1d.—balance, £3,379. 12s. 4d. Besides all the expenditure for improved building, clerk of works, trials of machinery, instruments at station, first cargo of coal, and other items. I am not overlooking the fact that a considerable sum has been paid for meters and connecting same which should be debited to capital (and this is a daily expenditure in consequence of the application for current), but this will be a source of revenue to the undertaking, and the larger the demand for meters the better for the undertaking. A large sum has also been expended in public lighting not included in the before-mentioned contracts, and this is a matter of account hereafter which will have to be paid by the Council and credited to the electric light account. I have gone into the monthly statements showing units generated, quantity consumed, cost of the production, etc., and believe that at the end of the first year's working the profit will not only be sufficient to pay all the interest on the sum borrowed, but a considerable amount on account of principal. At Lady Day our private consumers numbered 98, and consumed 5,967 units; at Midsummer, 105, and consumed 7,742; at Michaelmas, 124, and consumed 10,182. And there are numerous applications from persons within the compulsory area waiting to be connected, but this cannot be done in consequence of the mains being charged to their utmost capacity. To comply with these applications, new feeders are being laid, and when this work is complete the plant will be sufficient to supply an almost unlimited amount of current throughout the town It is said that the purchase of the Town Mills has been secured for the sole purpose of the electric light undertaking. But this is a misconception; the object was to secure the water rights, not only for electric light purposes, but for the general use throughout the town hereafter, and in justification of this step I would point to the reported evidence of the borough surveyor at the recent Local Government Board enquiry. Further, I am advised and convinced that the Town Mills site was inadequate for the electric light station, and that the Council acted wisely in selecting the Castle-street side, upon which were dilapidated buildings requiring a considerable sum to be expended to make them tenantable. I will now deal with the general finances, and I think I cannot do better than give you the balances at Michaelmas of the Town Council and Urban District Council accounts, for which rates are levied for the past six years, from which you will gather that there has been no extravagance as alleged. At the year ending Michaelmas, 1898, the credit balance was £1,530. 4s. 2d; 1899, £780. 9s. 3d.; 1900, £654. 17s. 10d.; 1901, £934. 19s. 7d.; 1902, £1,322. 15s.; 1903, £1,285. 14s. 1d. In addition to the above credit balance, there is to the credit of the other accounts of borough, such as markets and schools, a sum of about £350. During the past half-year special payments have been made amounting to nearly £200 for the costs of a licensing appeal, presentation to Mr. F. C. Gould, works in markets, and purchase of a horse. My statement, therefore, made in August last, that there would be a balance of about £1,800 was correct, as will be seen by the addition of the three last items. Until the past half-year the annual precepts to the overseers have been the same, and there has not been any increase in the general district rate. During this period £300 had to be provided for elementary education, £150 towards the cost of wiring the Council's premises, and £150 towards the costs of the recent action, and these sums have been paid. It will be remembered that although the borough has been extended and very considerable works of street improvements executed, it has not been found necessary by the Council to increase the rates. The increase has been caused by demands over which the Council have no control, and they are not responsible for the increase of the rates. There is no party majority in this Council, our united aim being—and it has been so since I have been a member—to protect the interests of all the ratepayers, and I can only express my amazement and regret that a member of this Board should associate himself with two others by signing his name to an address which, in my opinion, casts a grave reflection upon every member of this Council." A discussion ensued, and a vote of thanks to the Mayor closed the meeting.

PROVISIONAL PATENTS, 1903.

Oct. 19.

22497. Improved electrical numerical switch. Joseph Makin, Bank-buildings, George-street, Sheffield.

22507. Improvements in and relating to electrically-controlled hoists. John Alexander Steven, 96, Buchanan-street, Glasgow.

22532. Improvements in and connected with electric arc lamps. John Owen Girdlestone and Carl Frederik Grimur Thorkelin, 16, Davies-street, Berkeley-square, London. (Complete specification.)

22551. Improvements in or relating to electric motors and controlling devices for use in the electrical propulsion of vehicles or trains of vehicles. John Smith Raworth, 46, Lincoln's-inn-fields, London.

22556. Improvements in and relating to electrically operating fire-alarms, burglar alarms, and the like. Edwin Hughes, John Charles Jones, and Arthur Graham Mackie, 322, High Holborn, London.

22572. Improved method of and means for working electrical winding engines. Siemens Bros. and Co., Limited, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Siemens und Halske Actien-Gesellschaft, Germany.) (Complete specification.)

22573. Improved safety fuse device for electrical installations. Siemens Bros. and Co., Limited, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Siemens und Halske Actien-Gesellschaft, Germany.) (Complete specification.)

Oct. 20.

22601. Improvements in electrical switches for electric ignition as applied to internal-combustion engines. Fredrick Harold Hall and Constance Hall, Unity Works, Highgate-street, Birmingham.

22602. Improvements in contact breakers for electric ignition of internal-explosive engines. Fredrick Harold Hall and Constance Hall, Unity Works, Highgate-street, Birmingham.

22606. Improvements in apparatus for the generation of electricity primarily designed for the electric lighting of trains. Thomas William Stainer Hutchins, 17, St. Ann's-square, Manchester.

22634. Improvements in or relating to terminals for stranded electrical and other wires. Frederick Henry de Veulle, 9, Exchange-chambers, Birmingham.

22643. Improvements in brush-holders for dynamo-electric machines. Milton Ellsworth Thompson, 52, Chancery-lane, London. (Complete specification.)

22654. An improved clip adapted to be used for suspending electric cables. Thomas Henry Walker, 72, Cannon-street, London.

22658. Improvements in induction electric motors. Franklin Punga, Oswaldestre House, Norfolk-street, Strand, London.

22664. Contact apparatus for electric relay master clocks. Oliver Imray, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Siemens-Schuckert-werke, G. m. b. H., Germany.) (Complete specification.)

22668. Improvements in electrical insulators. James Ernest Spagnoletti, 53, Chancery-lane, London.

22673. An improved current regulator for electric machines. Albert Richard Müller, 6, Lord-street, Liverpool. (Complete specification.)

22674. Improvements in and connected with telephone systems. Paul Hardegen, 6, Lord-street, Liverpool. (Complete specification.)

22680. Improvements in and relating to coherers for wireless telegraphic systems. Louis Dorman, 77, Chancery-lane, London. (Complete specification.)

22696. Electrical vibratory motor. Charles Sumner Whitney, Palace-chambers, Westminster, London. (Complete specification.)

22698. Improvements in telephone transmitters. Jerome Prince, 18, Buckingham-street, Strand, London. (Complete specification.)

Oct. 21.

22742. Improvements in dynamo-electric machines and motors. Henry Francis Joel, 74, Windsor-road, Forest Gate, London.

22758. An improved voltage-regulated electric lighting system for railway and other carriages. James Dalziel, 104, Savernake-road, Hampstead, London.

22778. Improvements in apparatus for commuting electric currents passing through combined arc and incandescent lamp circuits. Campbell Smart, 65, Chancery-lane, London.

22785. Improvement in storage battery plates. Edward Wanton Smith, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London (Date applied for under Patents Act, 1901, Sept. 10, 1903, being date of application in United States.) (Complete specification.)

Oct. 22.

22804. Improvements in means for controlling electric circuits. Henry Leitner and Richard Norman Lucas Lynton, Dartnell Park, Byfleet.

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22805. Improvements in regulators for electric circuits. Henry Leitner and Richard Norman Lucas Lynton, Dartnell Park, Byfleet.

22820. Improvements in electrical fuse-boxes or fittings. Charles Douglas Burnet, 15, Water-street, Liverpool.

22840. Improvements in lampholders for electric lighting. Albert Moore Barnes, 12, Warbeck-road, Shepherd's Bush, London.

22858. Improvements in or relating to electrically-synchronised clocks and the like. Frederick Augustus Chandler and Bahne Bonniksen, 18, Hertford-street, Coventry.

22904. Improvements in controlling electric boosters. Edgar Alfred Carolan, 83, Cannon-street, London. (The General Electric Company, United States.)

22905. Improvements in electric rheostats. Edgar Alfred Carolan, 83, Cannon-street, London. (The General Electric Company, United States.)

22906. Improvements in machines for covering electric conductors or the like with insulating material. Edgar Alfred Carolan, 83, Cannon-street, London. (The General Electric Company, United States.)

22907. Improvements in and relating to controlling devices for electrically-propelled vehicles. Edgar Alfred Carolan, 83, Cannon-street, London. (The General Electric Company, United States.)

22908. Improvements in electric switches or circuit breakers. Edgar Alfred Carolan, 83, Cannon-street, London. (The General Electric Company, United States.)

22909. Improvements in dynamo-electric machines. Edgar Alfred Carolan, 83, Cannon-street, London. (The General Electric Company, United States.)

22910. Improvements in bearings for electric meters and other measuring instruments. Edgar Alfred Carolan, 83, Cannon-street, London. (The General Electric Company, United States.)

22911. Improvements in alternating-current motors. Edgar Alfred Carolan, 83, Cannon-street, London. (The General Electric Company, United States.)

22912. Improvements in dynamo-electric machines. Edgar Alfred Carolan, 83, Cannon-street, London. (The General Electric Company, United States.)

22913. Improvements in alternating-current motors and methods of controlling the same. Edgar Alfred Carolan, 83, Cannon-street, London. (The General Electric Company, United States.)

22914. Improvements in emergency brakes for railway and tramway vehicles or trains. Edgar Alfred Carolan, 83, Cannon-street, London. (The General Electric Company, United States.)

Oct. 23.

22955. An electric wire terminal grip. Walter Henry Copus, 22, Clapham-road, London.

22981. Improvements in welding by electricity and apparatus therefor. Johann Harmatta, 4, South-street, Finsbury, London.

22996. Improvements in connection with incandescent electric lampholders with shade carriers. William Robert Newbold Gard, 18, Southampton-buildings, Chancery-lane, London.

Oct. 24.

23021. Improvements in electrical switches, cut-outs, and the like. Vernon Hope, 55, Market-street, Manchester.

23043. Improvements connected with magnetic compasses. William David White, 100, Wellington-street, Glasgow. (Complete specification.)

23057. Improvements in single-phase alternating-current motors. Benjamin Garver Lamme, Westinghouse-building, Norfolk-street, Strand, London. (Date applied for under Patents Act, 1901, Oct. 31, 1902, being date of application in United States.) (Complete specification.)

23086. Improvements in or relating to the regulation of dynamo-electric generators. Martin Hamilton Kilgour, 46, Lincoln's-inn-fields, London.

COMPLETE SPECIFICATIONS ACCEPTED.

To be published Nov. 12, 1903.

1902.

22712. Alternate-current motors. Fynn.

23344. Electrical billiard marker and indicator. Malam.

23694. Automatic shunting switch for protecting the shunt coils and carbon-holders of arc lamps. Eckstein and Angold.

24102. Surface-contact structures for electric railways and tramways. Carolan. (General Electric Company.)

24531. Appliance for use in testing for electric currents. Oliver.

25965. Systems of electrical distribution. Carolan. (General Electric Company.)

26035. Photometers. Carolan. (General Electric Company.)

26037. Electric railways on surface-contact or like systems. Carolan. (General Electric Company.)

26379. Magnetic clutches. Carolan. (General Electric Company.)

26385. Electric arc lamps. Carolan. (General Electric Company.)

26673. Devices for the measurement of electrical energy. Lake. (Arno.)

26706. Electrical resistances. Bray, Markham, Reiss, and Bray, Markham, and Reiss, Limited.

26717. Electric locomotives. Swinburne.

27752. Arc-extinguishing devices. Carolan. (General Electric Company.)

27754. Apparatus for forming coils for dynamo-electric machines. Carolan. (General Electric Company.)

27759. Control systems for searchlight projectors. Carolan. (General Electric Company.)

27762. Electric condensers. Carolan. (General Electric Company.)

27766. Potential indicators for high-voltage electric circuits. Carolan. (General Electric Company.)

1903.

346. Conduits and troughs for electric conductors. Devonshire.

13373. Electromagnetic face-plate or work-holder for machine tools. Margowski and Gorick.

15048. Electric signalling apparatus for railway trains. Bonemeyer.

16698. Means for actuating valves, cocks, electric switches, and similar apparatus at predetermined times. Boot.

16878. Printing telegraph instruments. Stiner.

19886. Electromotive force regulators. Lamme. (Date applied for under International Convention, Oct. 2, 1902.)

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.	Last price
Commercial and Industrial.—	£	£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1 ..	¾-⅞
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1 ..	¾-⅞
British Insulated and Helsby Cables, Ord., 1-100,000	5 ..	6-6¼
—— 5 per cent. Cum. Pref., 1-100,000	5 ..	5¼-5⅜
—— 4½ per cent. Mortgage Debentures	100 ..	102-105
British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red.	100 ..	103-105
British Westinghouse Elec. and Manuf., 6 per cent. Pref., 275,001-375,000	5 ..	5-5¼
—— 4 per cent. Mortgage Debenture Stock	100 ..	100-102
Brush Electrical Engineering, Ordinary, Nos. 1-105,751	2 ..	⅞-1⅛
—— Non. Cum., 5 per cent. Pref.	2 ..	1-1⅛
—— 4½ per cent. 1st Debenture Stock	100 ..	97-100
—— 4½ per cent. 2nd Debenture Stock	100 ..	85-90
Callender's Cable, Debentures	100 ..	106-110
—— Ordinary	5 ..	11¼-12¼
—— 5 per cent. Pref.	5 ..	5¼-5⅜
Crompton and Co.	3 ..	2-2¼
—— 5 per cent. Debentures	100 ..	100-104
Edison and Swan United, "A" Shares, 1-99,261	3 ..	¼
—— "A" Shares, 01-017,139	5 ..	1¼-2¼
—— 5 per cent. Debentures	100 ..	76-81
—— 4 per cent. Deb. Stock, Red.	100 ..	72-77
Electric Construction, Limited, Nos. 1 to 112,100	2 ..	1¼-1⅜
—— 7 per cent. Cumulative Pref.	2 ..	2¼-3
—— 4 per cent. Perp. 1st Mort. Deb.	100 ..	97-100
Ferranti Limited, 5 per cent. 1st Mort. Deb. Stock, Red.	100 ..	90-95
General Electric Company (1900), 5 per cent. Cum. Pref.	10 ..	9⅜-10¼
—— 4 per cent. 1st Mort. Deb. Stock	100 ..	96-99
W. T. Henley's Telegraph Works, Ordinary	5 ..	14-15
—— 4½ per cent. Preference	5 ..	5-5¼
—— 4½ per cent. Debentures	100 ..	108-112
India Rubber, Gutta Percha, and Telegraph Works	10 ..	18¼-19¼
—— 4 per cent. Debentures	100 ..	100-103
Parker, Thos., Limited, Ordinary	10 ..	14¼-15¼
Telegraph Construction and Maintenance	12 ..	34-37
—— 5 per cent. Bonds	100 ..	100-103
Electric Lighting and Supply.—		
Blackheath & Greenwich District Ordinary 1,201-101,200	1 ..	⅛-¼
—— 4½ per cent. Deb. Stk. Certs., Red. and Conv.	100 ..	116-119
Bournemouth and Poole, Ordinary	10 ..	12½-13½
—— 4½ per cent. Cum. Pref., 7,501-15,000	10 ..	10-11
—— 6 per cent. Cum. Second Pref., 15,001-22,500	10 ..	11-12
—— 4½ per cent. Debenture Stock, Red.	100 ..	103-106
Bromley (Kent) Electric Light and Power Co., 4½ per cent. 1st Debenture Stock, Red.	100 ..	102-105
Brompton and Kensington, Ordinary	5 ..	10⅛-10⅜
—— 7 per cent. Preference	5 ..	10-10¼
Calcutta Electric Supply Corp., Ordinary, Nos. 1-40,000	5 ..	7-7¼
—— Nos. 20,001-30,000	5 ..	7-8
Cambridge Electric Supply Company, Ltd., £10 Ord.	8 ..	14¼
—— ,, ,, £10 Ord.	6 ..	10⅝
Central Electric Supply, Ld., 4 per cent. Guar Deb. Stock	100 ..	107-110
Charing Cross and Strand, Nos. 1-70,000	5 ..	9-9¼
—— 4½ per cent. Cum. Pref.	5 ..	5¼-5⅜
—— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000	5 ..	4⅜-5
—— 4 per cent. Debenture Stock, Red. (Prov. Certs.)	100 ..	104-106
Chelsea Electricity Supply	5 ..	5⅛-6
—— 4½ per cent. Debentures	100 ..	108-111
City of London, Ordinary	10 ..	9¾-10¼
—— 6 per cent. Cumulative Pref.	10 ..	13-14
—— 5 per cent. Debenture Stock	100 ..	122-127
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100 ..	102-105
County of London and Brush Provincial, Ordinary	10 ..	7¼-8¼
—— 6 per cent. Cum. Pref.	10 ..	11¼-12¼
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	100 ..	107-110
Edmundsons' Electricity Corporation, Ordinary, 1-50,000	5 ..	6¼-6⅜
—— 6 per cent. Cum. Pref.	5 ..	6¼-6⅜
—— 4½ per cent. First Mort. Deb.	100 ..	105-108
Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-30,000	5 ..	3¼-4¼
—— 5 per cent. Debenture Stock, Red.	100 ..	95-98
Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000	5 ..	5⅜-6¼
—— 4½ per cent. First Deb. Stock, Red.	100 ..	100-103
Hove Electric Lighting, Limited, Ord., 1-13,000	5 ..	7¼-8¼
Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000	5 ..	10¼-11¼
—— per cent. Debenture Stock Red.	100 ..	103-106

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Name.	Amount paid.	Last price.
	£	£
Kensington and Knightsbridge and Notting Hill	100 ..	101-104
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10 ..	9½-10½
London Electric, Ordinary	3 ..	1¾-2¼
—— 5 per cent. Pref.	5 ..	5¼-5⅝
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100 ..	100-102
Metropolitan, Ordinary	10 ..	17½-18½
—— ½ per cent. First Mortgage Debenture Stock	100 ..	110-114
—— ½ per cent. Mortgage Debenture, Red.	100 ..	97-100
Newcastle-upon-Tyne Electric Supply, Ordinary	5 ..	98-101
—— Preference	4 ..	100-103
Notting Hill Electric Lighting	10 ..	12½-13⅝
—— 4 per cent. First Mort. Debs., Nos. 1-500 (Reg.)	100 ..	96-101
Oxford Electric, Ordinary, 1-96 and 407-14,310	5	5¼-5⅜
—— 4 per cent. Debenture Stock	100	98-101
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100 ..	98-100
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5 ..	3-3½
—— 4 per cent. Debenture Stock	100 ..	85-90
South London, Ordinary	5 ..	3½-4
St. James's and Pall Mall, Ordinary, 101-80,080	5 ..	14½-15½
—— 7 per cent. Pref.	5 ..	8-9
—— 3½ per cent. Deb.	100 ..	97-100
Urban Electric Supply Co., Ordinary, 8-30,007	5 ..	4⅞-5⅛
—— 5 per cent. Cumulative Preference, 50,001-80,000	5 ..	4⅞-5
Westminster, Ordinary	5 ..	12-13
—— 5 per cent. Cum. Pref., 110,101-138,251	5 ..	6-6½

Electric Railways.—

Central London, Ordinary	100	..	95 98
—— 4 per cent. Pref.	100	..	99-102
—— ,, ,, deferred	100	..	99-102
—— ,, ,, 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100	..	115-118
City and South London, Consolidated Ordinary	100	..	51-53
—— 4 per cent. Debenture Stock	100	..	115-118
—— 5 per cent. Pref. Stock '91	100	..	127-130
—— ,, ,, ,, '96	100	..	126-129
—— ,, ,, ,, '01	100	..	122-127
Liverpool Overhead, 5 per cent. Pref.	—	—	13-13½
—— Ordinary, 1-50,000	—	—	7⅛-8
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	—	—	102-104
Waterloo and City, Ordinary	100	—	93-96

Electric Tramways.—

Anglo-Argentine, 1-260,007	5	..	4⅜-4⅝
—— Permanent 6 per cent. Debenture Stock, 1888	100	..	125-130
Blackpool and Fleetwood Tramroad	10	..	13½-14½
Brisbane Tramway Invest., Lim., Ord., 1-75,000	5	..	2-3
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5	..	4-4½
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100	..	98-102
British Columbia Electric Railway Co., Ord., Nos. 1-20,000	100	..	84-87
—— Non-Cum. 5 per cent. Pref., Nos. 25,001-38,600	100	..	92-95
—— 4½ per cent. 1st Mt. Debs., Nos. 1-6,250, of £40 each	40	..	102-104 p.c

Name.	Amount paid.	Last price
	£	£
British Electric Traction, Ord. 1-300,000 & 60,001-90,000	10 —	11⅛-12⅛
—— 6 per cent. Cm. Pf., 30,001-60,000	10 —	11-11½
—— 5 per cent. Perpetual Debenture Stock	100 —	120-125
Buenos Ayres and Belgrano Tram., Ord., 1-100,000	5 —	2⅜-2⅝
—— "A" 6 per cent. Cm. Pf., 1-40,000	5 —	5-5½
—— "B" 6 per cent. Cm. Pf., 1-27,500	5 —	4½-5
—— 5 per cent. Deb. Stock, Red.	100 —	107-110
—— Prov. Cert., all paid	100 —	99-102
Cape Electric Tramways, Nos. 1-480,000	1 —	2⅛-2⅜
City of Birmingham Tramways, 5 per cent. Cum. Pref.	10 —	5-5½ xd
—— 4 per cent. 1st Mortgage Deb., 1-3,000 (1917)	100 —	99-102
Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red.	100 —	102 105
Cork Electric Tramways and Lighting Co., Ordinary	10 —	13-14
—— 5 per cent. Cum. Pref.	10 —	11-12
—— Debentures	100 —	96-99
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10 —	12-13
—— 6 per cent. Pref., Nos. within 1-60,000	10 —	15-16
—— 3½ per cent. Mort. Debs., 1-3,000, Red.	100 —	94-97
Imperial Tramways Ordinary	all —	22-22½
—— 6 per cent. Cum. Pref.	all —	14½-15½
—— 4½ per cent. Deb Stock	100 —	113-114
Isle of Thanet Electric Tramways and Lighting, 5 per cent. Cum. Pref., Nos. 30,001-60,000	5 ..	3½-4½
—— 4 per cent. Debenture Stock	100 —	92-95
Kidderminster and District Lighting and Traction, Pref.	5 —	3¼-4
London United Trys. (1901), 5 per cent. Cum. Pref.	10 —	11½-12
—— 4 per cent. 1st Mt. Db. Stock, Red.	100 —	104-106
Metropolitan Electric Trams., Deferred, 1,000 001-1,314,016	1 —	5/16-5/16
—— 5 per cent. Cum. Pref., 500,001-814,016	1 —	⅛-⅛
New General Traction, Ordinary	5 —	2-2
—— 6 per cent. Cum. Pref.	5 —	2-3
—— 5 per cent. Mortgage Debentures, 1-1,713 (Regd.)	100 —	88-93
Oldham, Aston, and Hyde Tramway, Ordinary	10 —	10½-10⅞
—— 5 per cent. Cum. Pref.	10 —	11½-12½
Perth Elec. Tramways (W.A.) 5 per cent. 1 Mort. Deb. Stk.	100 —	99-102
Potteries Electric Traction, Ordinary, 20,001-40,000	10 —	9-10
—— 5 per cent. Cum. Pref., 1-20,000	10 —	8¼-9¼
—— 4½ per cent. Debenture Stock	100 —	104-107
South Lancashire Electric Traction and Power Company—		
—— £250,000 Ordinary	1 —	1
—— £101,132 5 per cent. Preference	1 —	1
—— £528,093 4½ per cent. Debenture Stock	100 p.c. —	100 p.c.

Telephones.—

National Telephone, Preferred	100	—	99-101
—— Deferred Stock	100	—	72-74
—— 6 per cent. Cum. First Pref.	10	—	13-14
—— 6 per cent. Cum. Second Pref.	10	—	13-14
—— 5 per cent. Non. Cum. Third Pref.	5	—	4¾-5¼
—— 5 per cent. Deb. Stock, Red.	100	—	92 94
—— 4 per cent. Deb. Stock, Red.	100	—	102-104
Oriental Telephone and Electric Company	1	—	⅛ 1

TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line	Traffic Returns for week			Increase or decrease.		Miles of single track open.		Accounts for past year.						Cost per car mile.
	Ending	1903.	1902.	Week.	Current year.	1903.	1902.	Ending	Total receipts	Passengers carried.	Car miles run.	Receipts per Pas-s'nger	Receipts per Car mile.	Receipts per Mile of track.	
		£	£	£	£				£			d.	d.	£	d.
Aberdeen Corporation	Oct. 24	1,141	825	+ 316	+ 4,112	19¼	17¼	May 31	37,931	9,099,715	794,641	0·98	13·02	1,970	6·14
Ayr Corporation	,, 24	204	194	+ 10	—	8	6	Sept. 25	12,503	2,979,276	290,099	1·00	10·34	1,560	4·7
Birmingham Tramways	,, 24	5,193	5,193	—	+ 9,095	6½	6½	—	—	—	—	—	—	—	—
Blackburn Corporation	,, 23	815	783	+ 33	+ 749	24	24	March 25a	40,964	7,234,106	826,558	1·36	11·87	1,705	7·44
Blackpool Corporation	,, 22	417	402	+ 15	— 225	17½	16½	,, 31	211,168	6,169,121	784,443	1·52	10·8	—	—
Blackpool-Fleetwood Tramways	,, 24	255	255	—	— 152	16½	16½	Dec. 31	30,923	2,049,677	584,989	3·62	12·68	1,932	6·99
Bolton Corporation	,, 25	1,745	1,640	+ 105	+ 7,255	38	25	March 31	85,704	17,761,605	1,896,247	1 15	10·75	3,430	5·87
Bournemouth Corporation	,, 23	921	—	—	—	10½	—	—	—	—	—	—	—	—	—
Bradford Corporation	,, 25	3,650	3,208	+ 442	+14,012	41	—	—	—	—	—	—	—	—	—
Brighton Corporation	,, 25	8 0	818	— 8	+ 6,087	6½	—	,, 31	—	10,432,508	1,031,928	1 00	10·10	—	—
Bristol Tramways Company	,, 23	4,860	4 465	+ 395	—	51½	51½	Dec. 31	223,480	41,192,899	5,724,114	1·30	9·38	4,348	—
Burnley Corporation	,, 24	822	688	+ 134	—	—	—	—	—	—	—	—	—	—	—
Burton Corporation	,, 25	376	—	—	—	—	—	—	—	—	—	—	—	—	—
Cardiff Corporation	,, 24	1,927	1,504	+ 422	+17,380	—	—	—	—	—	—	—	—	—	—
Carlisle Tramways Company	,, 24	190	174	+ 16	+ 592	—	—	,, 31	—	2,216,583	320,129h	—	—	—	—
Central London Railway	,, 24	6,737	7,243	— 506	— 5,590h	6	—	,, 31	367,225	45,305,110	1,276,971a	1·87	66·6 a	59,076	35·6 a
City and South London Railway	,, 25	2,946	3,757	— 811	— 6,625	6⅜	—	,, 31	165,003a	19,069,319a	—	—	—	—	—
Cork E. T. and L. Company	,, 22	505	733	— 228	— 3,099	—	—	—	—	—	—	—	—	—	—
Darwen Corporation	,, 24	220	227	— 7	— 215	7·23	—	March 31g	12,341	2,360,735	254,279	1·25	11·65	1,707	9·36
Dover Corporation	,, 24	184	200	— 16	+ 96	3	—	—	—	—	—	—	—	—	—
Dublin & Lucan Electric Railway	,, 25	98	107	— 9	+ 159h	—	—	Dec. 31	5,795	364,796	102,087	3·81	13·62	559	7·68
Dublin U. T., electric cars	,, 23	3,774	3 665	+ 109	—	46	46	March 31	126,121	24,553,133	3,429,356	1·23	8·82	2,741	5·06h
Dublin S. District, Electric	,, 24	812	761	+ 71	—	22	22	May 15	35,874	9,081,522	752,814	0·93	11·276	1,630	—
Dundee City Tramways	,, 21	843	754	+ 89	—	10·75	7·52	March 31	25,341	9,971,337	650,224	0·61	9·35	2,357	—
East Ham Corporation	,, 24	628	480	+ 148	—	—	—	—	—	—	—	—	—	—	—
Farnworth U.D.C.	,, 21	150	143	+ 7	—	—	—	—	—	—	—	—	—	—	—
Glasgow Corporation	,, 24	13,898	12,544	+1,354	+31,764	124	101	May 31g	656,572	177,179,549	14,008,750	0·88	11·25	5,489 b	7·40e
Halifax Corporation	,, 22	1,105	1,139	+ 146	+ 4,745	30¼	27¾	—	—	—	—	—	—	—	—
Huddersfield Corporation	,, 24	1,225	1,057	+ 168	—	34	35	March 31	56,631h	9,738,213	1,218,539	1·4	11·14	1,618	6·38
Hull Corporation, E. S.	,, 24	1,883	1,728	+ 155	+ 2,810	19	19	,, 31	87,707h	21,065,999	2,218,696	1·00	9·49	5,004	5·07
Ilkeston Corporation	,, 22	145	—	—	—	—	—	—	—	—	—	—	—	—	—
Kirkcaldy Corporation	,, 21	159	—	—	—	—	—	—	—	—	—	—	—	—	—
Leeds Corporation	,, 24	5,320	4,910	+ 410	+10,499	77	—	March 25	252,656	57,239,779	5,773,651	1·11	10·91	3,283	—
Liverpool Corporation	,, 17	10,242	9,979	+ 263	+14,021	101	95	Dec. 31	504,304	108,906,472	11,705,425	1·11	10·34	5,000	6·88
Liverpool Overhead Railway	,, 25	1,632	1,541	+ 91	+ 1,924	15½	15½	June 30	79,252	10,466,726	986,185a	1·82	19·30a	5,110	— a
Lowestoft Corporation	,, 10	206	—	—	—	—	—	—	—	—	—	—	—	—	—
Nelson Corporation	,, 24	91	—	—	—	3	—	—	—	—	—	—	—	—	—
Newcastle-on-Tyne Corporation	,, 24	3,643	3,035	+ 608	—	38½	36	March 25g	150,334	33,474,122	3,379,119	1·08	10·93	4,175	6·17
Portsmouth Corporation	,, 24	1,463	1,379	+ 84	—	29	29	Sept. 30	47,651	9,168,157	868,157	1·24	13·17	1,643	—
Rochdale Corporation	,, 26	113	116	— 3	—	4½	—	March 31	5,416	925,281	127,456	1·38	10·27	—	7·66
Rotherham Corporation	,, 15	457	—	—	—	—	—	—	—	—	—	—	—	—	—
Salford Corporation	,, 26	3,925	3,821	+1,104	+35,193	—	—	—	—	—	—	—	—	—	—
Sheffield Corporation	,, 25	4,493	—	—	—	53½	46½	Mar. 25g	216,709	56,812,049	4,926,083	0·904	10·428	7,510	7·0
Southampton Corporation	,, 22	9·7	961	+ 6	—	11	11	,, 31	35,874	9,084,522	752,814	0·946	11·436	3,760	—
Sunderland Corporation	,, 25	1,088	1,049	+ 39	+ 1,948	18·48	17·18	,, 31	59,930	13,987,121	1,270,957	1·03	11·3	3,243	6·43
Wallasey U.D.C.	,, 24	625	545	+ 80	+ 2,805	10 5	10·5	,, 31g	31,307	5,690,378	654,553	1·32	11·47	2,981	6·97

* Includes maintenance of permanent way and proportion of profits paid to the tramway companies for term of unexpired lease. a Train mile.
b Per mile of single track. e Includes rail and tram. d including depreciation. f Including one section of horse traction. g 1903. h Half-year's figures.

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NOTES.

Electro - Harmonic Society.—The society's next concert is a "ladies' night," and will be held in the large King's Hall at the Holborn Restaurant on Friday evening, the 13th inst. Mr. Robert Kaye Gray, president of the Institution of Electrical Engineers, will be in the chair.

Royal Institution.—A general monthly meeting of the members of this institution was held on Monday afternoon, Sir James Crichton-Browne, treasurer and vice-president, in the chair. Mr. A. K. Huntingdon, Sir Oliver Lodge, LL.D., D.Sc., F.R.S., Mr. J. Francis Mason, and Mr. Edward H. Woods were elected members.

Tramways and Light Railways Association.—The council of the above association announce that they will annually grant a prize of a bronze medal and books to the best essay on improved means of communication. For this year's prize papers must be sent to the secretary, Mr. Ernest Benedict, on or before the 30th inst. Essays must not exceed 4,000 words in length.

Institution of Electrical Engineers.—We would remind our readers that the inaugural address of Mr. Robert Kaye Gray, as president of the above Institution, will be delivered at the opening meeting of the session to be held at the Institution of Civil Engineers at 8 p.m. on Thursday, Nov. 12, and that the annual dinner will be held at the Hotel Cecil on Wednesday, Dec. 10.

Electricity in Green Park.—An important stage in the daily transformation scene progressing round Buckingham Palace in connection with the laying-out of the ground plans for the National Memorial of Queen Victoria was reached on Saturday, when a portion of the new roadways from the Mall and the grounds contiguous to them were lighted by electricity for the first time. After a successful test, permanent wrought-iron standards will take the place of temporary poles, and powerful arc lamps will be gradually extended to light every part of the large site.

Physical Society.—At the end of last session the council of the above society decided to hold meetings alternately in the afternoons and evenings, and to change the place of meeting from the Chemical Society to the Royal College of Science, where the facilities for experimental demonstration are very complete. The first evening meeting will be held on Friday, the 13th inst., at 8 p.m., when Sir Oliver Lodge will describe and illustrate by experiments (1) "Means for Electrifying the Atmosphere on a Large Scale," and (2) "An Arrangement for Driving Mercury Pumps."

Glasgow Municipal Telephones.—We have received from the telephone department of the Glasgow Corporation an interesting little booklet on the progress of the telephone undertaking in that city. It shows that over 10,100 instruments are now working mostly on direct lines to the exchange, and in other respects a very healthy state of affairs is presented. The numerous testimonials which the department is able to print at the end of the booklet indicate how highly the municipal service is appreciated by the citizens. At the present time the traffic through the various switch-rooms is at the rate of 32 million messages per annum.

Lectures on Rays.—Prof. Arthur Schuster is delivering a series of lectures on "Rays and Radioactivity" at the Manchester University. The second of the course delivered last week dealt with the different kinds of radiation observed in a vacuum tube. Cathode rays, Röntgen rays, and radium rays were described successively, and Prof. Schuster concluded by speaking of the use of light rays in the cure of lupus and other skin diseases. Several photographs were thrown on the screen showing the treatment of patients by this method in the Manchester Skin Hospital. The course promises to be very popular, the first two lectures having attracted large audiences.

Technical Education in the Transvaal.—We are glad to see that a determined effort is to be made to organise technical education in the two new South African Colonies. Prof. H. S Hele-Shaw, of Liverpool University, has been entrusted with this responsible duty, his appointment having been announced through the Colonial Office. The appointment is not a permanent one, and Prof. Hele-Shaw has been granted leave of absence by the Liverpool University Council until September next year. In his mission the professor will take into view not only the immediate organisation of technical education, but the future university scheme of the Transvaal and Orange River Colonies.

Rumoured Electrical Combine.—Rumour is again busy as to a proposed American-Continental electrical combine. This time the names of the following companies are coupled together: the French Thomson-Houston Company, the Mediterranean Thomson-Houston Company, the General Electric Company of America, and several important German electric construction companies. Rumour also has it that the French Thomson-Houston Company is about to obtain a large share of orders in connection with the electrification of the London Metropolitan Railway, but this is officially denied in Paris. We give the above information for what it is worth, but we may add it has obtained considerable credulity on the Paris Bourse. The present close relations between the above companies gives support to this rumour.

Underground Cables.—So satisfactory has been the progress made in the work of extending the underground telegraphic system from Birmingham to the North, that it is hoped to complete the line as far as Carlisle in about two months' time. The next step will be for Parliament to vote the money necessary for extending the service to Edinburgh and Glasgow. A short underground cable has been laid in the Beattock incline, in a very exposed part of the south of Scotland, and a breakdown of the overhead wires would not now, it is thought, interrupt telegraphic communication between London and the two principal Scottish cities. As regards the North of England, the Department have commenced to lay an underground cable from Manchester to Leeds, Warrington, Manchester, and Liverpool being already connected in this manner.

Future of Wireless Telegraphy.—Prof. Silvanus Thompson lectured on this subject at the Hampstead Conservatoire on Tuesday evening. After tracing the progress of the art from the earliest experiments to the present time, he gave it as his opinion that within the next few years we should probably be able to hold wireless communication with the Antipodes. He advocated the adoption of an international agreement such as was recommended by the Berlin Conference for the benefit of ships of all nations, and instanced a recent occurrence when a ship in distress called repeatedly for help, and the nearest wireless telegraph receiving station either could not or would not receive the messages. Future arrangements should be made in a perfectly frank and scientific manner, and not by the haphazard methods of the financier. In his opinion, the financier had been the bane of wireless telegraphy.

Manchester Local Section.—This section of the Institution of Electrical Engineers opens its winter session

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on Nov. 17, when Mr. E. W. Cowan, chairman, will deliver his address, followed by a short demonstration of the properties of radium by Dr. Schuster. Subsequent meetings are as follows: Dec. 15, "Polyphase Electric Traction," by Mr. A. C. Eborall; Jan. 19, "Coal Consumption in Central Stations," by Mr A. S. Giles; Feb. 2, "Steam Turbines," by Mr. W. Chilton; Feb. 16, "Manchester Tramways Equipment," by Mr. J. M. McElroy; Feb. 26, annual dinner; March 1, "The Mersey Railway," by Mr. H. L. Kirker; March 24, at Liverpool, joint meeting with the Liverpool Engineering Society, "Notes on the Design of Electrical Machinery," by Mr. J. L. Hunt; March 29, "Safety Devices for Electric Traction," by Mr. T. W. Sheffield; and April 12, general meeting.

Electrical Cardcutting.—The use of automatic cardcutting machines in connection with textile patterns has been much sought after in recent years, and there have been a large number of attempts to utilise electricity in the process. The ordinary process of cutting these cards in the piano machines, with foot power for driving the punches, takes a considerable time, and is none too accurate unless highly skilled operators are employed. We understand that a Bradford syndicate have been developing a machine designed by an Austrian engineer named Zerkowitz, and that they have succeeded in turning out an electrical cardcutting machine on the following lines: The machine works on the principle which has been often tried before, but which has previously failed, due to troubles of practical nature. The design is painted on a metal surface with some non-conducting material, and then a number of pins resting on the plate determine which of the punches shall operate. The actual details of the machine are not before us, but we understand that it enables the design to be cut at the same time as the groundwork, and that the speed is at least 10 times greater than by previous methods of cardcutting.

New Zealand Cables.—There is trouble brewing between the Eastern Extension Telegraph Company and the Australian Commonwealth with reference to the telegraph cables which connect New Zealand and Australia. The company, it seems, has gone so far as to threaten to lift its two cables unless better support is accorded by the mercantile community. From what we hear, however, there is not much likelihood of the threat being put into executon. As a matter of fact, the Colony is only waiting a chance to lay State-owned cables between New Zealand and the mainland, and if the company does as it says, there could be no better opportunity. At all events, nobody would be in the least hurt except the company itself. This, however, the company will doubtless realise, and if it really wants to get out of its obligations so far as telegraphic communication between New Zealand and Australia is concerned, the Government of New Zealand has declared itself ready to negotiate for the purchase of the company's cables, provided the price be equitable. A State-owned cable direct between the Commonwealth and New Zealand would, with the present portion of the Pacific cable now connecting the islands with Queensland, give the Colony a splendid service between the two countries.

Municipal Loans.—Money is dear, and the time is unpropitious for the issue of big loans. This is beginning to be recognised by the corporations generally throughout the country, and in many cases large and costly works are being held over until the money market should assume more favourable an aspect. Also just now there is found to be considerable difficulty in obtaining the underwriting for municipal loans, and corporations have been forced to cast about for some other means of raising small sums of money than in the ordinary money market. The obvious course which commends itself in these circumstances is to appeal direct to the public for loans of moderate amount, and in many instances at the present time this action is being had recourse to. Thus, the Glasgow Corporation is asking for loans, by means of advertisements, on mortgage at 3¼ per cent., and Bolton, Middlesbrough, Sunderland, and Leicester are in the same line. For temporary accommodation the offer made is usually at the rate of 3 per cent. This will give the small investor a chance to obtain a safe and profitable outlet for his surplus funds, and, what is more, the corporations will be able to get money at a cheaper rate than if they adopted the usual course of raising loans with the large financial houses, which are bound by the market price prevailing at the time.

International Electrical Congress, 1904.—Some further information is available concerning the international electrical congress which it is proposed to hold during the second week of September next year at St. Louis. In addition to our own Institution of Electrical Engineers, which has already decided to attend the congress, the Italian Institute of Electrical Engineers, the Verband Deutscher Elektrotechniker, as well as other German and French scientific societies will be officially and largely represented at the meeting. According to the tentative programme adopted in regard to the European delegates, they will arrive in New York from Sept. 3 to 15, and, under the direction of a reception committee of the American Institute of Electrical Engineers, will visit the large electrical power stations and factories in the city and its environs. On Sept. 7 the delegates will depart for St. Louis, stopping at Washington *en route*, where the new laboratories of the National Bureau of Standards will be dedicated. Arriving in St. Louis on the 10th, the delegates will have plenty of leisure to visit the exposition before the congress opens on the 12th. A committee has been appointed to make the necessary preparations for the congress, with Prof. Elihu Thomson as president, and the advisory Board includes such men as Mr. B. J. Arnold (the incoming president of the American Institute), Mr. B. A. Behrend, Mr. W. J. Hammer, and Prof. C. P. Steinmetz.

Mechanical Road Vehicles.—The *Journal* of the Society of Arts for Oct. 30 prints the third of Mr. Mr. W. Worby Beaumont's Cantor lectures delivered before the society on the subject of mechanical road vehicles. The lecture in question embraces the subject of electrical cars, as to which, however, there is very little variety in either the principles of design or in the practice as to batteries, motors, or general arrangements of the machinery. For those who can afford to pay for an electrical vehicle and its maintenance, a thoroughly practical and trustworthy vehicle with any form of body can be had. The construction of lighter vehicles, of motors better suited to the requirements, with some improvements not only in the batteries in themselves, but more particularly in their usage, have made it possible to-day to produce electrically-propelled vehicles much more economical and satisfactory than were some of the older forms of electric cars. At no very distant date their radius of travel will, no doubt, be increased by the extension in the numbers of vehicles in use, by the standardisation of the cells and batteries and methods of connection, by universal methods of exchange of cells and batteries, and by extended knowledge and care in the use and charging of the cells. This must, however, be of gradual growth, and for a field more limited than that of vehicles less heavily weighted, of longer range, and cheaper propelling power. The storage battery may be slightly decreased in weight, but any great

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decrease must wait for the discovery of other than present known materials or combination of materials. Great promises, says Mr. Beaumont, frequently come across the Atlantic, sent by enthusiastic newspaper correspondents. There is some little ground for these claims, but not much.

Electrical Pumping Machinery.—At the opening meeting last week of the Birmingham Municipal Technical School a paper on pumping machinery was read by Mr. Edward C. R. Marks. In the course of his remarks Mr. Marks urged that for electrically-driven pumps gearing should be dispensed with as far as possible, and referred to the efforts of pump-makers and electric motor manufacturers in this direction. Whilst on the one hand electrical engineers had directed themselves, with a great measure of success, to the reduction of the speed of electric motors to adapt them for pump driving, hydraulic engineers were now making pumps known as "express pumps," in which the piston or plunger speed was much increased, as compared with ordinary pump practice, to permit of direct coupling to an electric motor. Hitherto a pump piston speed much above 200ft. per minute had been considered impracticable, but with Riedler and other type water-valves in which a mechanical operation or control was adopted, pumping engines of large size were now working with piston speeds exceeding 600ft. per minute. In the adoption of such high plunger or piston speeds for large steam pumping engines, he thought it was open to question whether the small economy in steam consumption attained might not be purchased too dearly.

Street-Lighting at Westminster.—Mr. J. W. Bradley, city engineer of Westminster, has issued another of his valuable quarterly reports comparing, from an economical point of view, the gas and electric lamps used for street-lighting in Westminster. While the Sugg high-pressure gas burner takes the lowest place in cost per candle-power per annum for this quarter, the average of the five quarters still shows it to be considerably behind the arc lamp. The average figures are gas 10·3d., as against 8·7d. for the arc lamps. The following figures, representing the total cost per candle-power per hour in every case, speak for themselves: for the electric arcs supplied by the Charing Cross and Strand Company the cost is ·0033d., those supplied by the St. James's and Pall Mall Company ·0036d., and those supplied by the Westminster Supply Corporation ·00238d. In the case of the gas lighting, the refuge lanterns fitted with four incandescent mantles cost ·0072d.; Sugg's high-pressure lamps with incandescent mantles, ·00232d.; ordinary single burners with incandescent mantle, ·00435d.; ordinary flat flame, with two burners, ·0062d.; and ordinary flat flame, with three burners, ·0117d. Thus it will be seen that while the lowest total cost per candle-power per hour of the electric arcs is ·00238d., or 9·4d. per candle-power per annum, the lowest figures for gas lighting are ·00232d. or 9·12d. respectively. Similarly, while the highest total cost per candle-power hour of the electric arcs is given at ·0036d. or 13·95d. per candle-power per annum, the highest cost of the gas lamps was ·0117d. or 46·3d. respectively. The value of the above figures is enhanced by the fact that they extend over a considerable period of time, and include all charges on capital account.

Depth of Electric Light Mains.—Electric lighting companies, and, incidentally, cable contractors, will welcome a decision which has just been given by the Board of Trade in a dispute as to the depth at which electric light mains should be laid under the public highways. The case in question occurred in the district supplied by the Leatherhead and District Electricity Company. This company wanted to extend its mains into the parish of Ashstead, which comes within the Epsom Rural District Council's area, and submitted plans showing that it was proposed to lay the mains at a depth of 18in. under pathways and 2ft. under the roadways. The mains in question are Glover's three-core, paper-insulated, lead-covered, and laid solid in Howard asphalt conduits. The Council refused their sanction to the work unless the mains were put at a depth of 3ft. throughout. To this the company objected, and on the advice of their consulting engineers, Messrs. Handcock and Dykes, appealed to the Board of Trade. The appeal was heard on the 22nd ult., the Council being represented by counsel; and Messrs. Handcock and Dykes and Mr. L. Atkinson, the London manager of Messrs. W. T. Glover and Co., the contractors for the work, gave evidence on behalf of the company. The Council urged, first, that in their opinion all electric lighting mains, as well as gas and water mains, should be laid at a continuous depth of 3ft., on account of the danger of damage, and, secondly, because, if the mains were laid at 18in. under the pathway, and the roads were subsequently widened, the Council might be at the expense of lowering these mains if the alterations should bring them too close to the surface. These objections, however, have been overruled by the Board of Trade, which gave its decision in favour of the company on all points.

Bending of Magnetometer Deflection Bars.—A paper on this subject was read by Dr. Chree before the Physical Society of London at the first meeting of the new session on the 23rd ult. A theoretical paper contributed to the society by the present author in May, 1901, proved, amongst other results, that the bending of the deflection bar of an ordinary magnetometer, under the combined weight of the bar and its load, must increase the distance between the deflecting and deflected magnets, during a determination of horizontal force, to an extent which is not negligible. This conclusion has been borne out by direct observations made at the National Physical Laboratory on a number of magnetometer bars, including specimens from the leading makers. The mean results thus obtained are recorded in the present paper. The great majority of the data were derived from direct observations made with a pair of microscopes. But a method is described whereby the necessary information can be deduced without the aid of microscopes from the magnetometer's own readings. The magnetometer is set up exactly as in an ordinary deflection experiment, with the deflecting magnet on its carriage at any convenient position on the deflection bar, and equal weights are hung up symmetrically one on each arm. The consequent increase in distance between the two magnets diminishes slightly the deflecting force on the deflected magnet, and a slight change of reading is observed in the magnetometer telescope. The weights are put off and on several times, and the mean change of reading determined. As a check it is well to observe at two distances. From the change of reading it is possible to determine the increase in distance between the two magnets. In many magnetometers the increase in distance due to the bending is roughly proportional to the distance itself. In the case of bars by the Cambridge Instrument Company, the bending increased the distance by almost exactly 1 part in 10,000 at all distances. It is hoped that the method employed will prove useful to magnetic observers who have not ready access to a physical laboratory.

Economy of Electric Traction.—Most of our readers will be aware that some 12 months ago steam traction on the Manhattan Elevated Railroad system in

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New York City was superseded by electric propulsion. The system has now been worked electrically long enough to afford an excellent opportunity to test the new against the old; in fact, too much stress cannot be laid upon the significance of the results shown in the first months of the electrical operation of this railway, in which the conditions, such as track, rolling-stock, character of traffic, etc., remain precisely the same, year in year out. For the sake of comparison, we take a period of three months in two successive years—viz., the quarter ending June, 1902, and the same quarter in 1903. During the 1902 quarter the gross earnings under steam operation amounted to £571,450. In the same quarter in 1903 the gross earnings under electrical operation were £654,357—an increase of £82,907. The expenses for the quarter in 1902 were £280,221; for the corresponding quarter in 1903 they fell to £260,418—a decrease of £19,803. The net earnings, therefore, showed for the quarter an increase due to the introduction of electrical traction of £102,710. And we must remember that both the company and the public have reaped the benefit, for while the former has increased its profits the public has been given a better, quicker, and more frequent service of trains. Whereas the old steam-engines exerted a maximum draw-bar pull of 7,000lb, with electric traction the power has been raised to the equivalent of a 20,000lb draw-bar pull, or the equivalent of about three of the steam locomotives. This has resulted in an acceleration of speed of from 20 to 30 per cent The immediate effect of increasing the capacity of the road, as stated above, has been an all-round improvement in the service, from which the public especially benefits. To sum up, we find that the change from steam to electricity has resulted in reducing the operating expenses at a rate of about £80,000 per annum, and increasing the earnings at the rate of over £400,000 per annum. Electrical engineers may be warmly congratulated on having accomplished this feat, with the added convenience to the public of higher speed and more frequent and more comfortable service.

New Books.—"Notes on Electric Railway Economics and Preliminary Engineering," by W. C. Gotshall (McGraw Publishing Company, New York). This book is based upon a series of lectures delivered by the author at Lehigh University last spring, the subject of which dealt with the economics of the preliminary and other determinations, and of the construction and operating of high-speed and heavy traction interurban electric railroads. — "Tube, Train, Tram, and Car; or Up-to-Date Locomotion," by Arthur H. Bevan. (Geo. Routledge and Sons, Limited, London, 6s.) This work is very amply illustrated, and contains an introduction by Mr. Llewellyn Preece, M.I.E E. The subject is treated in a popular vein, the object being to present to the layman information about tube, train, tram, and motorcar, avoiding as much as possible technical and scientific detail. From this point of view the book contains much that is of interest at the present time, and its value is greatly enhanced by reference to and descriptions of special cases, such as the London United Tramways, and the Fischer "combination" omnibus, which Londoners hope to see running in the streets of the Metropolis before long.—"Elementary Telegraphy and Telephony," by Arthur Crotch. (E. and F. N. Spon, Limited, London. 4s. 6d.) This is one of the Finsbury Technical Manual Series, edited by Prof. Silvanus P. Thompson. The book is evidently intended especially for the elementary student, as its scope is that of the syllabus of the ordinary grade examination of the City and Guilds Institute. The volume is profusely illustrated.—"Theorie und Berechnung Electrischer" [illegible] Zeitungen von Dr. Ing. H. Gallusoer, engineer of Brown, Boveri, and Co., and Dr. Ing. U. Hausmann, engineer at the Allgemeine Electricitäts-Gesellschaft. Dedicated to their technical instructor, Prof. E. Arnold, director of the electrotechnical branch at the Grand Ducal Technical College, Karlsruhe. (Julius Springer, Berlin. 5s.)—"Liquid Fuel and Its Combustion," by W. H. Booth. (Archibald Constable and Co., Limited, Westminster. 24s.) "Proceedings of the Chemical and Metallurgical Society of South Africa." (R. W. Hunter, Edinburgh. 21s.) This volume records the proceedings and transactions of the society from February, 1897, to September, 1899. Its publication has been delayed through the late war, during which period the various papers could not be revised by their respective authors. The third volume—May, 1902, to June, 1903—is now in preparation.

Magnetism of Basalt.—A paper, entitled "On the Magnetism of Basalt and the Magnetic Behaviour of Basaltic Bars when Heated in Air," was contributed by Dr. G. E. Allan to the proceedings at the meeting of the Physical Society of London on the 23rd ult. In the experiments carried out by the author, bars cut from basalt obtained from Rowley Regis and from Linz, Germany, were tested by means of a magnetometric method to determine their magnetic properties at temperatures from 15deg. to 800deg. C. Hysteresis curves are given in the paper, and the temperature permeability curves show that whilst the English basalt has, in general, a maximum permeability near 500deg. C. followed by a minimum about 550deg. C, the temperature of maximum permeability in the case of the German basalt lay in the neighbourhood of 50deg. C., there being a subsequent gradual loss of strength with rise of temperature. Sections of heated and unheated rocks are also given, showing evidence of chemical change in some of the rock constituents, and a table of values of susceptibility of the specimens is appended. Prof. W. F. Barrett made an interesting written communication on the paper, in which he stated that several years ago he examined the magnetic properties of various specimens of columnar basalt which had been taken from the Giant's Causeway in co. Antrim, and a note on the result of this investigation was published in the *Proceedings* of the Royal Dublin Society for December, 1889. Each block was found permanently magnetised with a strongly marked north and south pole, the magnetic axis running diagonally through the block, and inclined to the horizon approximately at the angle of dip. As the blocks formed part of vertical columns in the causeway, their magnetisation was undoubtedly due to the earth's magnetic field, the concave end of each block—for the ends are not plane, but slightly concave or convex—was (in all the blocks examined) found to be a north-seeking pole, and must therefore have been downwards when *in situ* at the causeway. The weight of the blocks varied from 24 kg. to 37 kg., and the specific gravity of a fragment of one of them was found to be 2·86. With such large irregular and feebly magnetised masses only a very approximate estimate of the magnetic moment was possible by the ordinary method. This was, however, attempted, the blocks being placed on a turn-table with their centres 60cm. distant from the reflecting magnetometer. As might be expected, the magnet moment per gramme was found to be very small, and almost alike in each case. The volume of the blocks being known, their permanent intensity of magnetisation was found to be less than that estimated by Everett for the earth, regarded as a uniformly magnetised body—viz., 0·079. Nothing could be inferred from this, as the blocks had been removed a long time from the causeway, and had been lying about in different magnetic positions to that which they originally

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occupied. The long retentivity of the direction of their original magnetisation, in spite of rough usage, was, however, somewhat remarkable.

Novel Electrolyte for the Wehnelt Interrupter. We are indebted for the following to a note recently read by Mr. D. E. Hauser before the Spanish Physical and Chemical Society: The use of a sulphuric solution in connection with the Wehnelt interrupter, as so far employed, presents, as is known, two essential drawbacks—viz., first, the necessity of a relatively high voltage as required for its operation, and, second, a comparatively high current traversing the primary of the Ruhmkorff coil, according to the great value of the voltage. The first difficulty, which only concerns small coils, has partly been overcome by Mr. Carpentier, by augmenting the conductivity of the electrolyte, raising the temperature of the latter in virtue of a rather complicated arrangement. As regards the second drawback, it has so far been obviated by increasing the resistance of the interrupter, diminishing the surface of the platinum point, so as to have the latter reach an incandescent state at a much lower expense in current. Another process for diminishing this increase in inefficient current consists in using an electrolyte which under otherwise equal conditions gives rise to an increase in the number of interruptions of the current traversing the primary of the coil, and according to the great self-induction of the latter, to an increase in the inductive resistance, this increase resulting in the intensity of the current in the primary being diminished without absorption of energy. The electrolyte best fulfilling this condition is a half saturated solution of magnesium sulphate, slightly acidulated with sulphuric acid. This electrolyte, though exhibiting a considerable conductivity, is not corrosive, and allows of starting the operation at a much lower voltage, although it works perfectly well as far as 118 volts, the author having discontinued his work with this limit. In the tables recorded by the author some experimental results are given, beginning with the sulphuric solution of the specific weight of 1,195, and adding afterwards to the latter successively increasing amounts of magnesium sulphate or potassium alum. In order to separate the effects due to the sulphuric acid from those caused by the salts, the author employed in a second series of experiments, first a more concentrated solution of sulphuric acid without salts, and afterwards a sulphuric solution more diluted and containing increasing amounts of salts. As a result of these experiments, a considerable decrease in the intensity of the current necessary to excite the interrupter has been found. Whereas, in fact, with a solution of sulphuric acid of the specific weight 1,195, the interrupter would begin working for 65 volts and ·26 amperes, only with considerable oscillations in the indications of the measuring instruments, and with sulphuric acid of the specific weight of 1,305, at a voltage of 20, and with 15 amperes, the author has succeeded, by using a solution of sulphuric acid of the specific weight of 1,050, containing 20 per cent. of magnesium sulphate, in starting the interrupter at 20 volts with a consumption of only five amperes; 20·5 amperes have been reached only at a point corresponding with 118 volts, whereas with the sulphuric solution more than 25 amperes were necessary under equal conditions, and with a number of interruptions much lower than with the magnesium solution. The above voltages indicate the number of volts absorbed while the primary and the interrupter were connected in series. The influence of potassium alum is very singular, the number of interruptions being very much increased even for lower voltages. The author further made some experiments with electrolytes containing sodium bichromate, the results being much inferior to those obtained with the above solution besides of the drawback of a very considerable corrosion. A current of 20 amperes was the maximum limit which the arrangement of these experiments would allow.

The Magnetic Storm.—On Saturday last the telegraph systems both in Europe and America were seriously interfered with by earth currents which in many cases rendered telegraphic communication impossible. Thanks to the care shown by our Post Office engineers, the confusion and interruption to business in this country were less than on the Continent. The magnetic storm which was apparently responsible for these violent earth currents was carefully noted in the various observatories, and the following facts taken from the *Daily Telegraph* report are of great interest. Last Wednesday, Oct. 28, it was announced in our contemporary's columns that a sunspot had appeared on the edge of the sun at the beginning of the week. On Saturday last this spot was "crossing the central meridian"—in other words, the sun, by making a quarter of a rotation on its axis during the week, had brought the spot nearly to the centre of the disc, so that it was, so to speak, immediately opposite the earth, and, as was indicated in the note referred to, it is when a large spot is in that position that terrestrial magnetic disturbances are to be expected. On Saturday morning, about six o'clock, the recording needles at Greenwich began to move. "True as the needle to the pole" is sweetly poetic, but departs somewhat from the hard facts of Nature, for the delicately-poised magnet which at Greenwich registers the "declination," or divergence from the direction of the North Pole in a horizontal plane, lies at present about 16deg. west of north, and is slowly changing its position. Moreover, under normal conditions, each day it vibrates gently through an arc of seven or eight minutes' amplitude. On Saturday this arc was increased nearly twentyfold, and the declination magnet from one o'clock in the afternoon until about an hour before midnight oscillated violently through an arc of 2deg. and more. Then the storm abated, and the magnets resumed their usual calm by nine o'clock on Sunday morning. The other registering instruments were equally agitated. There are two wires about three miles in length laid down in the earth for the purpose of recording at the Royal Observatory the occasional spontaneous electric currents which pass through them. On Saturday afternoon these records showed disturbances as violent as those of the declination magnet above described, which is exactly analogous to the experience of the telegraphists who found their instruments useless. This is the greatest storm of the kind which has occurred for 21 years; for the previous worst happened on Nov. 17, 1882. The attempt to establish a relation between sun spots and weather always meets with the rebuff that weather is local, and varies at different parts of the earth; but this is not the case with magnetism. These storms invariably begin sharply; there is no gradual increase of vibration or of current, no warning, but suddenly the earth current leaps, as it were, through the wires, and the needles swing. Mr. William Ellis, F.R.S., who has made this subject peculiarly his own, in a paper read before the Royal Society in 1892 showed that on 17 occasions, and he might have added many more, at eight observatories in widely different parts of the world, this sudden beginning happened practically simultaneously. There were small variations in some cases for a few minutes, but the author was not prepared to say that these small differences were not due to imperfections of the records; at any rate, the fact that the whole of the earth is disturbed magnetically at the same moment was sufficiently proved.

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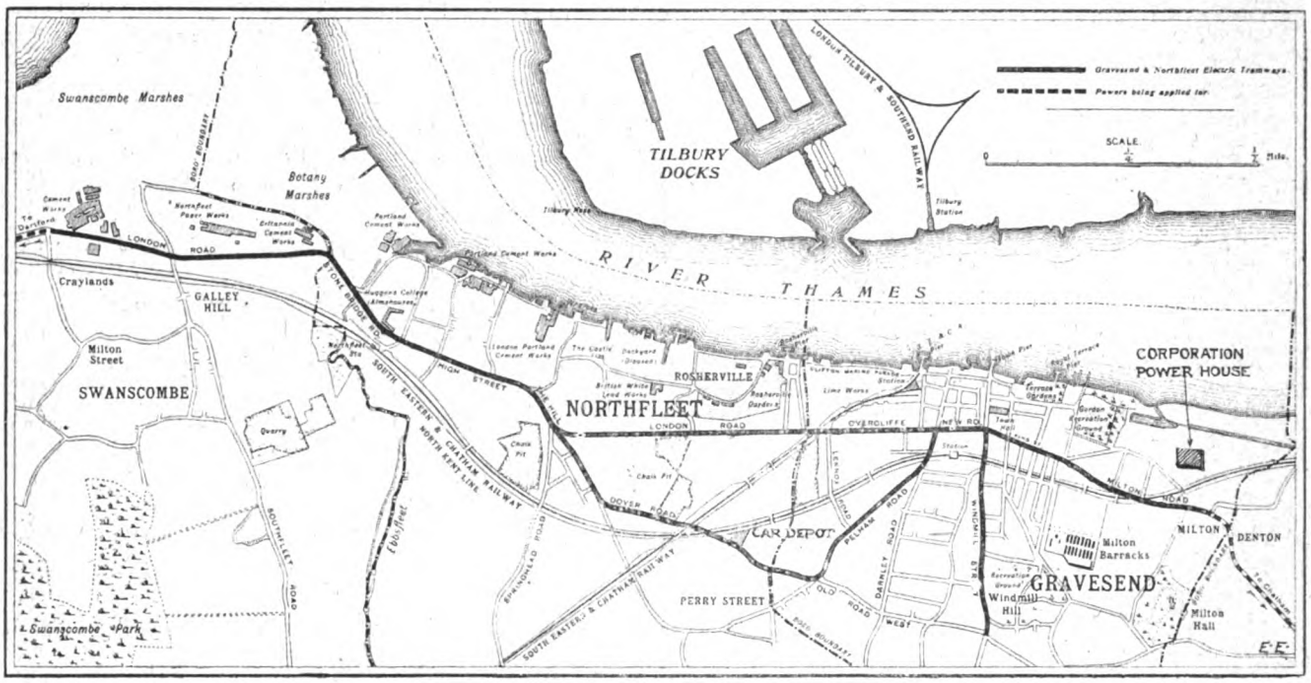
GRAVESEND BOROUGH ELECTRICITY SUPPLY.

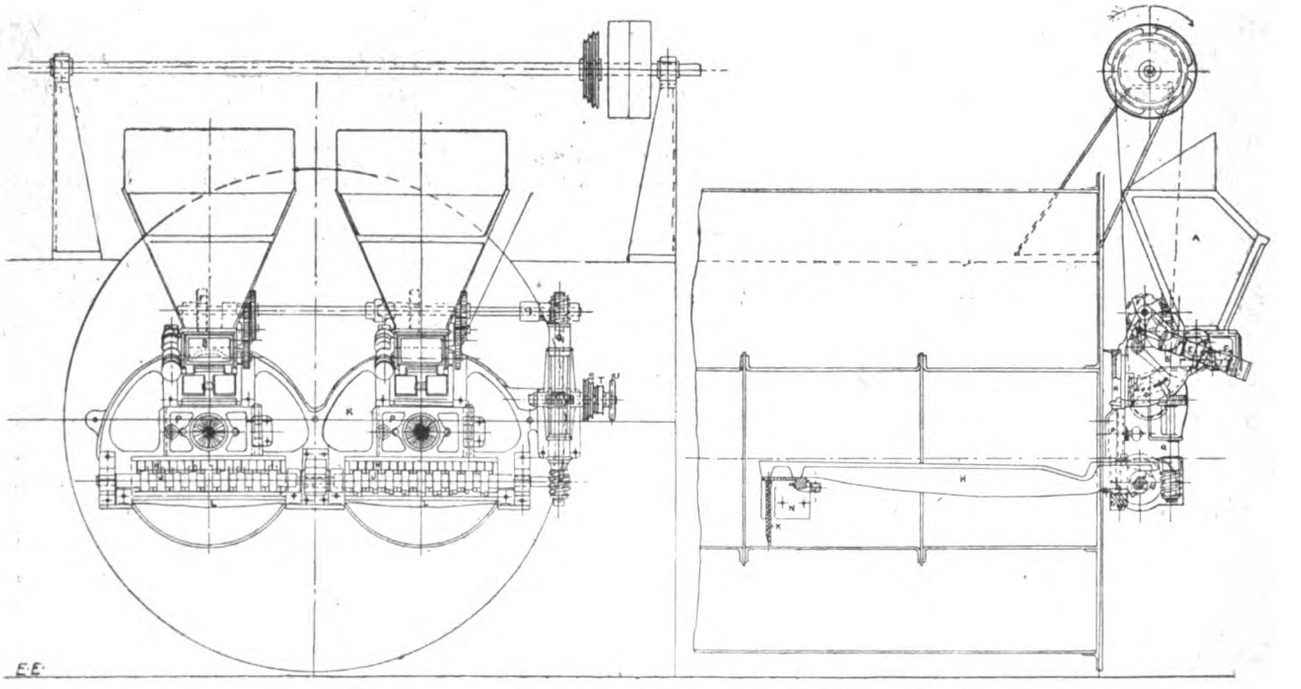
BY B. PONTIFEX.

The above scheme was originally designed by Mr. W. H. Trentham, and has recently been extended to cope with the extra load due to traction and increased lighting. The alterations and additions have been carried out by Mr. C. F. W. McInnes, the electrical engineer to the Corporation. Low-tension continuous current is supplied on the three-wire system, with separate mains and feeders for public lighting, private consumers, and traction work.



Map of the Gravesend and Northfleet Electric Tramways.

Power-House.—This is situated near the river, close by the canal basin at the boundary of Milton and Denton parishes, in a convenient position for railway facilities, and also for securing circulating water. Feed water is obtained from an artesian well, 150ft. deep, sunk by Messrs. Isler, and fitted with a three-throw Isler pump, and a 2-b.h.p. Western Electric Company's motor. The average demand is for 1,000 gallons per hour, though, as the result of an experimental trial, 250,000 gallons were obtained in 10 hours. There are three Babcock and Wilcox boilers, and two Lancashire. One Babcock boiler receives the hot gases from a four-cell Sterling refuse destructor as a supplement to its own grate, which arrangement is estimated to produce 100 h.p. if the refuse is of fair burning quality. This boiler is of the double-drum pattern, and is capable of evaporating 8,000lb. of steam per hour, at a pressure of 180lb. per square inch, which is lowered by a reducing valve to 160lb. per square inch. The other two Babcock boilers are of the single-drum type and have an evaporative capacity of 6,400lb. per hour at 160lb. pressure. All the boilers, except the double-drum Babcock and Wilcox, are fitted with "Triumph" mechanical stokers made by Messrs. Ransomes and Rapier, Ipswich, and driven by electric motors from a countershaft. The Lancashire boilers, built by Messrs. Galloway, are 30ft. × 8ft., fitted with five Galloway cross-tubes to each flue. They can each evaporate 6,700lb. of steam per hour at 165lb. pressure, and are fitted with "Triumph" mechanical stokers and Sugden's U-tube superheaters with isolating dampers. There is a 96-tube Green's economiser with by-pass flue. The feed pumps are two compound, vertical, double acting, by Messrs. Hall, of Peterborough, and are capable of



Elevation and Section of the Triumph Stoker.

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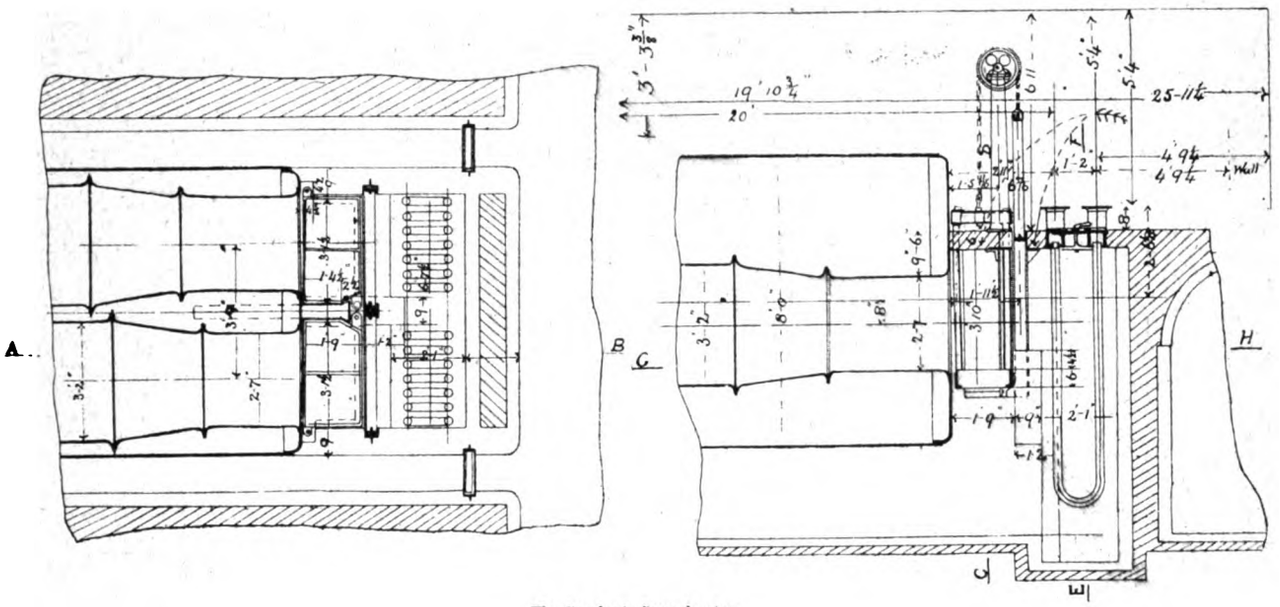
dealing with 3,000 and 2,000 gallons of water per hour respectively. The Lancashire boilers are also supplied by a three-throw motor-driven pump, supplying 1,100 gallons per hour. The armature of this motor has a double commutator and winding, which, by means of a change-over switch, allows the two halves of the armature to be put in series or parallel, so that with the help of a regulating resistance any speed may be obtained from 450 revolutions per minute to 900 with good efficiency.

Maclellan Lancashire dynamo sets, working at 160lb. pressure. The engines are three-crank tandem compound enclosed single-acting, 11in. × 18in. × 9in. stroke, running at 400 revolutions per minute, and fitted with piston valves. Contrary to general practice, the dynamos are not overcompounded, which necessitates the use of positive boosters for the traction load, as will be seen farther on; they also have a switch fitted on the magnet frame of each machine, to enable them to be run as shunt machines for

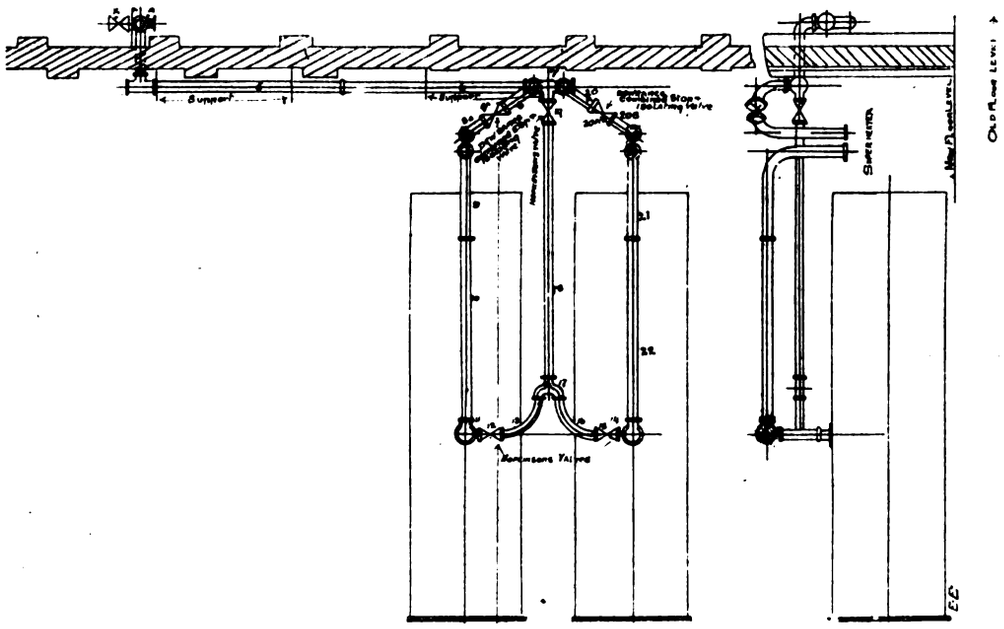


The Sugden's Superheater.

Estimates are now being obtained for the erection of a coal store in accordance with designs by Mr. McInnes, fitted with automatic coal-handling plant, with a capacity for dealing with 350 tons. Coal will be tipped out of trucks into the elevator hopper and be carried up to the large conveyor which will distribute it over the floor of the coal store by means of suitable outlets. When the coal store is full, or before that if necessary, these outlets can be closed. Coal will then be taken along the small conveyor, and delivered into the hoppers of the mechanical stokers at each boiler. In order to empty the coal store, a small conveyor along the front of the store picks up coal from the store floor and redelivers it into the hopper at the foot of the elevator. The Corporation have also recently sanctioned a proposal by Mr. McInnes to instal a storage tank of 15,000 gallons capacity, with the necessary filter tanks for improved methods of treating the feed water, but the details of this are not yet available.

The engine-room contains three 200-kw. Alley and accumulator charging. The engines are fitted with ejector condensers. There is also a 100-kw. Belliss-Westinghouse set in course of erection, to run at 450 revolutions per minute at 160lb. pressure, the engine being two-crank compound enclosed with central valves. There is a 7in. centrifugal pump by J. and H. Gwynne, driven by a 10-h.p. motor by the Lancashire Dynamo Company, for pumping the circulating water.

The main switchboard, supplied by Messrs. Brook,



The Steam Pipes as Rearranged at Gravesend.

Hirst, and Co., of the Northgate Electrical Works, Chester, is of enamelled slate, with separate panels for each section, but not for each generator or feeder. The lighting section is arranged on the plug principle, so that any generator can be put on to any feeder. The battery section contains the usual regulating step-by-step switch, on the negative end of the battery, and connections for the lighting boosters and balancers; each generator can either be put on the traction or lighting circuits. Western Electric and Thomson-Houston circuit

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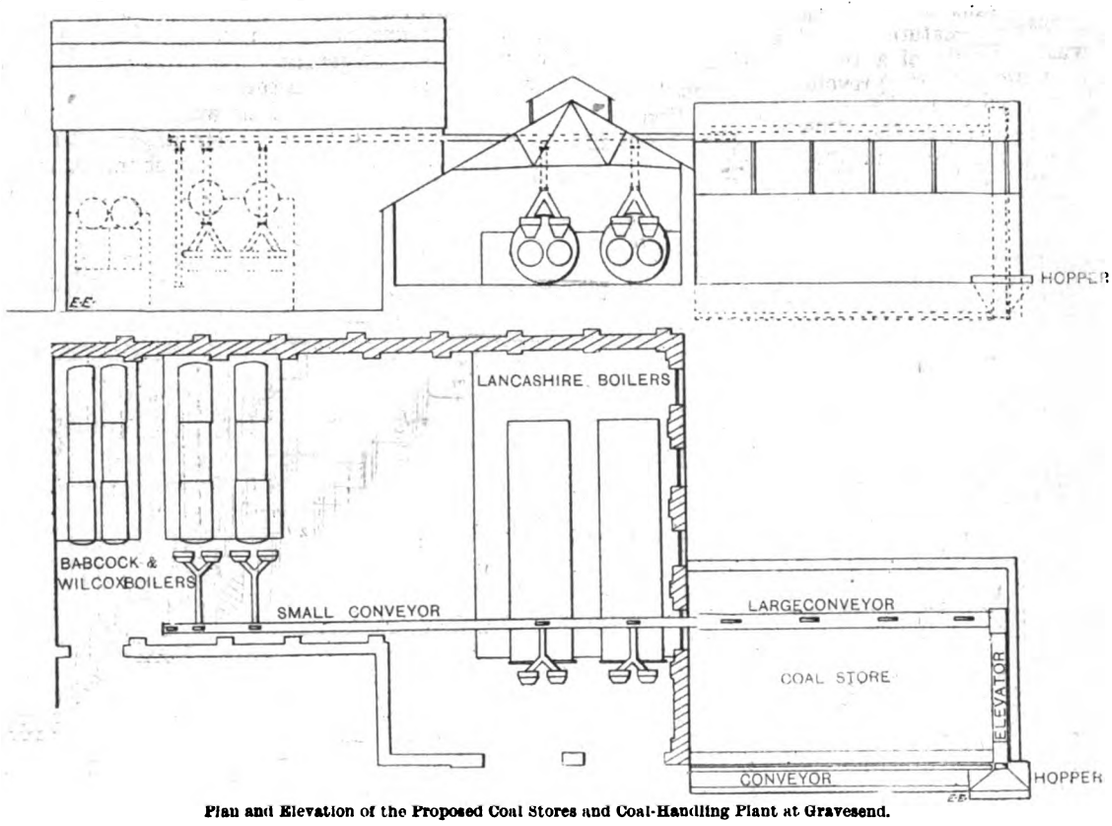
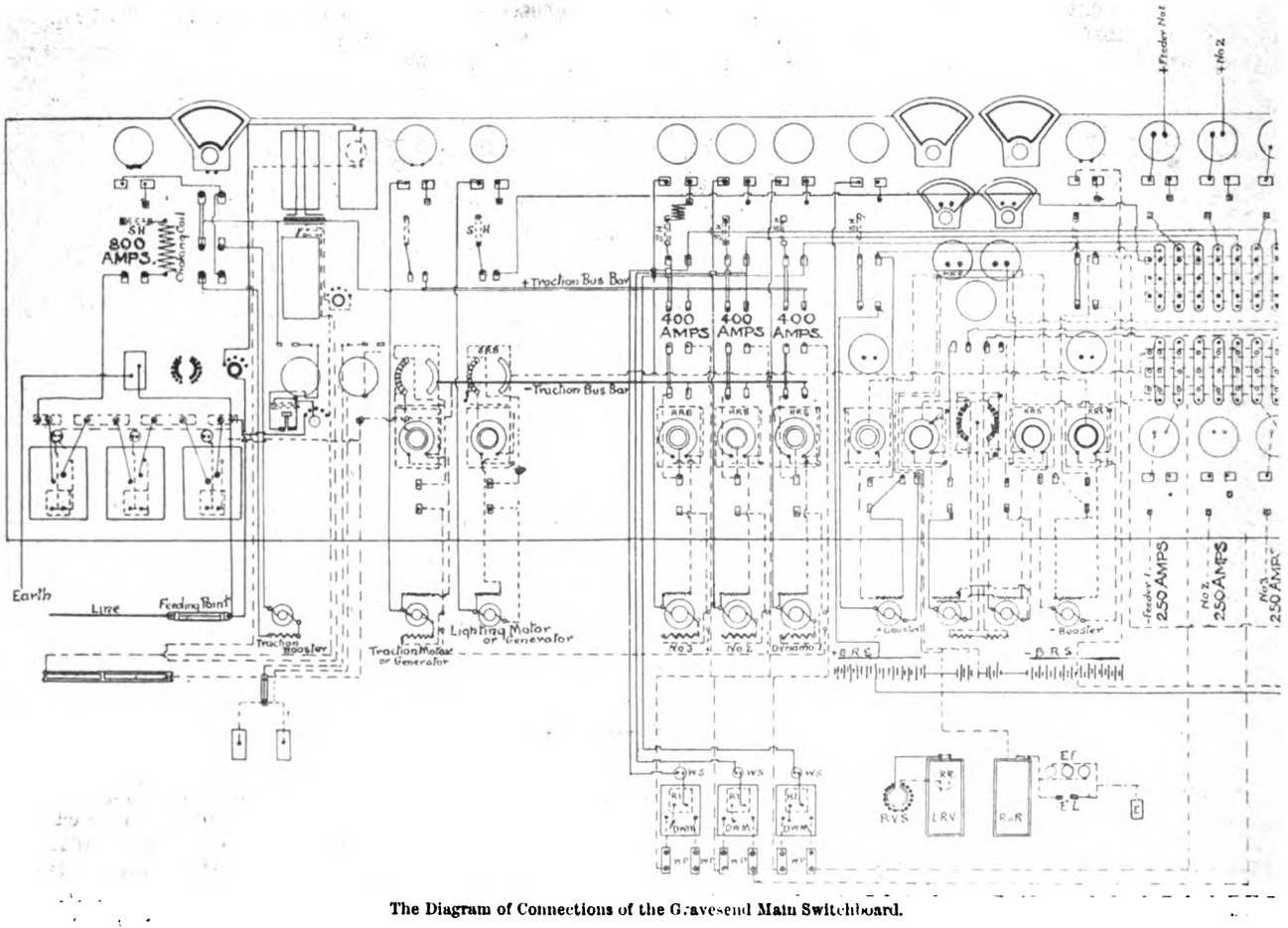
breakers are now being fitted. The generator switches, etc., carry 400 amperes, each lighting feeder panel is constructed for 250 amperes, and the traction board for 800. The traction board has the usual Board of Trade connections, and also change-over switches, so that the positive booster can be switched in to help the generators when necessary. This booster, which can carry 500 amperes at 60 volts, is on an extension of a 50-kw. motor-generator, which is arranged so that the traction side can take the lighting at light loads and *vice versâ*. The lighting balancers can work up to 38 kw. at 250 volts, while the boosters are constructed to give 100 amperes at 110 volts. All cables have disconnection links placed under the switchboard gallery.



Plan and Elevation of the Proposed Coal Stores and Coal-Handling Plant at Gravesend.

There is a battery of 280 640 ampere-hour accumulators by Messrs. Pritchetts and Gold in glass boxes, 23 plates per cell, arranged on wooden stands in two tiers. These are always in use for lighting, and have only on rare occasions been placed on a traction load. The station is fitted with a hand-driven 10 ton overhead travelling crane by



The Diagram of Connections of the Gravesend Main Switchboard.

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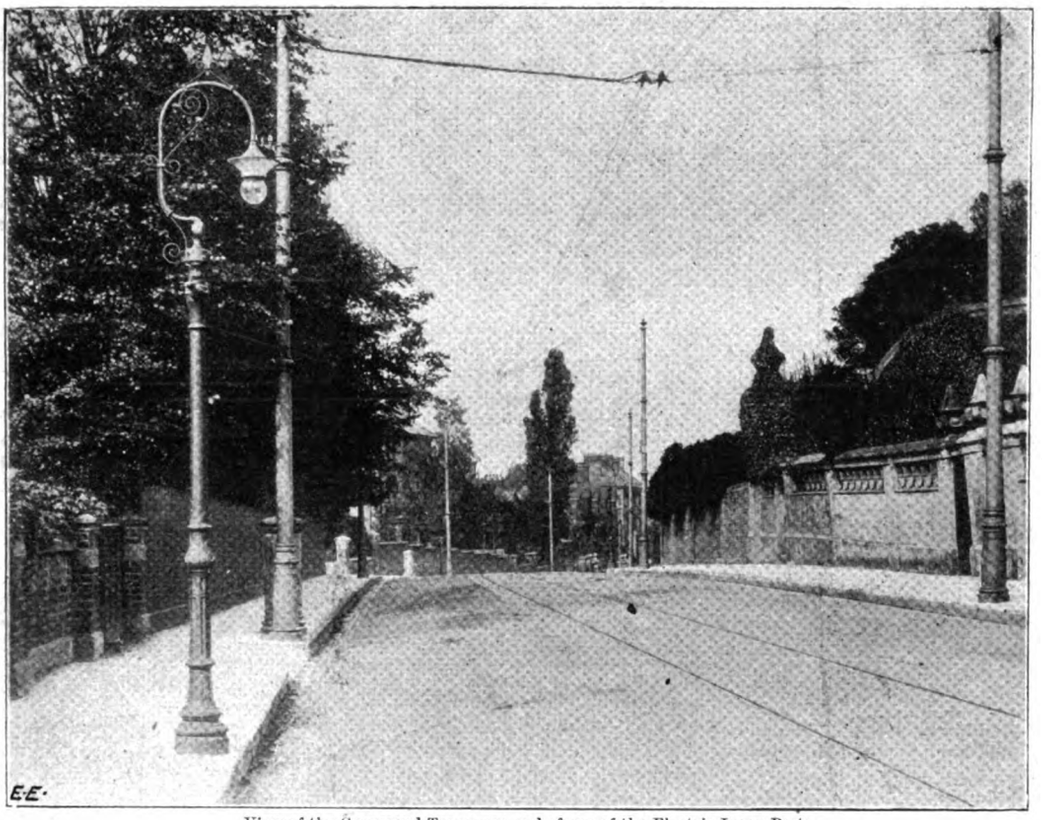
Messrs. Garrick and Sons, of Edinburgh, having a span of 38ft. There is also a small workshop for effecting any repairs or alterations which are necessary.

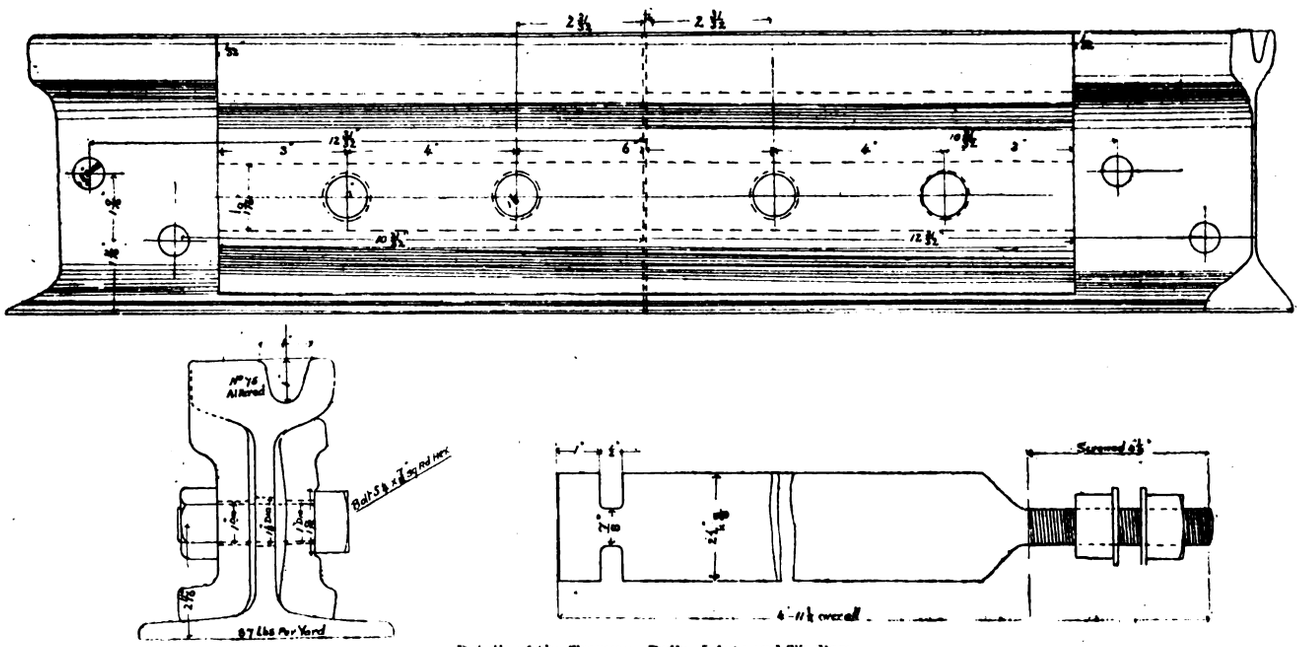
Mains.—These are made by the Western Electric Company, and are lead-covered, paper-insulated, laid solid in wooden troughing and stoneware conduit. The four feeders are triple concentric, with a positive inner and neutral outer, the cross-section of each in square inches being as follows: ·25 × ·25 × ·12, 2 × ·2 × ·1, ·12 × ·12 × ·06, ·1 × ·1 × ·05. The distributors are three-core twisted cables, paper-insulated and lead-covered, and laid in the same way as the feeders. Their size is ·125 square inch × ·125 square inch × ·062 square inch.



View of the Gravesend Tramways and of one of the Electric Lamp Posts.

success of the scheme can best be judged by the fact that Nernst lamps have been ordered to be fitted as opportunity occurs, wherever the public mains are carried. The average life of the lamps is rather over 700 hours. Some of the arc lamps are suspended from the tramway side poles. There is a private telephone installation, so that an employé can communicate with the power-house from any feeder box. Ferranti and Bastian meters are used.

Tramways.—These are run by the Gravesend and Northfleet Electric Tramways Company, who purchase their electric energy from the Gravesend Corporation. At present there is in operation 6½ miles of single track with turn-outs, consisting of the main line, Denton to Swanscombe, a loop line from Gravesend to Northfleet, and a shuttle line along Windmill-street. Extensions are now being negotiated to Dartford and to Chatham. The gauge of the line is 4ft. 8½in. The feeders are two ·3 square inch twin concentric, paper-insulated cables, laid solid in wooden troughing with the outer earthed at the generating



Details of the Tramway Rails, Joints and Tie-Bars.

The public lighting is varied in character. There are three sets of nine open-type arc lamps by the New Century Company, 30 enclosed Western Electric arcs, two in series, and 55 ½-ampere Nernst lamps. These last were adopted in order to keep the public lighting cost at the same or a lower figure than the previous gas contract; the

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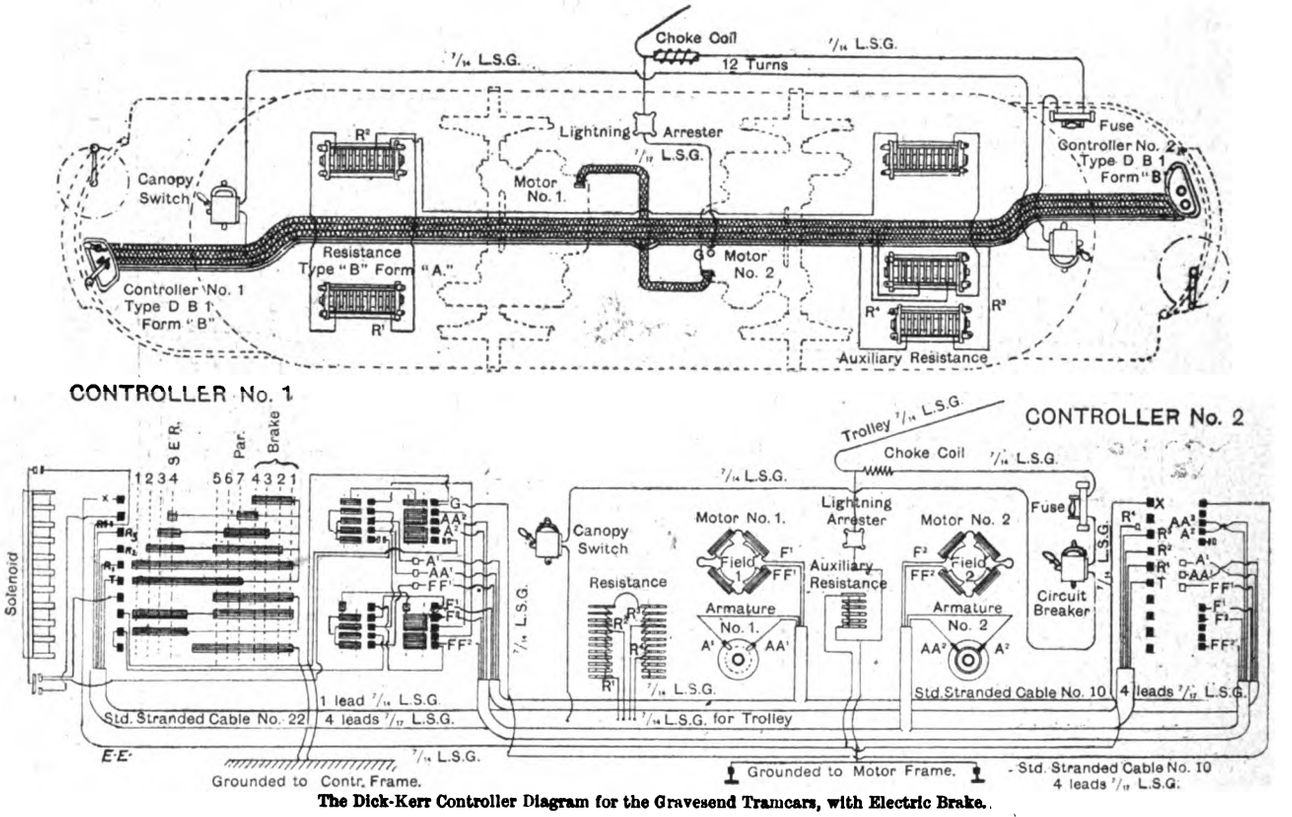
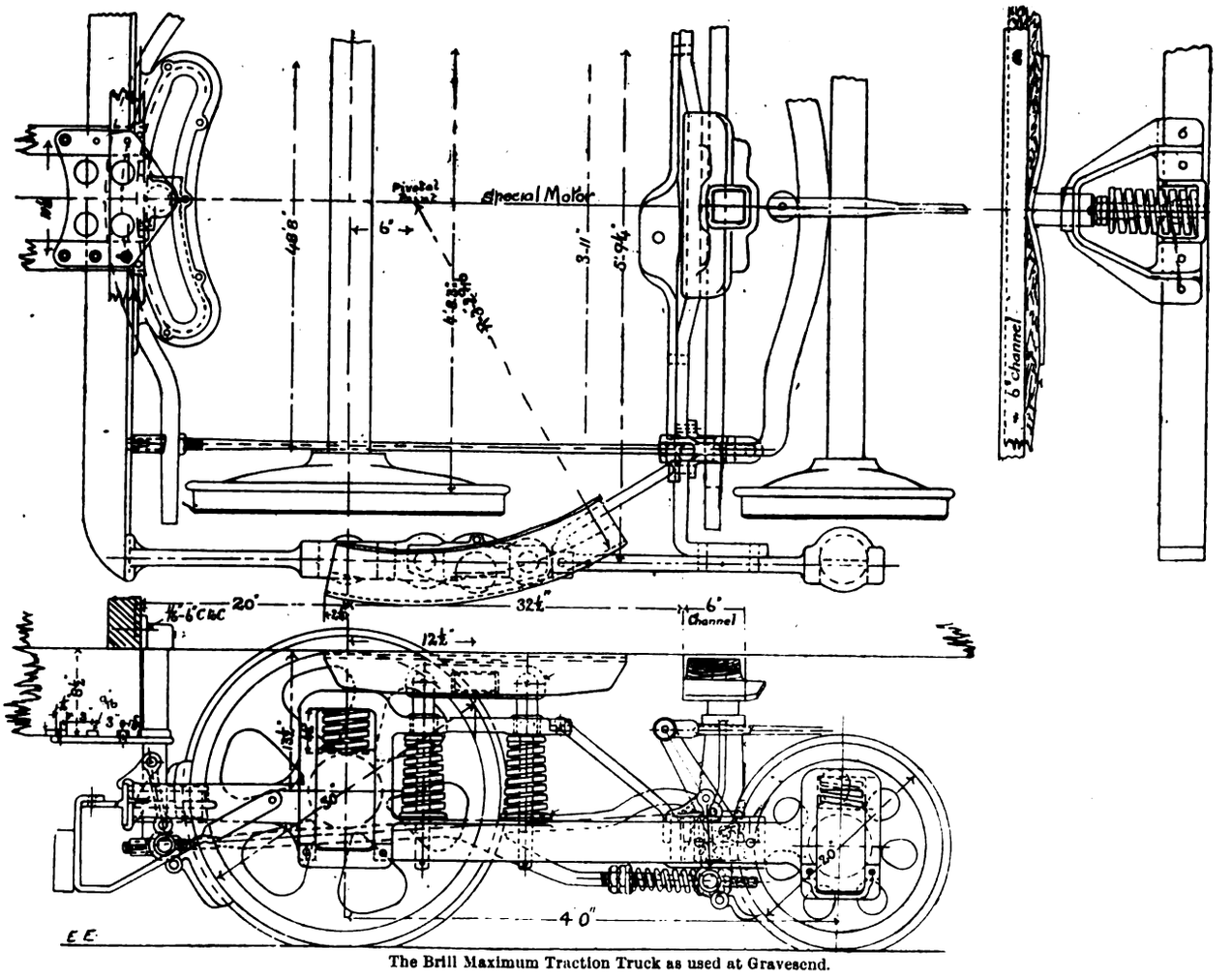
station. The sub-feeders are single cables of the same type, varying in sectional area from .3 to .25 square inch. These are all laid solid, and, together with the main feeders, were supplied by the Western Electric Company. There is also a four-core $^{7}/_{21}$ pilot cable. The feeder pillars are of the British Electric Traction Company's standard pattern with Brush panels and Bates fuses, a telephone being fitted to each pillar in a separate cast-iron box; the telephones are supplied by the General Electric Company.



The Dick-Kerr Controller Diagram for the Gravesend Tramcars, with Electric Brake.

The overhead work was carried out by Messrs. G. Hill and Co The trolley wire is 0 S.W.G., and is suspended from side bracket arms and span wires, flexible suspension being used throughout the job. There are no centre poles,



The Brill Maximum Traction Truck as used at Gravesend.

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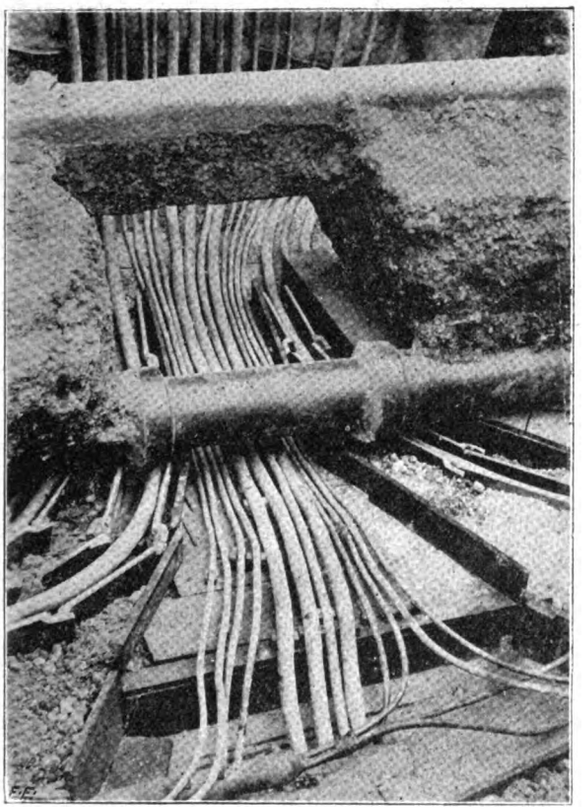
At every turn-out, from which it is impossible to see the next one, signalling apparatus has been installed by Messrs. Saxby, Farmer, and Co., who have fitted their "Dover" type of signals throughout. The track is of standard construction, the girder rails weigh 87lb. per yard, and the joints are Messrs. Dick, Kerr, and Co.'s patent without sole-plates. There are two "Columbia" bonds to each joint, and cross-bonding is used every 100 yards.

There are 20 cars at present in use, 10 single-truck and 10 double-bogie, all of them double-decked cars of the Liverpool with reversed stairway, supplied by Messrs. Dick, Kerr, and Co. The trucks are of Brill standard patterns 21 E and Eureka. The bogie cars are run with the pony wheels leading, although the trucks were not built for this, increased smoothness of running and less hammering on the permanent way being the most noticeable results. The cars are fitted with hand wheel brakes, lever track brakes, and electric short-circuiting brakes, and also carry Tidswell standard lifeguards.



Cable Laying at Gravesend.

The car depôt is situated by the railway on the loop line between Gravesend and Northfleet, and has five tracks each with a pit running the full length of the shed and connected by means of a subway with a small bogie running on metals for carrying heavy machinery from one pit to another. One track is prolonged into the paint shop, and one into the repair shop, which is furnished with the usual tools, including a 120-ton Miller wheel press, lathes, jacks, drills, etc. A 5-h.p. Westinghouse motor drives all machine tools by means of a countershaft carried under the floor. The depôt is laid with 65lb. Vignoles rails spiked to sleepers.

My best thanks are due to Mr. McInnes, the Corporation electrical engineer; Mr. Kipping, the tramways manager; and Mr. Barber, the tramways engineer, for their courtesy in affording all possible assistance in the preparation of the above article.

ELECTRIC FIRE ALARMS v. AUTOMATIC SPRINKLERS.

On Wednesday, the 4th inst., an interesting trial of the May-Oatway fire-alarm system took place in the offices of the *Glasgow Herald*, Buchanan-street, Glasgow, in the presence of a large number of leading merchants, scientists, engineers, fire brigade and insurance experts. Prior to the test being made, Mr. Oatway explained that the alarm differed from others, inasmuch that it did not necessitate a fixed temperature as the call point, but was compensated to maintain an even actuating point of 25 per cent. above the normal temperature of the apartment. The position of the fire in the building was indicated by the lowering of a drop indicator, and a distinctive signal was transmitted to the fire station over a metallic circuit line wire by a specially constructed automatic transmitter. At the fire station, in addition to the imprinting of this Morse code signal on a tape, a legibly inscribed shutter fell indicating the name of the building attacked. The tape signal acted as a check on the lowering of the shutter, insomuch as the latter might be dropped by a fault on the line, in which case the Morse signal would not be given. The shutter in turn prevented the misreading of the code signal by the officer at the fire station. In order that the test might be thoroughly impartial, a committee consisting of the fire-masters of Edinburgh, Glasgow, and Aberdeen, Dr. Gourlay, Mr. W. A. Chamen (electricity works), and Mr. Buyers Black (of the Liverpool, London, and Globe Insurance Company), and Mr. D. L. Laidlaw (of the North British and Mercantile Insurance Company) were appointed to time and regulate the test, while two gentlemen were selected from the spectators to proceed to the fire station as a guarantee against any special provision being made there to facilitate the test. The test was of a rigid nature, as may be seen from the official report given below. The results were of a highly satisfactory nature, as may be indicated by the fact that the fire brigade was on the spot several minutes before the sprinkler began to eject water. This report of the above committee reads as below:

"We, the undersigned, the committee nominated to supervise comparative test of the May-Oatway automatic fire-alarm system with the sprinkler installation at the *Glasgow Herald and Evening Times* building report as follows: The fire, consisting of two spirit tanks, one 24in. in diameter and the other 36in. by 18in., was placed in a position on the floor level indicated by us about 7ft. equidistant from each of a group of three sprinklers, and 12ft. from the 7½ft. May-Oatway detector, adjusted to ⅜in. Windows and doors were kept open during the test, and representatives were sent to the fire brigade station to see that no preparations were made in advance for the call. Temperature 60deg. F. Dimensions of room furnished by the engineer to the *Herald*, 66ft. by 50ft.; area, 3,300 square feet; height, 12ft.; protection, 42 sprinkler heads, two May-Oatway detectors. From the lighting of the fire the May-Oatway alarm sounded in 1 min. 4 sec. The indicator showed fire in publishing room on ground floor of Mitchell-street block, and the alarm was telegraphed to the central fire station. Sprinkler installation started 11 min. 22 sec., ejecting air; water a few minutes after. Fire brigade arrived 3 min. 45 sec. from ringing of alarm. Salvage corps arrived 3 min. 50 sec. Diameter of additional spirit tanks lighted, if any, after May-Oatway alarm was given, *one of 24in.*"

(Signed) ROBERT GOURLAY, as representing the *Glasgow Herald*; WILLIAM PATERSON, firemaster, Glasgow; A. PORDAGE, firemaster, Edinburgh; DANL. L. LAIDLAW, North British and Mercantile Insurance Company; J. BUYERS BLACK, Liverpool and London and Globe Insurance Company; W. INKSTER, firemaster, Aberdeen; W. T. CHAMEN, Glasgow Corporation electrical engineer."

"We certify that no preparation had been made at the fire station prior to receipt of the alarm.

"E. H. MONTGOMERY and JAS. TYRE."

Newcastle.—At a meeting of the Tramways Committee it was agreed to make a survey of the proposed extensions in Heaton district. With reference to the wages and employment of persons to act as motormen and conductors, it was arranged that a report should be prepared by Mr. Le Rossignol dealing with the subject, to be presented at the next meeting of the committee. It was agreed that steps be taken to obtain about 2,000 tons of new rails to be used for renewals. It was also agreed that the rails should be obtained from English firms, if possible.

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WILKINSON OVERHEAD TRAMWAY ACCESSORIES AND SIGNALLING SYSTEM.

The cost of upkeep of an overhead system of an electrical tramway is closely bound up in the type and durability of the accessories used. Defects in construction tending to increase this cost are, of course, discovered after trial, and in consequence it is to tramway engineers that we have to look for improvement in design of such accessories. The following fittings are the invention of Mr. J. Wilkinson, the tramway engineer to the Hull Corporation, and they will be of great interest to all tramway men.

The trolley tester (Fig. 1) is an ordinary ear with a loose centre piece, E, arranged to move vertically up or down. When the trolley wheel passes under E, this is lifted, and either the circuit of an electric bell is closed or a mechanical gong is struck. To perform either of these operations, however, the spring of the trolley pole must be sufficiently screwed up to lift the dead-weight, C, which is carried on an extension of E. As a general rule, trolley-pole springs err in being too slack, with a resultant tendency to jump the wire, especially at frogs and crossings—a defect which the present form of the apparatus shows perfectly. One of these trolley testers fixed just outside each car-shed would show if the trolley on each car is in order as the cars leave the shed each day.

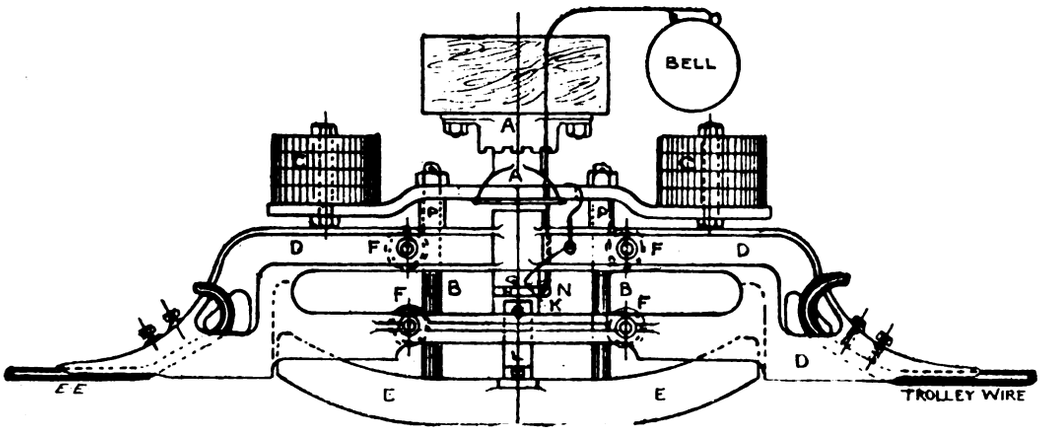

FIG. 1.—Wilkinson's Patent Trolley Tester. A A, car shed suspender; B B, guide rods; C C, adjustable weights; D D, trolley ear E E, movable runner; F F, guide sheaves; G, ebonite; H, contact piece; K, contact screw; L, flat spring; M, flexible connection; N, terminal from bell: P, loose distance pieces.

Some New Line Fittings.—The trolley signalling ears (Fig. 2) are an adaptation of the same principle to signalling, the upward pressure of the trolley raising the loose centre-piece of the ear until contact is made between insulated terminals which close the circuit that actuates the signalling apparatus. The difference between the details of the two ears shown is owing to the fact that A is for use on systems that employ independent batteries for the signalling work, and B for those that use current from the line. B would appear to be simplest and most easy to maintain. A diagram of the signalling connections is

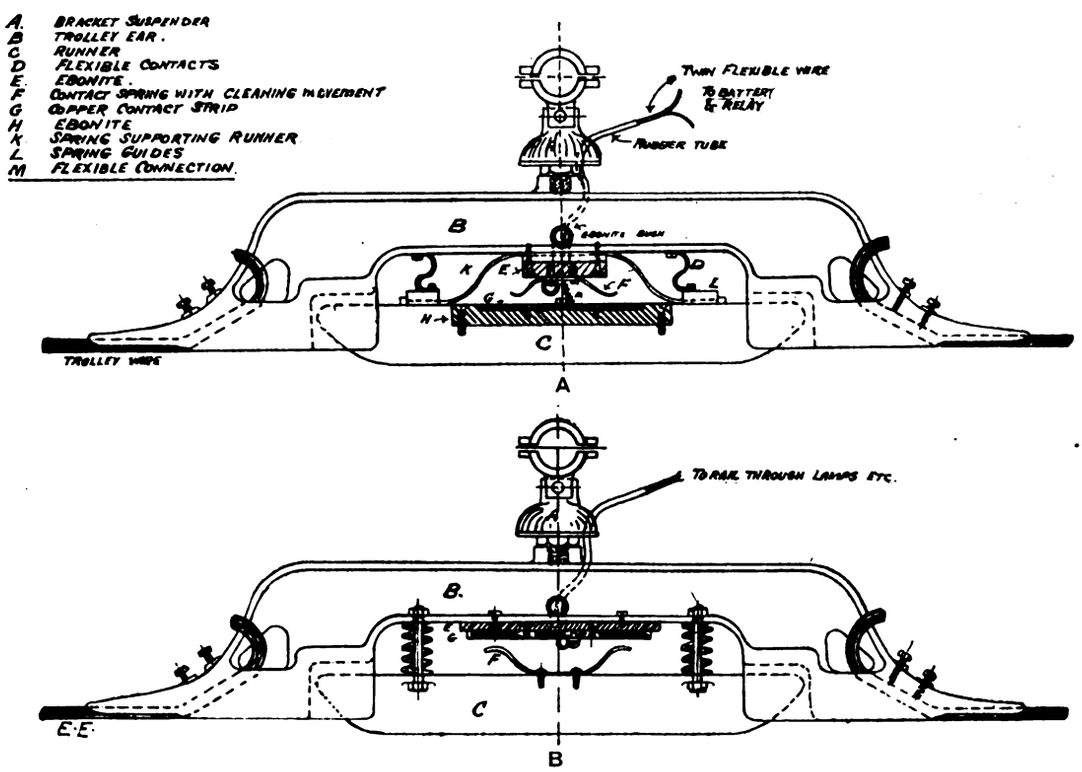

FIG. 2.—Signalling Ears.

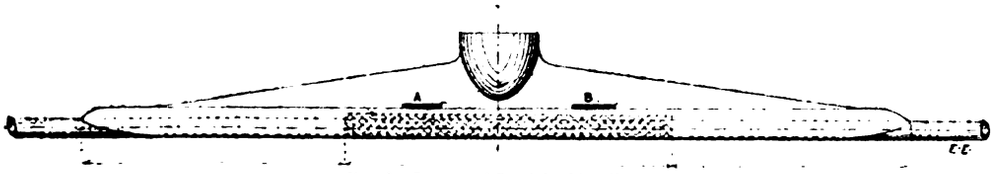

FIG. 4.—Improved Straight-Line Ears.

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shown (Fig. 3). It will be seen that when the contact at A is closed the armature switch D is pulled down, whereupon the magnet, F, is excited and places the semaphore in the "danger" position, where it is locked by the lip and catch, K and L; as soon as the trolley leaves the ear, A, contact is broken, and the semaphore arm remains locked until the trolley reaches A_2, when the armature switch D_2 is pulled down and current passes through the magnet, N, which attracts L and releases the semaphore, which drops to the "clear" position. The feature of the straight-line ear, shown in Fig. 4, is that slots are provided at A and B where solder and flux can be applied, so that the wire is only soldered to the ear at the centre, thereby leaving the physical condition of the wire unaltered by heat at the ends of the ear, where mechanical strength is most important.

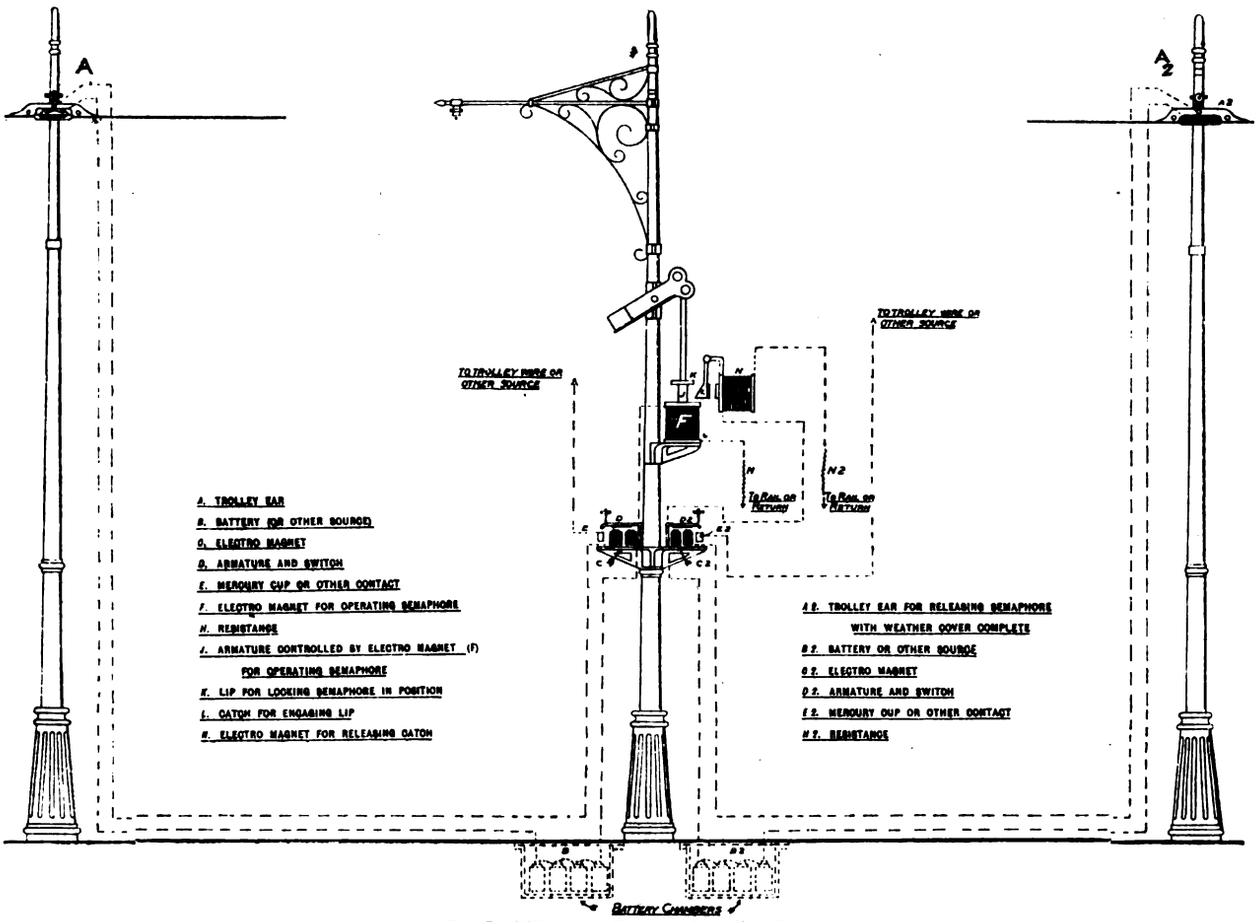

FIG. 3.—Wilkinson's Tramway Signalling System.

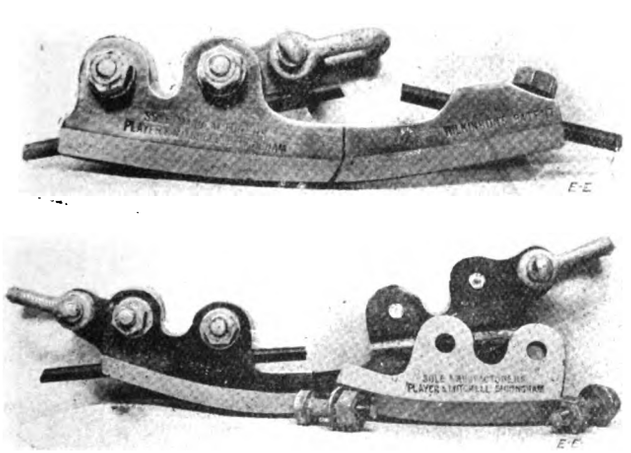

FIG. 5.—Wilkinson's Emergency Clamps for Repairing Broken Trolley Wires.

Fig. 5 shows some emergency trolley clamps for use when the wire breaks during running hours. They are speedily fixed, and allow cars to run past the repair without any necessity to either slacken the pace or swing the trolley over the joint. The first illustration shows a clamp for use, one on either side of a broken ear, the lower one for use between ears. They are strong and easily fixed, and have been proved to give satisfaction in use. It will be further noted that the clamping grooves are arranged at an angle that brings the two halves of the broken wire together in a straight line without any bending of the loose ends, which would only prove a further source of weakness, especially in the scramble that usually takes place over emergency repairs.

With the above brief notice we would commend to our readers the tramway accessories patented by Mr. Wilkinson. The drawings and photographs make further detailed description unnecessary, but the articles seem to fill distinct requirements which have been discovered in the practical running of the overhead trolley system. All these accessories are being manufactured and put on the market by Messrs. Player and Mitchell, of Birmingham.

FORTHCOMING EVENTS.

MONDAY, NOV. 9.

Institution of Mechanical Engineers (Graduates' Association).—At 7.30 p.m., ordinary meeting. Paper: "Heating and Ventilating on the Plenum System," by Mr. Walter H. A. Robertson.

TUESDAY, NOV. 10.

Institution of Electrical Engineers (Glasgow Section).—At 8 p.m., ordinary meeting. Inaugural address of Mr. Wm. A. Chamen, chairman.

Institution of Civil Engineers.—At 8 p.m., ordinary meeting. Paper: "Tensile Tests of Mild Steel, and the Relation of Elongation to the Size of the Test-Bar," by Prof. W. C. Unwin, F.R.S.

THURSDAY, NOV. 12.

Institution of Electrical Engineers.—At 8 p m., opening meeting. Address of Mr. Robert Kaye Gray, president.

FRIDAY, NOV. 13.

Physical Society.—At 8 p.m., ordinary meeting, Royal College of Science. Papers: "Means for Electrifying the Atmosphere on a Large Scale" and "An Arrangement for Driving Mercury Pumps," by Sir Oliver Lodge.

Electro-Harmonic Society.—At 8 p.m., "Ladies' Night" concert in King's Hall, Holborn Restaurant.

SATURDAY, NOV. 14.

Glasgow Scientific Society.—At 7.30 p.m., ordinary meeting. Paper: "Motorcars," by Mr. Alex. Govan.

West Hartlepool Scientific Society.—At 7.30 p.m., ordinary meeting. Paper: "The Absurdities of the Present System of Measures," by Mr. Wm. C. Barrowman.

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QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any questions should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

633. Several car axles of an electric tramway have broken lately, all *exactly* in the same place—viz., ½in. inside keyway of gear wheel. Upon examination of these and other axles they show signs of being eaten away by electrolysis. Describe a remedy for this, also the action of the electric current upon the axles. The motor box is used for the earth return.—JANET.

634. Describe the theory and working of the Diesel oil-engine, and state wherein its advantages lie over a good make of ordinary oil or gas engine.—E. R. A.

ANSWERS.

Question No. 625.—If a three-core distributor (of ·15 square inch section) was supplied at one end with three-phase currents from three single-phase transformers connected on the mesh system, having 220 volts on the secondary coils; if incandescent lighting constituted the whole of the load. and consumers were supplied with single-phase current from one of the three sides at the rate of one ampere per two yards run, arranged so as to obtain a good balance—(1) How would the carrying capacity and drop be calculated? (2) To what distance would it distribute efficiently? (3) How would the lamps on each phase be affected if (*a*) one transformer burnt out, (*b*) one of the three low-tension fuses blew, (*c*) one of the high-tension transformer fuses blew?

Best Answer to No. 625 (*awarded* 10*s.*).—Customers taking one ampere for every two yards run, and the circuits being evenly balanced, it follows that one ampere is taken off each phase on six yards, and consequently the current in each core of the cable is increased by $\sqrt{3}$ amperes for every six yards run. The diagram with one one-ampere lamp on each phase would be as shown in Fig. 1; thus with a length

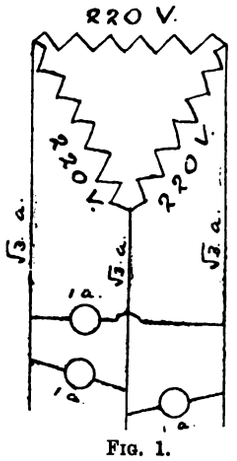

FIG. 1.

of x yards of distributor the current entering each core of the cable will be

$$\frac{\sqrt{3}\,x}{6} \text{ amperes} \quad . \quad . \quad . \quad . \quad . \quad (1)$$

and as it dwindles to nothing at the end the average current will be $\frac{\sqrt{3}\,x}{12}$ amperes per core. The resistance of stranded copper of ·15 square inch section may be taken as ·000166 ohm per yard. The resistance of each core of this distributor, x yards long, is therefore 000166 x ohm. The total drop in each core (average amperes × resistance) will be $\frac{\sqrt{3}\,x}{12} \times$ ·000166 x, and the drop, as measured across one side of the mesh at the extreme end, will be $\sqrt{3}$ times this, or $\frac{3x}{12} \times$ ·000166 x—*i.e.*,

$$\cdot 0000415\, x^2 \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

Note.—The relation between drop per core and drop on the phase is best seen from Fig. 2 (grossly exaggerated).

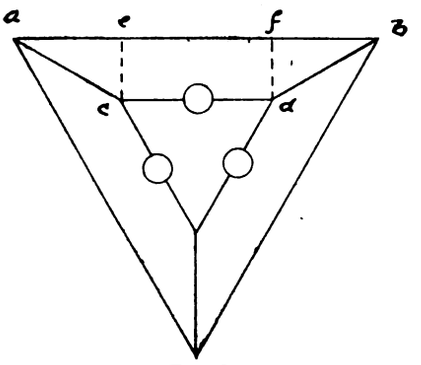

FIG. 2.

Here $a\,b$ represents the transformer voltage, $a\,c$ and $b\,d$ represents the voltage drop in two of the cores, and $c\,d$ is the voltage across that phase at the lamp. Clearly the total drop at the lamp is the sum of $a\,e$ and $f\,b$; or, with equal loading, $a\,c\,\sqrt{3}$—*i.e.*, $\sqrt{3}$ times the drop per core. The expressions (1) and (2) above give the current per core and maximum drop on the lamps for any length of distributor.

2. The determining factor in most cases as to length of distributor is the necessity of complying with the Board of Trade regulations, which stipulate that the voltage upon

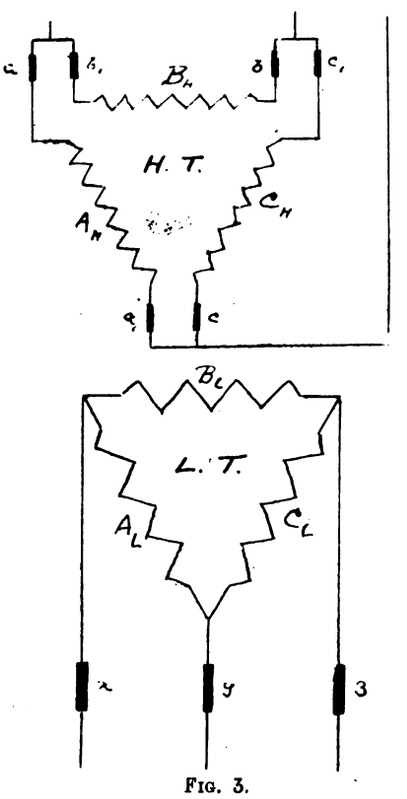

FIG. 3.

the distributing mains must be kept within 3 per cent. of the declared pressure, in this case 220 volts—*i.e.*, the voltage of all parts of the main must at all times lie between 213·4 volts and 226·6 volts, giving a range of 13·2 volts. What proportion of this may be safely dropped in the distributor must depend on many things, from the relative lengths of the high-tension feeders to the likelihood of customers substituting 32-c.p. lamps for present 16's; but, for the sake of illustration, we may suppose that a drop of eight volts in the distributor may be allowed at full load. Thus we have the drop as calculated above—viz.,

$$\cdot 0000415\, x^2 = 8,$$

$$x^2 = \frac{8}{\cdot 0000415} = 193{,}000,$$

or,

$$x = 440.$$

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i.e., we may run this distributor 440 yards without incurring a drop of more than eight volts on the furthermost lamp. The current entering this cable will be $\frac{\sqrt{3} \times 440}{6} = 127$, giving a current density at this point of 850 amperes per square inch, and this may be allowed in lighting work.

3. The wording of this part indicates that in the present case there are six fuses on the high-tension side (two to each transformer), and on the low-tension side three, or one on each core of the feeder. The connections are, therefore, as in Fig. 3 (switches are omitted). There may be three double-pole or one triple-pole on the high-tension, and one triple-pole on the low-tension.

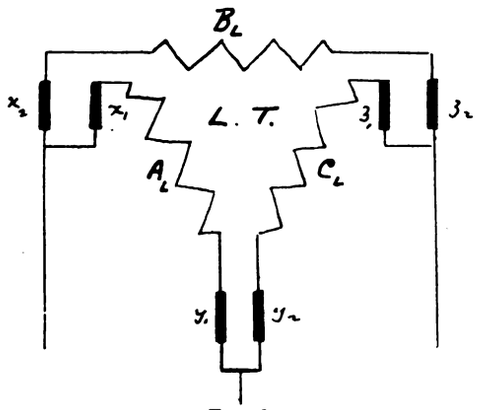

FIG. 4.

(*a*) If, now, one transformer, say A_H A_L, burns out, it will at once blow its high-tension fuses, *a*, a_1, but as its low-tension coils are connected to the two good transformers, it will be kept alive, and the burnout will, therefore, cause the other high-tension fuses—viz, *b*, b_1 and *c*, c_1—to blow as well. Supply will then be entirely off the distributor until the faulty transformer is cut out, and fresh high-tension fuses are supplied. If there are fuses on each transformer on the low-tension side, as shown in Fig. 4, then matters will still be the

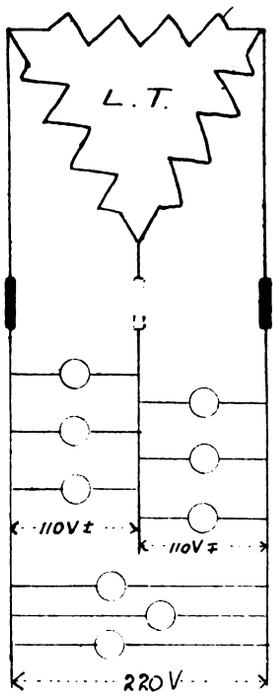

FIG. 5.

same, for on the transformer, A_H A_L, burning out and its high-tension fuses blowing, then the low-tension side will be fed from B_L and C_L through the fuses, x_2 and x_1 and y_2 and y_1, at its two ends; and as the fuses x_2 and y_2 will be carrying the line current as well as the burning-out current, they will blow before x_1 and y_1, and, as a consequence, supply will be shut down. If, however, these low-tension fuses, x_1, x_2, etc., were replaced by non return auto cut-outs, then a transformer might burn out and disconnect itself, leaving two transformers alive and able to keep up supply on all phases.

(*b*) If one of the three low-tension fuses of Fig. 3 blows, the connections on the low-tension side become as in Fig. 5, one phase remaining intact while what were the other two phases become the two halves of a three-wire system across the good phase. The voltage on these being something like half the proper voltage, of course the lamps upon them are useless as light givers If the low-tension fuses are placed as in Fig. 4, the circumstances become similar to "*c*," as below

(*c*) If one of the high-tension transformer fuses blows (*vide* Fig. 3), then we still have two transformers alive and at work—A_H and C_H, for instance These are supplied with the proper voltage and phase, and consequently produce the correct voltage and phase in their low-tension coils, and these maintain the proper relationship between the three cores, and hence the supply on all three phases is maintained. The third transformer is excited from its low-tension side, so keeps alive and in proper phase although the high-tension fuses are gone. The only point to be noted is this. Owing to the uselessness of transformer B, the current in A and C (assuming balanced lamps) is raised in the proportion of 1 to $\sqrt{3}$ (with, in addition, the no-load low-tension current of the third transformer), so that, if it was a heavy load that blew the one fuse, it is almost certain that the others will go too. If, however, the load is not too heavy, the blowing of the high-tension fuses on one transformer will not affect the supply. Should there be only three high-tension fuses arranged as the low-tension ones of Fig. 3, then the blowing of one will destroy the utility of two phases, just as discussed under (*b*), except that the two idle transformers will exactly balance the pressure on the two half-voltage circuits.—C. E. C.

Answer to No. 625 (*awarded* 7*s.* 6*d.*).—Let us first of all consider the exact relation between the current in each of the three cores of the cable and the length in yards.

The total current from the three phases } = 1 ampere every two yards.
The current per phase... = 1 ampere every six yards.
The current per core ... = $\sqrt{3}$ amperes every six yards.

If, then, the length of the distributor is *n* yards, the current flowing into each of the three conductors is

$$\frac{n}{6}\sqrt{3} \text{ amperes,}$$

and the average current is of course, half the current at the feeding end—that is

$$\frac{n}{12}\sqrt{3} \text{ amperes.}$$

From tables we find that the resistance of a copper conductor of sectional area ·15 square inch is about $\frac{1}{6000}$ ohm per yard, hence the drop in volts for *n* yards when carrying a current of $\frac{n}{12}\sqrt{3}$ amperes, is $\frac{n^2}{72{,}000}\sqrt{3} = \cdot 000024\, n^2$. This fall of potential can be shown by a curve most easily by starting at the distant end of the distributor and plotting

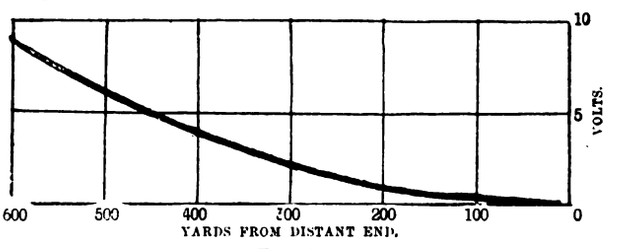

FIG. 1.

the relation between the rise of voltage and the yards travelled towards the feeding point. Such a curve is shown in Fig. 1; it is, of course, a parabola, and the ordinates at any point represent the total drop in the distributor when its length is that given by the abscissa.

In Fig. 2 is shown the vector diagram of voltages. A B C is an equilateral triangle whose sides represent the phase relationship between the impressed volts; each side represents to scale 220 volts. As we proceed from the feeding

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point the triangle shrinks in size, and at some distant point on the distributor the triangle A′ B′ C′ would correctly represent the actual E.M.F.'s; the lines A A′, B B′, and C C′ give in phase and magnitude the fall of potential in the three mains respectively, and can be obtained from the curve in Fig. 1, as described. It will be seen from Fig. 2 that A′ B′ is less than A B by an amount equal to $\sqrt{3}$ times A A′—that is, the E M.F. per phase is less than the impressed E.M.F. by 1·73 times the voltage drop that has taken place in each conductor of the three-core cable.

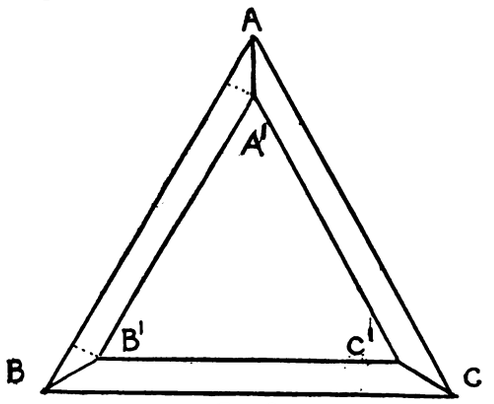

Fig. 2.

We can now calculate the maximum length of distributor that can be used, if the variation of voltage on the lamps is not to exceed 4 per cent. Suppose the voltage per phase at the feeding end is raised to 228, and the length of the distributor is such that when fully loaded the voltage at the far end is 212 per phase, so that the maximum variation from 220 is within 4 per cent. The reduction in voltage per phase is 16; therefore, the allowable drop in each conductor is $\frac{16}{\sqrt{3}} = 9{\cdot}25$ volts, and from reference to Fig. 1 the length of distributor is seen to be 620 yards. Under these conditions as to permissible fall of potential, the total current supplied to consumers is 310 amperes, and the distributor provides, of course, for both the outgoing and return currents of all three phases. The maximum current per conductor is $\frac{620}{6} \times \sqrt{3} = 180$ amperes approximately. For a current density of 1,000 amperes per square inch the current per conductor would be 150 amperes, so that the actual maximum current density attained is $\frac{180}{150} \times 1{,}000 = 1{,}200$ amperes per square inch. This is in no way excessive; it only applies to the first few yards of cable at full load.

In answer to (3*a*), the lamps would not be affected in any way by the burning out of one transformer, provided the remaining two were capable of maintaining their voltage and phase relationship, for on reference to Fig. 2 it will be seen that two sides of the triangle A B C are sufficient to fix the relative positions of the points A, B, and C.

(3*b*). If one of the low-tension main fuses blows, the supply becomes a single-phase one; one phase is unaffected. The lamps that were on the other two phases are now in series with the conductor whose fuse is blown, acting as a middle wire. The voltage on these two sets of lamps will be about half of the normal; exactly half if quite balanced.

(3*c*). If one of the high-tension fuses blows, the effect on the lamps will be nil, as when one of the transformers is burnt out [see answer to (3*a*)] the transformer whose high-tension fuse had blown would remain excited from the low-tension side.—SUPERHEAT.

Question No. 626.—Give sketch and description of a good clock switch for use in switching on and off incandescent lamps.

Best Answer to No. 626 (*awarded* 10*s.*).—Choice may be had of about 20 types of clock switch (many of them very unreliable). The requirements of a good clock switch are (1) simplicity of construction; (2) accuracy as timekeeper; (3) reliability of switch mechanism; (4) must not require frequent attention. To secure these requirements the clock should not itself supply the energy for the switch; the switch-off must be rapid; *mercury must not be used.*

Fig. 1 shows the most reliable clock switch that the writer has used, but it only switches off. A 4*s.* 6*d.* German alarm clock is taken. On the alarm mainspring spindle an eye of wire is soldered; a hole is bored in the case, and through this is put a piece of catgut fastened to the eye (when the clock is wound up). A bracket, B, is screwed to the wall with a projecting rod supporting the hinged platform, A. A 3lb. weight is attached by a cord and spring to the switch handle. The working is as follows:

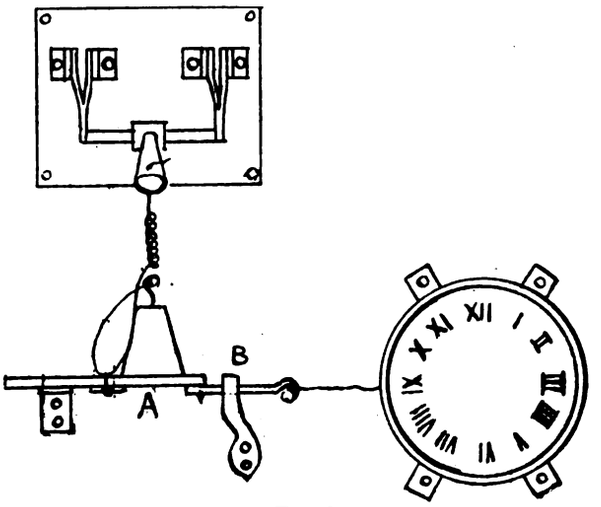

Fig. 1.

Set the alarm to the hour desired. Immediately this is reached the main spindle turns, winds up the gut and pulls away the rod supporting A, the weight drops and pulls off the switch. The spring on the cord should be somewhat stiff. To reset, wind up the mainspring of the alarm again, but note only a few turns are necessary.

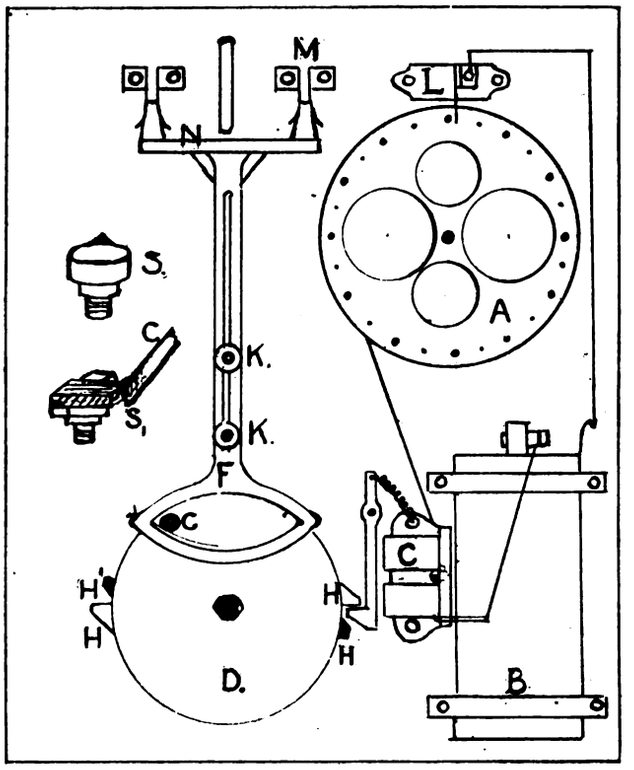

Fig. 2.

To switch off and on a more complicated apparatus is necessary, but the device shown will be found as simple as any, and quite reliable. It is not patented, so may be used by anyone. A and D (Fig. 2) are two double-spring Swiss 18-day clock mechanisms, costing wholesale 10*s.* each. On the hour spindle of each is firmly fixed (and in D bolted) a brass disc. In A holes are bored round the edge and tapped to receive the screw S, shown full size. The holes represent the hours and as many sub-divisions as the maker chooses to make. L is a vulcanite block with a brass piece screwed to it carrying a light nickel spring, which projects over the plate, A. The plate D has four projections, H, H, H^1, H^1, shaped as

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shown (Figs. 2 and 3), engaging with the armature of an electromagnet, C. The end of the armature is shown in detail in Fig. 3. G is a pin about 60deg. away from nearest H. F is a cam of shape shown, and struck with same radius as D; it is slotted as shown to receive two steadying pins, K_1, K. N is a vulcanite bridge carrying two copper wedges to make contact with switch tongues of double-pole switch, M. B is a dry cell. The plate A is perforated to allow of winding up the mechanism; D also is perforated, but for clearness this is not shown. The holes in A are numbered 1 to 12, with sub-divisions. Method of operation: Suppose we want to light up at 7 and switch off at 10 p.m. Put in a pin, S, at 7 and one at 10 on A.

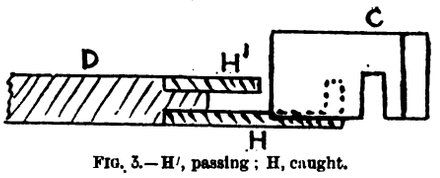

FIG. 3.—H', passing; H, caught.

Let the switch be off at present. A little before 7 p.m. S will make contact with L; the armature of C will be attracted and H^1 will get past, but H will catch. At 7 L will break contact, the armature will fly back, and H will get past; G will then put cam round to position shown in Fig. 2. Switch on. A little before 10 p.m. the next pin, S, makes contact and H_1 is released, but as G is travelling in a circle, no motion of the cam takes place; H now catches. At 10 p.m. L breaks contact, H gets past, and G flies round. At its fastest speed it throws down the cam and switches off. With a 24-hour dial any number of off and on positions may be chosen.

The following detail points should noted: The dial, A, should be fairly large, and spring, L, carefully adjusted to make positive contact, but not too long a contact. Where the mechanism is to be left absolutely in the hands of unskilful persons, it is well to make the pins S as at S_1 (the shaded part being vulcanite), and the stem so adjusted as to allow the spring, L, to take the position shown. The spring, L, then first catches on the vulcanite, and springs off on to the brass projection, making positive contact without any jerks.—POLYPHASE.

Answer to No. 626 (*awarded* 5*s.*).—Automatic time or clock switches have not come into general use to any great

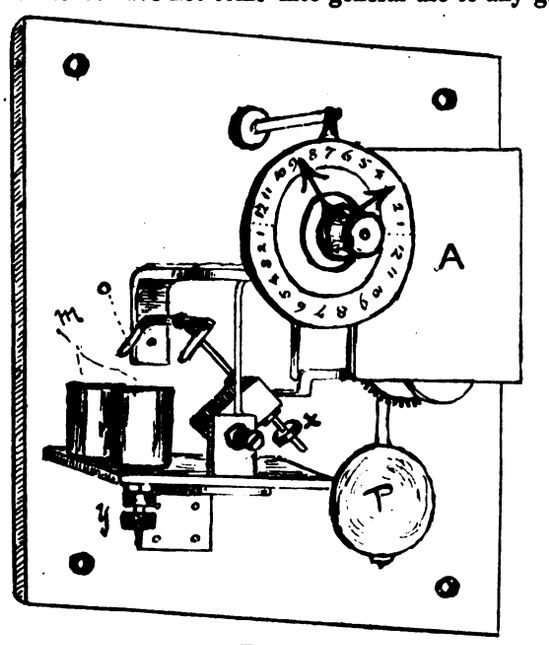

FIG. 1.

extent during the last few years, chiefly because of the somewhat complicated clockwork that is necessary, as the whole principle of the clock switch is identical in most respects with that of the ordinary alarum clock, which rings a bell at any required hour. Consequently, without very careful attention as regards cleaning and winding up, these switches cannot be relied on with much accuracy. But in places where careful attention has been paid to the switches, etc., satisfactory results have been obtained both for single lamps and a whole street of lamps. Fig. 1 gives a rough outline sketch of a satisfactory clock switch made by the Improved Electric Glow Lamp Company, Limited. This switch is made in two sizes—No. 1 size, with brush contact, to make and break up to three amperes at 500 volts; and No. 2 size, with mercury contact (as shown in sketch), to make and break up to 25 amperes at 500 volts. The mercury pots are shown at M in Fig. 1, and the circuit is closed and the lamps switched on when the contact maker, O, is released, *x* and *y* being the terminals to which the circuit is connected. P is the pendulum of the clock, and A is a polished slab on which are placed the keys, etc., for winding up the clock and adjusting the hours for lighting up. The clock only requires winding up once a week, and the hour of lighting up can be altered every night if necessary, or a fixed hour can be maintained throughout the year. The whole clock and switch is mounted on a slate slab, which can be fixed to a wall or switchboard as required.—P.

Answer to No. 626 (*awarded* 5*s.*).—The best form of time switch to use for this and many other purposes is the one made by the Reason Manufacturing Company at Brighton. It was originally designed for use in connection with the maximum demand tariff for which Brighton is famous, and more than 100 are now successfully in use on the Corporation supply circuits. It consists essentially of a strong cast frame provided with lugs for screwing to a vertical wall (or it may be stood on a bracket), carrrying the following apparatus: (1) a heavy pendulum about 10in. long, with regulating screw for adjusting the length of the pendulum to get very accurate time-keeping; (2) a small solenoid coil wound with fine wire; (3) a make-and-break arrangement in series electrically with (2), and connected across the supply mains; (4) an iron core attached to the pendulum and oscillating with same in and out of the solenoid; (5) pallett mechanism, and an ingenious arrangement for making contact at (3) when the oscillation of the pendulum falls to a certain point—both these mechanisms are carried by the pendulum; (6) an ordinary clock dial face provided with hands; (7) a dial provided with hands which may be set to operate the trip mechanism at any desired time—by this means the time of making and breaking circuit can be nicely adjusted; (8) an ingenious trip mechanism actuated by the dial (7); (9) a weight, which we will call the striking weight, to which is attached a striking rod; (10) a mercury change-over switch, having either four or eight terminals, according as the instrument is used on a two-wire or three-wire circuit; (11) a weatherproof cover provided with sealing arrangement and having two glass windows, one for the clock face and the other to indicate whether the lamp or other circuit is switched on or off.

The action of the switch is briefly as follows: The instrument having been suitably connected up, the heavy pendulum is started by hand and the mechanism (2), in conjunction with (3), keeps the clock going, an impulse being given three or four times a minute. When the proper time arrives for the lamps to be switched in, circuit (7) operates to trip (8), which allows (9) to come into play. The weight falling a short distance strikes the change-over switch a sharp blow and knocks it over, while at the same time the weight is pulled up again ready for the next trip by a suitably arranged spring. When the time for breaking the circuit arrives this process is repeated.

The writer has tested a number of these switches for several months and has not found a single instance of the clocks stopping so long as the pressure is maintained at the terminals of (2) and (3). The action of the mechanism is accurate and reliable, and they have apparently a very large field of usefulness. The overall dimensions of the complete instruments are about 14in. by 7in. by 7in. By suitable modifications a single clock can be made to operate *any number* of switches either at the same time or at *different times*, and the switches, each controlling a separate circuit, can be placed at any distance from the clock, the only connection required being a couple of small wires (bell or telephone wires). No sketch is given as it would require a detailed drawing to show the exact arrangement (which is patented), and not really complicated, but doubtless the manufacturers would be pleased to give information and quote for same.—E. D. W.

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ELECTRIC FIRE PROTECTION.

One of the earliest uses to which electricity was put was that of giving alarm in case of fire. The form of apparatus first used for the purpose consisted of the ordinary mercury thermometer, in the stem of which are fused two wires. The first of these is in the mercury bulb, while the second s placed up the stem at a point corresponding to the temperature at which an alarm signal is to be given. This type of apparatus has one or two serious defects, and we presume that it is owing to this that electric fire-alarm systems have not been sufficiently recognised either by the fire insurance companies or by the fire brigade authorities of some of our large towns. In this respect the London Fire Brigade is the chief offender, in that it refuses to allow in its fire stations any automatic signalling apparatus for giving direct alarms of fire from private systems Quite apart from the details of any of the various systems now on the market, the subject is a most interesting one. An examination of the facts concerning particular instances of fires which have been exceptionally severe in causing damage and loss of life is especially so, as showing how these losses could have been minimised. Taking first any particular factory or building most liable to fire risk, there is likely to be an internally-organised fire service. In fact, in certain instances we have in mind the fire-extinction apparatus installed in factories are amply sufficient to meet all contingencies without calling on the brigade. In all of these, however, electric fire-alarms are used, in order that the firemen taken from amongst the employés may have prompt warning both that a fire has occurred and of its locality. The protection which these firemen are able to give entirely depends upon the hold which the fire has obtained before they are able to commence playing water on to the same. In other instances, while a fire service is organised amongst the staff, outside help is relied upon, and here it is that there is most need of prompt connection between the firm and the fire brigade. With the present attitude of the London fire brigades there are two ways in which a call can be made—the first is by telephone, and the second by utilising one of the fire-alarms placed in the public streets. Both of these call for individual effort at a time when confusion reigns, with the result that many more lives are lost and much more damage is done than need be. As an example, without mentioning names, we would instance a fire we have full particulars of, in a building which was amply provided with electric fire-alarms, and which was situated within two minutes of a fire brigade station. A fire occurred which the staff were quite unable to cope with, and nearly ten minutes elapsed before anyone remembered to call in the brigade. As a result several lives were lost which could have been saved if the warehouse in question had had its electric alarm system connected up to the brigade. Elsewhere in this issue will be found some particulars of some trials made in Glasgow on Wednesday last at the offices of the *Glasgow Herald*. The fire, of course, was an artificial one, and hence we should deprecate any close comparison between the electric fire-alarm and the automatic sprinklers as a means of securing protection. The interesting fact is that the fire brigade received warning of the fire in one minute four seconds from the time it was lighted, and that they were on the spot within five minutes. There was an interval of eleven minutes twenty-two seconds from the lighting of the fire before the automatic sprinklers went off, so that with the conditions of the test the electric alarm obtained the attendance of the fire brigade some six and a half minutes before the temperature had risen sufficiently to operate the automatic sprinklers. This fact should impress fire insurance company experts

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with the advantages of the electric system when connected right up to the fire brigade, and if they are convinced we look for two results: the first is that such connections between fire brigades and large premises having electric alarms will become universal; and, secondly, that the electric fire-alarms will entitle their users to a reduction in premium. At the present time this method of coping with fire risks is, we believe, the only one not recognised by the tariff offices when fixing premiums.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

WATER-LEVEL INDICATOR.

SIR,—In reference to the above subject, I have examined the provisional specification No. 1,748 of 1878, and handed same to my patent agent, who informs me that I am in no way infringing Mr. Kelway's invention. I shall be glad to demonstrate my system to Mr. Kelway if he will kindly make an appointment. I shall not, however, be at our London office until the end of present month.—Yours, etc.,

C. MAY.

Glasgow, Nov. 3, 1903.

STEAM-TURBINES.

SIR,—In your issue of Oct. 30 you print an abstract of a paper by Mr G. Wilkinson on "Steam Turbo-Electric Generating Plants." The author gives in parallel columns the supposed performance of a 1,400-kw. set, with triple-expansion reciprocating engines, recently erected by us at the Leeds central station, and that of a steam-turbine at the Newcastle and District Electric Lighting Company's works. We say supposed performance, because the actual result for our set was 19·49lb. per kilowatt, and not 19·9lb, and this, again, was water measured into the boilers, and includes boiler and steam-pipe losses, the actual engine consumption measured at the hot-well (as, no doubt, in the case of the steam-turbine) being only 18·7lb. per kilowatt.

The turbine was, moreover, running at 237deg. F. superheat, whilst we had about 71deg. F., which, of course, makes an enormous difference. With triple-expansion engines of 500 b.h.p. running at 25·4in. vacuum, and with 200deg. F. superheat, we have obtained 16·1lb. per kilowatt, and with 237deg. F. superheat we should be prepared to guarantee for the Leeds engine something under 16lb. per kilowatt, as against the 17·73 shown for the 1,750-h.p. turbine. Immediately preceding the above comparison, figures are given for a Sulzer-Kolben plant with *saturated* steam and *24in. vacuum*, and a Parsons turbo-generator with *100deg. superheat* and *28in. vacuum*. Such comparisons are, of course, worthless and misleading. The 4in. difference in vacuum at 4 per cent. per inch as given in the paper means 16 per cent. to the turbine, and the 100deg. of superheat another 12 per cent., as also stated, so that after due allowance has been made for the vacuum and superheat, the result for the turbine comes out worse and not better than the other.

Again, the tests of the 500-kw. turbo-alternator at the Cambridge electricity works, after 12 months' running, are made with 9lb. higher steam pressure and 3·3in. better vacuum than on the original test, when 24·1lb. per kilowatt was registered. At the 4 per cent. per inch, the vacuum is good for 13·2 per cent., and the consumption should have come down to 20·92lb., or allowing for the working of pumps, say, 21·5lb., but instead of this it goes up to 25lb., and yet the conclusion is come to that the trials show that there has been no deterioration due to wear.

It is in our opinion regrettable that advocates of steam-turbines should make such misleading statements. At the present date the turbines of Mr. Parsons's make or design are the only ones having any claim to be considered beyond the experimental stage, and the latest tables published in the electrical papers giving the figures for 12 months' running show that these turbines are very far from behind reciprocating engines in economy in actual central-station work, though the results with them on the test-plate were supposed to be good.

The present booming of the turbine will surely result in a serious set-back when experience has been purchased at a heavy cost by the users.—Yours, etc.,

BELLISS AND MORCOM, LIMITED.

P.S.—It should always be borne in mind that the cost of obtaining the high vacuum necessary for efficiency with steam-turbines may become a very formidable item in the majority of inland stations.

THE "PHIELASHOK."

SIR,—My attention has been called to a notice in your last edition concerning the introduction by Messrs. Oliver and Co. of an appliance called a "Phielashok." I am greatly

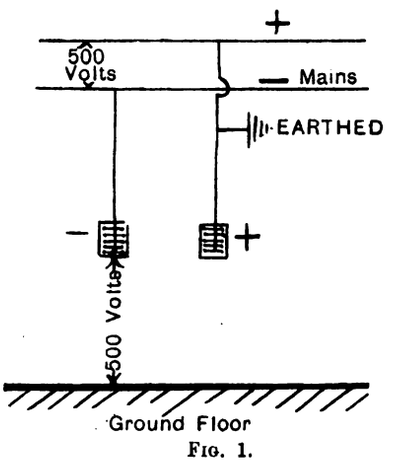

FIG. 1.

surprised and almost "shocked" that such an instrument should ever have been invented. I feel quite sure that if it be used on a great many of the electrical installations now at work, very unpleasant, if not disastrous, consequences will be experienced. In order to use the "Phielashok," one hand must be placed *directly upon* one pole of the circuit. What, then, will be the effect if the other pole at some other part of the installation is earthed through damage or accident?

The sketch will show how an operator will take, with his bare hand unprotected, a shock of the full supply voltage, whether that is 100, 200, 500, or 1,000 volts. By reference to Fig. 1 it will be seen that the operator will get a shock through left hand, arm, and feet to earth without the slightest current passing through the "Phielashok." Then, again, in Fig. 2 it is seen that the circuit

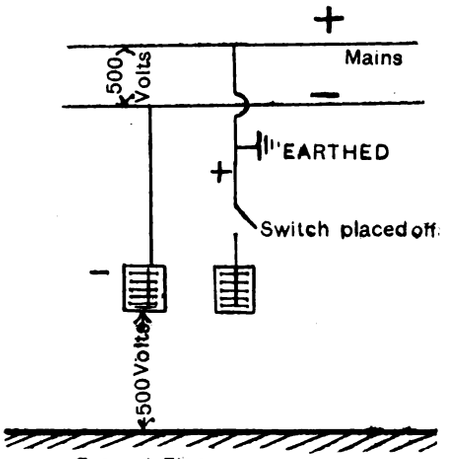

FIG. 2.

may be opened on one side, and still the operator will get the same violent shock. In this case there would be no advantage and no indication with the instrument.

No doubt need ever exist in the minds of those engaged in the repairs or alterations to electric circuits as to whether certain wires are "alive" or not. I always recommend and never fail to use a simple appliance, cheap and inexpensive, and, above all, always handy, for it is to be found on every

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electrical installation, both large and small. Its parts consist of one lamp (of normal voltage), one lampholder to suit, and two pieces of $^1/_{18}$ insulated wire. Wire together in the usual way, and it is complete. There is nothing new in this, but it is the best friend I have ever met when on duty amongst live wires. It is really wonderful how much assistance and information this humble appliance will give when intelligently applied.

If you will permit, I shall be pleased at an early date to show to those of your readers who are employed on live circuits how a good deal of the everyday troubles may be tracked down and located.—Yours, etc., J. ISAACS.

11, Highfield-terrace, Somerby-road, Grantham.

A NEW GRAPHITE RESISTANCE.*

The large number of patents taken out for the employment of graphite for electrical resistances shows how strong a desire to use graphite for such purposes exists. The

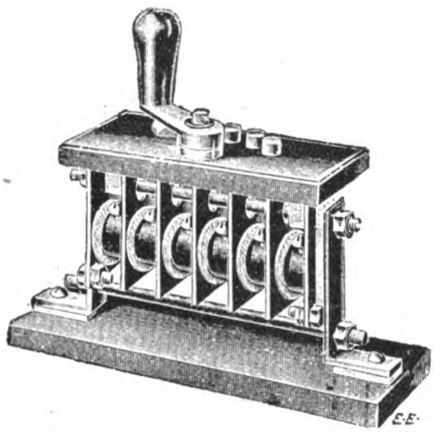

FIG. 1.

writer has for several years been working in this direction, and his latest results are given below.

Figs. 1 to 4 shown the form taken by these resistances. The graphite is in the form of a powder, and is put into separate iron rings closed at the ends by iron plates, which are, however, insulated from the rings by mica and asbestos. The iron plates carry the current and also serve to rapidly dissipate the heat generated inside. As many such cells

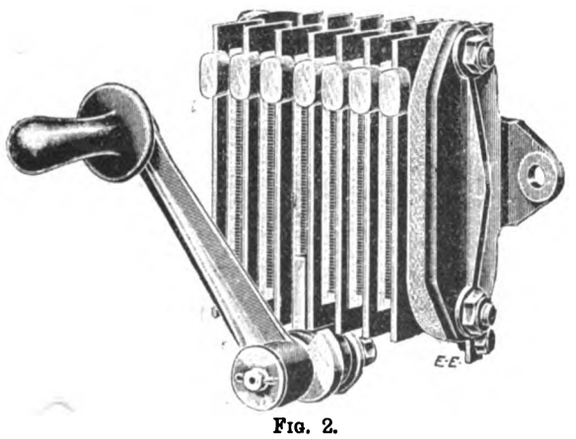

FIG. 2.

as are required can, of course, be connected together in series. If such a resistance, say a 6-h.p. 220-volt starting resistance, is connected directly to 220 volts, the current commences at about five amperes, but increases in less than 10 seconds to 35 amperes. Within the next five seconds it will increase to over 100 amperes, so that the resistance has fallen from 42 ohms to 6·3 ohms in the first 10 seconds and to 2·2 ohms in the next five seconds. If, however, after the first 10 seconds an additional adjustable resistance is put in series and regulated to maintain a constant current of 35 amperes, the voltage across the graphite resistance will fall from 220 to about 130 volts within the next 10 seconds, and will then remain constant, however long the test be continued. The writer is of opinion that this and similar results are probably to be explained not by the heating, but by the fact that the numerous infinitesimal sparks occurring between the different particles of graphite serve to ionise the air remaining in the apparatus, and that then this air, rather than the graphite itself, carries the current.

TABLE 1.

Amp.	Volt.	Ohm.	Amp.	Volt.	Ohm.
0·1	40	400 0	2 6	127	49·0
0·2	43	215 0	2·8	130	46·5
0·4	54	135 0	2·9	132	45 5
0·8	66	82·5	3·0	135	45·0
1·0	76	76·0	3·4	144	42 5
1·2	84	70·0	4·0	164	41·0
1·6	96	60·0	4·8	183	38·0
1·9	105	55·5	5·5	202	36·8
2·1	113	54·0	6·0	216	36·0
2 3	118	51·3	6·3	221	35·0
2·5	122	49·0			

Table 1 shows the result of another experiment. A small resistance consisting of three cells, and which had been in

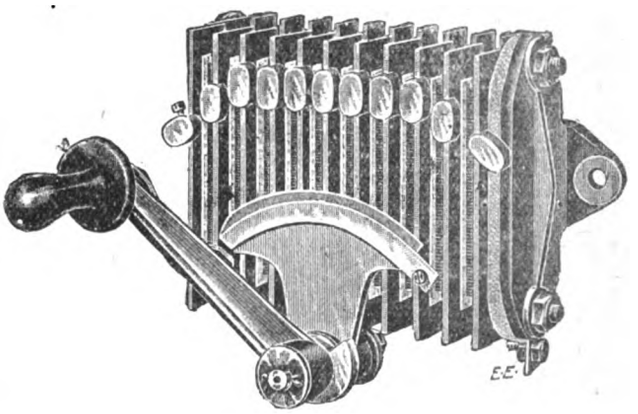

FIG. 3.

constant use for some time previously, was tested at different currents for quite short periods at a time, an interval of a quarter of a minute was allowed between each reading and the next, so that the resistance remained practically as cool at the end as at the beginning of the test. The resistance was quickly measured in each case by means of a dead-beat ammeter and voltmeter. It will be seen that at ·1 ampere the resistance was 400 ohms, whilst at 6·3 amperes it had fallen as low as 35 ohms. It is also clear that the differences between successive readings become smaller the higher the current strength,

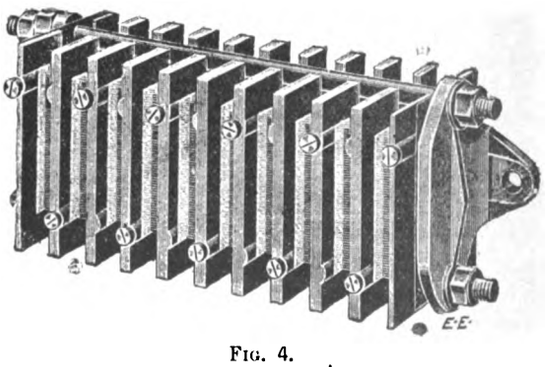

FIG. 4.

so that it would seem that the resistance finally becomes independent of the current. After the last reading the current was suddenly reduced to ·2 ampere again, and the resistance then measured 213 ohms against 215 ohms when quite cold. The apparatus was then connected direct on to 221 volts, and showed 6·3 amperes again. After five seconds' connection to 221 volts the current had risen to 7·5 ohms and the resistance load fallen from 35 ohms to 29·5 ohms. The current was then once more suddenly reduced to ·2 ampere, and the resistance then measured 195 ohms.

This same test was repeated with 10, 15, and 20 seconds' loading, and showed the following results :

* Translation in abstract of an article by R. Hopfelt in *Elektrotechnische Zeitschrift* for Oct. 8, 1903.

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At start.				After 5 seconds.
6·3 amperes,	35	ohms	.....	7·5 amperes, 29·5 ohms.
				·2 „ 195 „
				After 10 seconds.
6·3 „	35	„	.....	8·8 amperes, 24 ohms
				·25 „ 140 „
				After 15 seconds.
6·4 „	34·5	„	.....	12 amperes, 18·4 ohms.
				·35 „ 71·5 „
				After 20 seconds.
6·7 „	33	„	.....	18 amperes, 12·3 ohms.
				·4 „ 37·6 „

An interval of half a minute was allowed between the tests. From these readings it is clear that after a considerable current has passed, the resistance rises considerably even in the first tenth of a second after reducing the current, showing that the resistance is practically dependent on the current strength and not on the heating.

As a further test, various currents passed for sufficient lengths of time for the resistance to become constant. After each test an interval of half a minute was allowed, and the following results were obtained:

At start	5 amperes	171 volts,	34·2 ohms
After 85 seconds		140 „	28 „
At start	8 „	165 „	20 6 „
After 60 seconds		115 „	14·4 „
At start	12 „	150 „	12 5 „
After 50 seconds		96 „	8 „
At start	15 „	115 „	7·7 „
After 40 seconds		70 „	4 7 „

These readings show that the higher the current, the shorter the time required for the resistance to become constant. Half a minute after the above tests weak currents of various amounts were passed through the resistances for about a second, and the resistances then measured showed that, although fairly hot, the original cold figures, especially at the higher currents, were almost repeated. After an interval of five minutes the exact original resistances had been reached once more, although the resistance was not yet quite cold. As a result of these changes of resistance, these regulators can be constructed with comparatively few contacts, and yet motors started with them will run up more evenly than with wire starters.

For cases in which a considerable change of resistance would prove harmful, the regulators must be so constructed that the changes of resistance are kept within the permissible limits This is the case, for instance, in feeder regulators and in tramway and crane work, since the resistances are often required for speed regulation.

These regulators are already largely employed for such purposes, as well as for ordinary motor starters, their small size being in their favour. They are also supplied as arc lamp resistances, as accumulator-charging resistances arranged with minimum current cut-outs, and also for use with accumulators charged at constant pressure, as they prevent the excessive rise of current at starting.

SOME NOTES ON STEAM TURBO-ELECTRIC GENERATING PLANTS.*

BY GEO. WILKINSON (MEMBER).

(Concluded from page 659.)

Economy in Steam Consumption.—According to the published data, the maximum steam consumption guaranteed by the builders of the Sulzer-Kolben plant works out with saturated steam at 150lb. pressure and a vacuum of 24in. at 22·2lb. per kilowatt-hour at full load, 23lb. per kilowatt-hour at half load. The makers of the Parsons turbo-generator guarantee the steam consumption, with steam at 150lb. pressure, vacuum of 28in., and superheat of 100deg. F., at 17·5lb. per kilowatt-hour at full load, 20lb. per kilwatt-hour at half load. I have not the exact steam consumption of the 5,000-kw. Curtis turbine which is running in Chicago, but it is a much more economical plant in this respect than the Sulzer-Kolben plant referred to above. At low loads the efficiency of turbo plants is shown by published returns to be superior to that of ordinary steam-engine generators of equal capacity. A further interesting comparison in this respect is given between the most economical of the two 1,400-kw. two-phase plants with triple vertical engines recently installed in the Leeds electricity works and the 1,750-h.p. direct-current turbo plants installed last year in the works of the Newcastle and District Electric Lighting Company.

—	Speed.	Superheat.	Kilowatts.	Steam pressure.	Vacuum.	Water per kw. hour.
				lb.	in.	lb.
Leeds	200	·76° F.	1,400	183	25·6	19·9
Newcastle.	1,710	237° F.	897	145,	26·5	17·73

Other advantages which may be named are as follows: (1) No expensive cylinder oil is necessary such as is demanded by reciprocating engines using superheated steam. (2) There is no oil in the condensed water, and it may be used for boiler feed without the provision and use of expensive and troublesome oil separators. (3) There are no "big ends," packings, and bearings to take up. (4) There is less difficulty in maintaining a good vacuum, there being no piston and valve rod packings through which air may gain admission to the condenser. The importance of a good vacuum is obvious in view of the fact that every 1in. of vacuum above 25in. or 26in. has been found to reduce the steam consumption by about 4 per cent. (5) A greater degree of superheat may be maintained with a great gain in efficiency and no danger. Tests on a 500-kw. turbo-generator have shown an improvement in steam consumption resulting from a superheat of 50deg. F. of about 8 per cent., and at 100deg. F. it averages about 12 per cent.

There are no figures, so far as I can find, showing the economy effected by using very high superheat, but I believe further economy in steam will be obtained in this direction provided the vanes at the high-pressure end of the turbo are made of a metal which does not become brittle at high temperatures. In the case of large engines of the usual types it is not advisable to superheat the steam by more than 200deg. F., and in some cases there is much trouble with the valves if the superheat exceeds 150deg. F., but in the steam-turbine there are no such limitations. In a recent paper read before the Institution of Naval Architects, Prof. W. H. Watkinson made the following interesting observations on this subject: "The steam-turbine is the only engine in which condensation of the steam by previously cooled internal surfaces does not take place; but the steam in turbines is, of course, wet from another cause—namely, on account of the expansion it has undergone while doing work—and the efficiency of this type of motor is very considerably increased when the steam is superheated prior to its admission to the engine. In steam-turbines the reduction in the amount of steam required when superheated steam is used is due mainly to the increased volume and the decreased frictional resistance between the rotating vanes and the steam. In steam-turbines of the De Laval type, using saturated steam, the discharge from the nozzle is generally more or less intermittent, due to the intermittent choking of the nozzle with the water in the steam. When the steam is superheated the discharge from the nozzle is free and continuous, and the velocity, and therefore the efficiency of the steam, is on this account still further increased."

So long as proper adjustments are maintained between the fixed and moving vanes, the efficiency as to steam consumption appears to be well maintained. This is shown by comparing a test made by Prof. Ewing on a 500-kw. turbo-alternator, driving its own air and circulating pumps, which had done heavy duty at the Cambridge electricity works for a period of 12 months, with a test made on the same plant 14 months earlier by the Cambridge Electric Supply Company's engineer, as set out below:

Date of test.	Steam pressure.	Vacuum.	Load in kw.	Lbs. steam per kw.-hour.
	lb.	in.		lb.
Prof. Ewing's tests,	148	27·8	518	25
January, 1901.	151	28·2	273½	28·3
Engineer's tests,	139	24·5	526·4	24·1
October, 1899.	145	26·6	256·1	27·5

In Prof. Ewing's tests the steam was not superheated, and there was no water separator, but water which collected in a pocket under a vertical limb of the steam-pipe leading to the engine was from time to time blown off. In the case of the engineer's tests in 1899 dry steam was used, and the turbine was not driving its own pumps. Prof. Ewing concludes his report as follows: "Considering the altered conditions in these two respects, I am of opinion that the results of the present trials show that there has been no deterioration due to wear." This view is confirmed by the following tests taken on a 300-kw. Parsons turbo-generator under my own control, in which the tests made at the Harrogate electricity works in February, 1902, are compared with tests made in the same works and under precisely the same conditions after over 19 months' heavy work. It will be

Date of test.	Steam pressure.	Superheat	Vacuum.	Load in kw.	Speed.	Lbs. steam per kw.-hour.
	lb.	lb.	in.			
Feb. 19, 1902						
Full load	130·5	41·9° F.	28	309·5	3,010	22·76
Half load ...	131	45° F.	28·8	157·4	3,010	25·1
Sept. 30, 1903						
Full load.....	130	35° F.	28	307·5	3,080	21·12
Half load ...	130	33° F.	28	127·1	3,080	23·24

* Paper read before the Leeds Local Section of the Institution of Electrical Engineers.

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noted that the results of the 1903 tests are better than those of 1902, which may be partially owing to the increased speed, but chiefly to the fact that the number of the vanes in the high-pressure end were found broken off on opening out after the tests of 1902.

In concluding these notes I have to express my thanks to Messrs. Parsons and Co., the Brush Electrical Engineering Company, the Thomson-Houston Company, and to Messrs. Greenwood and Batley, who have willingly placed data at my disposal.

DISCUSSION.

Mr. Wilson Hartnell said that he would like a little more information, especially on the small points in which Messrs. Willans and Robinson's turbine differed from the Parsons. In conversation with Mr. Robinson he had told him that he thought the time for reciprocating engines for electrical work was slowly coming to an end, and he himself fully recognised that fact. One point he might mention was that of driving at a uniform speed. He mentioned a town where there were 50-h.p. motors driving direct, and which had given trouble owing to the pinions wearing as much on the back as on the front side. To get the same low consumption of steam with a reciprocating engine as with a turbine, the very greatest pains in every direction would have to be taken.

Mr. Holiday said that he had been using Parsons turbines at a colliery since 1895. When asking for quotations for reciprocating engines and turbines, the reciprocating engine-makers told them that they could not do a worse thing than get a Parsons turbine for power purposes, but in spite of that they got two 150-unit machines, and were so pleased with them that they had now got more. They were not big units, the largest being about 300. Being a new thing, a little difficulty was experienced at first with the very varying loads, due to the armature connections breaking off at the commutator. That was owing to insufficient flexibility, but was overcome, and since then the trouble had not recurred. He had some reciprocating engines driving dynamos, and the attendants said they would rather run the whole of the turbines than one of the reciprocating engines. Messrs. Parsons had fitted an automatic brush rocking gear, which consisted of a piston with a spring on the top. It always drew the brushes back to the normal position as the steam pressure on the first blade was always proportional to the load. There was a pipe from this first row of blades underneath the piston, the steam from which always worked against the piston locking the brushes This had been running for 18 months, and had caused no trouble whatever. The speaker mentioned a rather curious fact—namely, that there was one megohm of resistance between the steel spindle of the turbine and the frame of the bearings in which it was running, the film of oil on the bearings being sufficient to insulate the shaft.

Mr. S. D. Schofield thought that the steam-turbine was the greatest advance in heat engines since the days of Watt. Many who had seen the large reciprocating engines at Pinkstown power station, Willesden, and other places, had no doubt wondered whether it would not be possible to obtain the same capacity by utilising the power of the steam direct in a rotary. One great advantage of the turbine was its low first cost, and also the inexpensive foundation required. The machine itself in the smaller sizes could be moved to suit the pipework, condensers, etc. Some 12 months ago he had occasion to borrow a 120-kw. machine from Messrs. Parsons until they could deliver a larger size, and to save expense of special pipes, he borrowed a number of scrap 12in. cast-iron pipes, bolted them together the best way they would fit, and then set the machine to suit them. With reference to the suggestion that in the Curtis turbine the condenser could not be driven from the shaft, he would suggest that a separate motor-driven condensing plant was much better, as he found that even driving the force pumps at times spoilt the governing of the machines. In the older type of the Parsons turbine both pump and governor were driven from one vertical shaft, and on two machines slight hunting of the governors occurred due to the reciprocating motion of the pump, causing the governors to slow up, owing to the back lash of the gearing. With regard to the claim that no expensive cylinder oil was necessary, he held, however, that an expensive lubricating oil was necessary. On two occasions he had had trouble with oil, once due to the water and oil combining, and the second time to impurities in the oil attacking the cast-iron reservoir and choking up the oil passages. He had found it a good thing to draw off a few gallons of oil each day, putting it into the filter and making up the deficiency with filtered oil. With regard to superheating, he had tried one machine with steam superheated over 600deg., and had not had the slightest trouble with the blades. The tests on a 200-kw. machine taken on Aug. 1, 1903, worked out as follows:

Steam pressure.	Superheat, deg. Fahr.	Vacuum, inches.	Load, in kilowatts.	Speed.	Lbs. of steam per kilowatt.
150	56	26·5	half load	3,000	26·6
150	56	26·5	full	3,000	22·23
150	166	26·5	half load	3,000	24·41
150	181	26·5	full	3,000	20·39

Note.—Excluding power for air and circulating pumps. Decrease of steam consumption for higher superheat = 8·3 per cent.

Mr. Stoney said that with respect to economy of space both Parsons and Curtis turbines were exactly the same, whilst the Curtis was double the height, and therefore took up double the amount of engine room. He would also like to know how the Curtis turbine could be taken to pieces when anything went wrong, as it appeared to him that the whole of the alternator would have to be lifted off. With regard to a vertical clearance of about $\frac{8}{100}$in., he would like to know how they managed to obtain such a small clearance as that. With reference to the tests given at the end of the paper, these tests were made on a 1 500-kw. machine, and results obtained now were 2 per cent. better than these, which were made 16 months ago. Regarding the oil consumption, he had both reciprocating engines and also turbines, and they saved £5 a week in oil for a load of 600 kw., being equivalent to a steam consumption of 2lb. per kilowatt-hour less.

Mr. Jackson said that the Curtis turbine was in no way an infringement of the Parsons patents. It was stated in the paper that in order to get the steam consumption one must multiply by 10 and divide by 6, but he would suggest that the figure be increased to 7, otherwise it put the efficiency of the generator rather too low. The friction with the Curtis turbine was so small that they could turn the governor balls round by hand. Mr. Jackson added that the Curtis people would shortly deliver a continuous-current turbine in which, he thought, they had overcome certain difficulties peculiar to that type.

Mr. W. J. A. London, referring to the De Laval steam-turbine, in which there was only 2mm. clearance between the exhaust end of the nozzle and the wheel, said he had always understood that steam issuing from a properly-constructed nozzle flowed in a parallel stream for a considerable distance, and that a clearance of 20mm. or so could be allowed without decreasing the efficiency. To bring out the point of parallel running still more, he would like to mention the instance of the Parsons-Brown-Boveri turbo-generator of 3,000 kw. installed at Frankfort. That machine was started up and put into parallel with a slow-speed machine without the slightest difficulty and without assistance from the turbine expert. He referred to the difficulty of dismantling a vertical turbine, and thought that it was very much more difficult to dismantle than the same machine would be if built on a horizontal plane. Referring to the Westinghouse turbine, the new machine was a modified combination of the De Laval and Parsons type, steam entering at the centre of the cylinder and issuing both ways through a series of stationary and revolving nozzles, the low-pressure expansion being taken care of by Parsons blades. The Westinghouse people had recently guaranteed on an 1,800-kw. machine, with a steam pressure of 180, vacuum 27½in., and superheat of 150deg., 16·4lb. per kilowatt-hour. The over-all length of the 5,500-kw. turbine for the London Underground Railway would only be about 40ft., which compared favourably with any slow-speed horizontal reciprocating steam-engine. The total weight of the combined plant was about 200 tons, being about one-third of the 3,500-kw. Sulzer-Kolben plant. He failed to see how any additional ventilation was obtained in the Curtis turbine, because with the generator being placed directly above and the steam entering at the top one would think there would be a great deal of radiation, and that the hot gases from the turbine would arise and heat up the generator to a greater extent than in a horizontal machine. With reference to oil economy, the speaker gave the following results, which he obtained whilst with a Continental firm, the machines being of 1,000 kw. output: reciprocating engine plant (per day's run of 24 hours)—four gallons engine oil, four gallons cylinder oil, four gallons filtered oil; steam-turbine—·8 gallon engine oil, ·4 gallon cylinder oil. Assuming a station of 10 units of 1,000 kw. reciprocating plant, and taking an average price for oil and assuming the machines to be giving two-thirds of their output all the year round, the oil bill for the year would come out about £2,300, whereas that of a turbine station would only be about £300. Considering the London Underground station consisted of a total kilowatt of 44,000, the saving would be quite a big factor, and he thought that the oil consumption was a point which should receive more consideration than it did.

Mr. A. B. Mountain said that the figures they had had given them showed what excellent results could be obtained providing the superheat was very high; but what was the difference in the coal bill? They knew a certain amount of coal had to be burnt to produce superheat, and he thought it was unfair for the author to compare the Sulzer plant with the Parsons plant, because in the one case he had a plant with saturated steam and in the other case one with 100deg. superheat. And, again, in one case there was 4in. more vacuum than in the other. He thought that the Curtis turbine would have a larger diameter than the Parsons. The other day he had a steam leakage of something like 100ths of an inch, and he was astounded at the amount of steam which could pass through that little space. It was obvious that if the diameter was increased, the leakage past the edge was also increased.

Mr. Samuelson said that by superheating 100deg. the steam consumption was reduced 1lb. Previous speakers had alluded to the fact that it was impossible to superheat without some expense. He would assume the consumption to be 19lb, and that they had improved their efficiency 10 per cent. That 10 per cent. was made up as follows: Four-tenths had been added in heat, and more coal had had to be put on the fire, but 2 per cent. more was obtained from the superheated steam. The quality which that steam had gave another 2 per cent., because when wet steam went through the machine the friction was very much greater than when the steam was dry, and thus nearly 6 per cent. represented the total gain. The speaker then gave some tests on a 500-kw. Curtis turbine, the steam pressure being 150lb., superheat 150deg., and vacuum 28½in. The full load consumption was 18·75lb. of steam, half load 20½lb., and quarter load 22½lb. The turbine was under-rated, as it was really a 750-kw. machine, and could be run up to 900. For 50deg. of superheat he had obtained 9½ per cent., and for 100 deg., 14 per cent. improvement in steam consumption. With reference to the machine being taken to pieces, there had been no occasion to do so since it was erected. Should that be required it is only necessary to lift the generator up a couple of inches or so, when the turbine could readily be got at. In that machine the temperature was not high inside as in the Parsons, being only 220deg He should like to add that the machines were designed to give a full load when running non-condensing, which meant that the steam only did half its work. The weight of a 1,500-kw. machine was 60 tons, and of a 3,000-kw., 130 tons. He

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also added that the blades on the wheels were cut from the solid, so that they would stand any amount of superheat.

Mr. Barker said that it was his privilege to have been the station engineer of the second turbine station in this country, and the history of that station (Cambridge) had been a continued success. The coal costs were rather high, the output being less than 500,000 units. The station was two miles away from the centre and transmitted a quarter of a mile before getting to a consumer. The centre of the town was composed of colleges, and the density factor could never be high. The coal cost of ·66d. per unit sold would have been equal to ·5d. if it had been direct current. Another thing was that the coal cartage was 8s. per ton from the pit to the station, whilst in their district, with cheap coal, the cost could be brought down to something like ·25d. or ·2d. per unit. He added that the blades in the Parsons turbine did not come out, although on one or two occasions through faulty material they had broken off, but such a thing was nearly unknown in the Parsons turbine.

Mr. Wilkinson, in reply, said that he did not anticipate any difficulty in replying to criticism, inasmuch as the subject matter consisted largely of statements and facts. He did not agree with the view of some speakers that the days of the reciprocating engine, so far as electric power stations are concerned, were numbered, as, notwithstanding the assurances which had been given that all the objections named as to the fitness of steam-turbines for driving direct-current generators were surmounted, there was no doubt that the future of direct-current generation laid with the slower reciprocating engine, at least until a type of turbine was perfected to run economically at speeds not exceeding 500 per minute. Automatic rocking gear for the brushes of direct-current generators, operated by a piston in a steam cylinder connected to the turbine side of the throttle-valve governor, had been named, but that was a makeshift device, and did not get over the difficulty of excessive wear and tear on the commutators and collecting brushes. He regretted that they had had no definite information given them as to the effect of high superheat, and he would suggest that it would be highly interesting and useful if they could have a paper dealing with the economics of superheat, both with reference to steam-turbines and reciprocating engines, setting forth exactly at what point the advantages of superheating were nullified by the increased consumption of fuel to produce such superheat. It had been suggested that it was unfair to compare the steam consumption of the Sulzer-Kolben plant with the Parsons plant, inasmuch as the results in the latter were obtained by superheating 100deg. with a 4in. better vacuum, but he contended that it was useful to compare results obtained in actual practice. It would be interesting to know why advantage was not taken in the Sulzer engine of the increased economy obtainable by superheating. Possibly it was not easy to improve the vacuum on the reciprocating plant, whereas one of the advantages of turbines was that no air was drawn into the condenser. A fertile cause of low vacuum in reciprocating plants was air leakage at the low-pressure piston rod and valve packings, and in such cases he found it of great advantage to waterseal the packings at the low-pressure end, especially in the case of engines with metallic packings. Recently in a 600-h.p. plant he had obtained by that means 2½in. increased vacuum in the condenser.

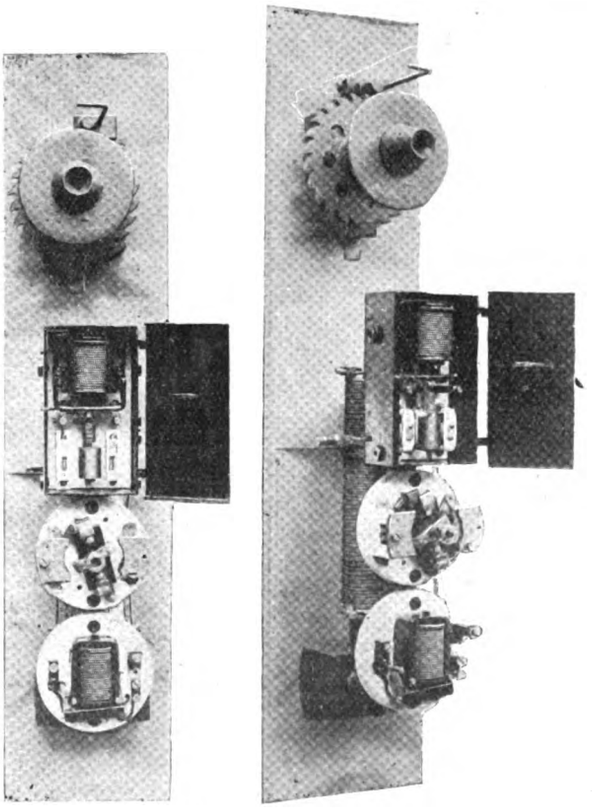
TRADE NOTICES AND NOVELTIES.

Arc Lighting in the Suburbs.

We draw attention to the new arc lighting of Kilburn, Harlesden, Hampstead, and Willesden, which has been carried out during the past year by the Gilbert Arc Lamp Company, Limited, of Chingford, for Mr. E. T. Ruthven-Murray, of Willesden, and Mr. G. H. Cottam, engineer to Hampstead, in which many of that company's most recent improvements and inventions have been made use of. The Hampstead lighting consists of lamps run in series off a constant potential of about 1,800 volts, special machines being provided in the borough's alternating station to supply continuous current at this pressure. The Kilburn and Willesden lighting is carried out with lamps in series off a constant potential of 480 volts. All the lamps are interchangeable, and are fitted on similar posts, of which we give an illustration (Fig. 1). They are provided with lowering gear, which is a speciality with the Gilbert Arc Lamp Company, and has been adopted on almost all the important work which that company have carried out for the past two years. The external appearance of this gear can be seen in Fig. 1, and it will be noticed that neatness and strength are combined in the design. It is mechanically very simple, uses very stout double cord for suspension, which whilst adding immensely to the strength, at very slight expense, also avoids any twisting of the lamps and allows plain knife switch contacts to be used, which can be effectively and clearly insulated. When the lamp is in position it is supported independently of the cord by special catches. The lamps used are of the Gilbert Arc Lamp Company's improved type. The feature of this lamp, which forms a departure from the usual practice, is the great power of the striking portion of the arc lamp mechanism. In other words, the lamps are able to open out the arc to a much larger extent than is usual, and with a very slight alteration in the electrical quantities. The advantage of this is proved by experience at Hampstead, where the engineers have ammeters in each of the series circuits. The uniformity of the ammeter readings is said to be very marked. These lamps are of the type which have previously been described in our columns, containing 6ft. of carbon. Most of the pillars are fitted with two incandescent lamps, which are provided with unusually substantial cast-iron fittings, forming also a suitable reflector.

FIG. 1.—A Gilbert Arc Lamp as used at Kilburn and Willesden.

These incandescent lamps are controlled by "Gilbert" patent automatic switches. We shall later give a separate detailed description of this switch, but shortly we may mention that it



FIGS. 2 AND 3.—Complete Gear for the Base of Arc Lamp Posts as standardised by the Gilbert Arc Lamp Company.

is a simple direct magnet switch, and its action is controlled at will, from a distance, by means of a catch, which takes a distinct time in accomplishing its motion, so that it engages or not, leaving the switch open or shut, in response to a short or

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longer application of electrical energy to it. The whole is contained in a neat cast-iron box 8in. by 4in. by 4in., and can be seen in our illustration of the "post gear." The box also contains double pole fuses and convenient terminals.

The gear used by the company in the bases of the arc lamp-posts will also be of interest to engineers, as this class of gear is too often unsatisfactory. In the usual way the controlling arrangements are independently fixed inside the post, and are quite inaccessible. As will be seen from our illustration, the Gilbert Arc Lamp Company build up a complete gear on one base-plate and insert it as a whole in the post base, where it is

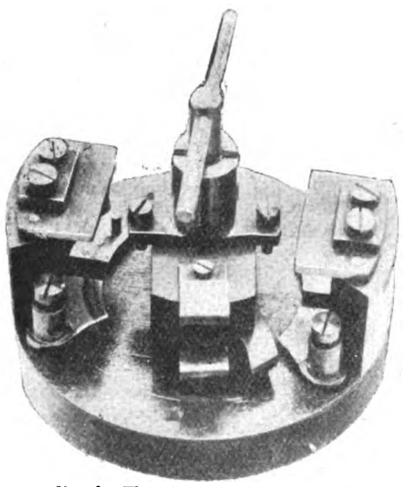
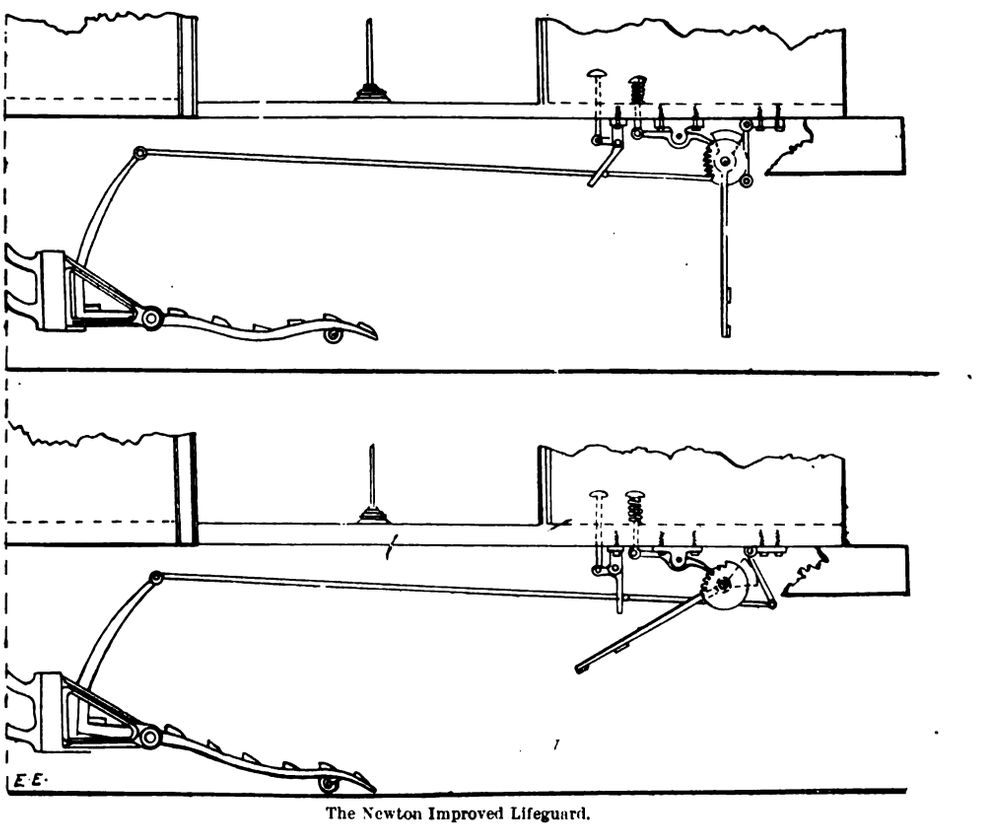


FIG. 4.—The Gilbert Arc Lamp Switch.

secured by two bolts. The various units of the gear, which can be seen in Figs. 2 and 3, have been specially designed by the company with a view of being used together. They are all mounted on porcelain bases so as to give a high insulation, and these are attached to a light iron frame. It is this iron frame which is fixed on to wood blocks in the post. The arc lamp resistances are kept a considerable distance away both from these wood blocks and the various cables. Any water of condensation falling down the inside of the post is kept off the apparatus by an umbrella over the top of the gear. The first apparatus, which will be seen below the winch, is the Gilbert automatic patent switch, described before, used for controlling the incandescent lamps by means of the arc lamp circuit. Beneath that is a special switch (Fig. 4) carrying out all the operations required in an arc lamp-post. It is a turn switch, mounted on porcelain, provided with a quick break. The break is double-pole, and is capable of dealing with ease with 20 amperes at 500 volts. The switch acts when necessary as a starting switch, utilising the compensating resistance as a steadying resistance—*i.e.*, switching on at the first position nine lamps out of ten, plus one substitutional resistance. In a few moments the tenth lamp can be put in in place of the resistance. This is always useful, and particularly so with such powerful and free-range sensitive lamps as the Gilbert. Of course, this switch will further act as a switch to cut the lamp out of circuit if required. The next porcelain base carries the automatic cut-out and strong terminals, capable of gripping and supporting the leads. The chief features of the cut-out are the absence of any part likely to stick or jamb and its unusual power, enabling a stiff rubbing contact of bronze to be used having a definite self-cleaning rub, which the firm have found to be more satisfactory than any touching contacts of carbon or any special metal. The resistances are made of steel wire wound on the usual spiralled porcelain formers, care being taken to securely clamp them from end to end, so that there is no harm done should they crack from the heat.

The Newton Lifeguard.

Mr. D. Newton, of 27, Hart-street, Southport, has put on the market a new tramcar lifeguard, of which the following is an illustrated description. It was recently tried successfully on the Southport tramways. It consists of a drop platform hung on trunnions fastened to the pilot board of a car, with an iron framework covered by wire netting, or wood laths, the back end of the guard being turned up to prevent an obstacle from falling off over its rear. Underneath and close to the front edge, which is slightly depressed, there are steel rollers, one at each side of this front portion of the guard, which run upon the rails when the platform is down, and keep the centre of the edge from contact with the ground, the rear end of the guard being sufficiently weighted to keep the guard in a horizontal position. Attached to the pilot board are adjustable brackets which uphold this weighted end, and can be made to raise or lower the front edge of the guard as desired. The gate in front automatically lowers the platform is struck by a body on the track, but it can also be lowered by the car driver by a foot-plunger, seen in the drawing. When the gate lowers the platform by means of the cams, seen in the drawing, it is locked by a pawl, and does not rise until this pawl has been released by the motorman. The advantages claimed for the "Newton" improved patent lifeguard are as follows: The platform or guard works loose on its pivots, and is retained in its position by counterbalancing weight only. The guard works both in conjunction with and independently of the gate, and is drawn down by the gate through the medium of the cam and lever. The guard is under direct control of the motorman, who can bring it down and return it to its position at will. The ratchet wheel and pawl arrangement, by which the gate and guard are locked. Last, but not least, there are no springs to get out of order. Major Druitt, an inspecting officer of the Board of Trade, has had this guard before him and tried the same, and approved of it subject to the Board of Trade requirements being carried out—viz., the placing of the drop platform or guard 2ft. 6in. away from the gate, which has since been done.



The Newton Improved Lifeguard.

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LEGAL INTELLIGENCE.

SPEED OF TRAMCARS.

On Saturday the West London magistrate was further engaged in hearing the summonses against four drivers in the employment of the London United Electric Tramways Company for driving their cars at a speed exceeding the limit of 10 miles an hour laid down in the Board of Trade regulations. The summonses were taken out at the instance of Mr. Moffatt Ford.

Colonel Matthew H. Purcell, the officer nominated by the Board of Trade to make an independent test of the speed at which the West London cars could travel, now gave evidence. He stated that he posted an assistant at the generating stations, and Mr. Parker, of the London Athletic Club, took the times. For his experiments he measured off a distance of one furlong at Goldhawk-road. With a flying start the following were the times made by the cars. No. 272: first trial, 34⅘ seconds, equals 13·006 miles an hour; second trial, 34⅘ seconds, equals 12·93 miles an hour; third trial, 32 seconds, equals 14·06 miles an hour. No. 75: first trial, 34⅗ seconds, equals 13·08 miles an hour; second trial, 33⅘ seconds, equals 13·37 miles an hour; third trial, 36 seconds, equals 12½ miles an hour. No. 60: first trial, 35⅕ seconds, equals 12·78 miles an hour; second trial, 36⅗ seconds, equals 12·29 miles an hour. No. 173: first trial, 33⅗ seconds, equals 13·39 miles an hour; second trial, 30⅗ seconds, equals 14·8 miles an hour. These results showed the highest speeds attained by these particular cars. Mr. Ford came up soon after the first test was taken, and said that unless the car was in exactly the same condition (number of passengers, etc.) it was no test at all. Mr. Ford then withdrew. The statement that Mr. Ford was not admitted to the test was untrue. Witness also tested two other cars that came along, and the fastest speed was 14·5 miles. Having ascertained the voltage power at the power station, he was of opinion that nothing was done to interfere with the test. He was not an expert.

Mr. Edward J. Smith, an electrical engineer, who was at the power station, said he did not think the system could have been interfered with.

Mr. Clifton Robinson, the managing director, said he gave instructions that the test was to take place under normal conditions. He denied that the cars could exceed 13 miles an hour.

The **Magistrate** said his difficulty was that evidence had been given as to the speed which was over the limit.

Mr. Ford then obtained permission to call **Colonel Crompton,** who said that, seeing there was no instrument in the car he was in to test the speed, he advised Mr. Ford to withdraw. He had tested the cars on other occasions, and they had exceeded the speed stated.

Mr. Evershed, of Chiswick, was of opinion that after passing Young's-corner on the day the tests were made the voltage was abnormally low, and the next day he communicated with Mr. Ford, whom he had not previously known. He judged by the speed and the lights.

A further adjournment of the hearing was ordered.

DISTRICT RAILWAY v. METROPOLITAN RAILWAY.

On Tuesday in the King's Bench Division, before Mr. Justice Wright, the Metropolitan District Railway Company brought an action against the Metropolitan Railway Company for a declaration that it was entitled to run over a certain piece of line affecting trains chiefly on the Inner Circle. For many years the two companies have run a joint service, and under an agreement the receipts derived from the traffic running between South Kensington and High-street, Kensington, stations are pooled. The District Company, however, claims the right to run over a piece of line and exchange its traffic from one line to the other at a junction just south of High-street Station, and divide accordingly. There had been previous contention, and the point at issue rested solely on the legal reading of documents.

Mr. Cripps, K.C., for the District Company, said it was not denying the right of the Metropolitan Company to keep its trains on its own line as long as possible. That was the right of both companies, but the District Company did claim the right to use this particular piece of line which belonged to it. As a matter of fact, what it now claimed to do was actually the method of working some years ago.

Mr. Robson, K.C., for the Metropolitan Company, pointed out that the piece of line in question was not sanctioned by Parliament, and it was clear this piece of line was not considered when parliamentary permission was given for the construction of the Inner Circle for a "continuous working" with the other portions of the line to the advantage of the public. What the District Company now asked for was rather a "discontinuous working" of the line.

His Lordship reserved judgment.

DEFINITION OF A WORKMAN.

At the Leeds Police Court on the 29th ult., the Stipendiary was called upon to define "a workman" in a case in which an estate agent's clerk named William Asquith was summoned for declining to pay the proper tram fare.

It was stated that on the evening of Oct. 1 the defendant travelled on a Stanningley car, and refused to pay more than 1d., the workman's fare. The conductor issued him a ticket under protest, and the defendant had since declined to pay the excess fare of 2d.

The defendant's reply to this was that the Corporation's by-laws provided that artisans, mechanics, and daily labourers might travel between certain hours at reduced fares, and he claimed that being in receipt of a weekly wage he was a daily labourer. Asquith added that since the date in question he had travelled at the reduced fare without any interference from conductors or inspectors.

The **Stipendiary** observed that in his opinion all this difficulty had arisen owing to non-compliance with the Act of Parliament, which provided not that workmen might ride on any cars between certain hours at reduced fares, but that the authorities should run cars specially for the purpose of conveying workmen.

In reply to the Magistrate, the **Conductor** said that if a man had soiled hands he should consider him a labourer. That was what they were given to understand was the definition in By-law 11 in their rules.

The **Stipendiary** (to the defendant): I understand that if you were working with your hands and making £4 a week you would be allowed to travel for a penny, but if you are a clerk earning 23s. a week you must not so travel.

Eventually his **Worship** said he would take time to consider the question, and adjourned the case *sine die*.

FERRANTI LIMITED.

Tuesday night's *London Gazette* contained a notification that a petition for the winding-up of Ferranti Limited has been presented in the High Court by a creditor, and that the same will be heard on the 17th inst.

PERSONAL.

A smoking concert was held at the Collingwood Hotel, Newcastle-on-Tyne, on Saturday, in honour of Mr. James Parmley Graham, who has just terminated his service of 15 years with J. H. Holmes and Co., as one of their commercial staff, to take up an important agency for the North of England for electrical and mechanical apparatus and materials. On behalf of the officials and staff, the secretary, Mr. Allen Crowe, presented Mr. Graham with a roll-top desk, and he was also the recipient of a handsome silver tea service from the firm.

Mr. C. F. Coldwell has been appointed electrical engineer to the Honley Urban District Council.

Subject to his passing a satisfactory medical examination, Mr. A. L. Coventry Fell has been appointed chief officer of tramways at a salary of £1,500 a year with retiring allowance, and on condition to give his whole time to the duties of his office.

On Thursday evening the general manager, Mr. W. Binns, on behalf of the staff of the tramways department, presented Mr. Robert J. Fardell, chief clerk of the tramways department, with a handsome leather travelling bag, fitted with toilet accessories, as a token of their esteem and good wishes on the occasion of his marriage.

The Rowley Regis District Council have appointed Mr. Evans, engineer to the British Electric Traction Company, as the engineer for the Council for the purpose of superintending the construction of the proposed new tramway from Old Hill to Blackheath.

Mr. H. England, who for the past 2½ years has been general manager of the municipal tramways at Sunderland, has resigned, having been appointed general manager for the Yorkshire Tramways Construction Syndicate, which proposes to establish an extensive system of electric tramways in Leeds, Wakefield, and West Riding districts. The Sunderland Tramways Committee had been prepared to recommend that Mr. England's salary be advanced by £100 a year till £700 was reached, but he is going to receive £700 per annum at once, rising to £900, with a five years' engagement.

The Norwich Electric Tramways Company have reappointed Mr. George Moore Chamberlin, of Norwich, to be one of the directors of the company.

We are informed that Mr. H. Smethurst, having terminated his engagement with Messrs. Wheatley Kirk, Price, and Co., London, after 18 years' service with the firm as chief of the staff, has commenced business as valuer, etc., to the engineering and allied trades under the style of H. Smethurst and Co., at 37, Ommaney-road, New Cross, S.E. Prior to his connection with Messrs. Wheatley Kirk, Price, and Co., Mr. Smethurst was a pupil of William Galloway, jun., Manchester, afterwards draughtsman and assistant to Mr. R. Heber Radford, consulting engineer and valuer, Sheffield; science and art master, Sheffield, under the Science and Art Department; first-class certificate in iron manufacture, City and Guilds of London; and chief draughtsman and demonstrator to the Institution of Mechanical Engineers, London, S.W.

APPOINTMENTS VACANT.

Improvers at high-tension alternating station, London. See advertisement issue of 23rd ult.

Advertisement Assistant, London County Council. Applications, by 10 a.m. on Nov. 16, to County Hall, Spring-gardens, S.W.

Engineering Assistants (2), London County Council, with good experience in the design and construction of the permanent way and general arrangement of electric tramways on the conduit system (if possible) and on the overhead system. Salaries up to £7 a week. Applications to Clerk of the Council, County Hall, Spring-gardens, S.W., by 10 a.m. on Nov. 10.

Improver, Perth Corporation Electricity Works. Commencing wages, 12s. per week. See advertisement in last issue.

Jointer, Erith Corporation, £2. 5s. per week. Also Mr. C. Turnbull, Tynemouth Electricity Works, North Shields. See advertisement in last issue.

Lecturer in Engineering, technical schools, Rotherham. Salary £129 per annum, Nov. 10. See advertisement.

Shift Engineer, Tunbridge Wells, £100 per annum.

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COMPANIES' MEETINGS AND REPORTS.

WESTERN TELEGRAPH.

The ordinary general meeting of the shareholders in this Company was held at River Plate House, E.C., on Wednesday, Sir John Wolfe Barry, K.C.B., presiding.

The **Chairman**, in moving the adoption of the report (which appeared in our last issue), said it indicated a steady and satisfactory business. The message fund amounted to £213,000, while that for the corresponding half-year of 1902 had been £196,500, so that a satisfactory increase of £16,500 was shown. A large proportion of the improvement was due to an increased business with the River Plate. The dividends on investments in other telegraph companies showed a small decrease of £800. Repairs to cables and expenses of ships were comparatively small during the corresponding half-year of 1902, so that for the half-year under review there was an increase of £11,000. The Company had lately bought a small steamer, which was being very usefully employed in South America. The revenue to date for the current half-year was not quite so satisfactory as for the corresponding portion of 1902. The decrease was not serious, but there were no signs of an increase. That was due to a falling off in the inter-South American receipts. The Company had to compete with the Governments, and had to do the best it could. On the other side of the accounts, he was happy to say the expenses and repairs to cables were below the average. As he had said on former occasions, the revenue depended on the trade of the countries served, and on the cost of the repairs to cables. On the whole, he could congratulate the shareholders on what was a satisfactory but uneventful report.

The motion was adopted.

BRITISH ALUMINIUM.

An extraordinary general meeting of this Company was held at Winchester House, E.C., on Wednesday, for the purpose of passing a resolution for the reduction of the capital from £400,000 to £310,000 by cancelling £9 per share upon each of the 100,000 issued ordinary shares. Mr. J. D. Bonner presided.

The **Chairman** said that the resolution only provided for the writing down of the capital by the minimum amount that anyone could have anticipated after the result of Mr. Harmood Banner's investigation into the affairs of the Company in 1902 became known. No doubt there were many shareholders who considered that the directors' proposals were not of a sufficiently drastic character, especially as the goodwill still figured in the accounts at the sum of £100,000, and as the large stock of aluminium was not valued on so conservative a basis as the present cost of production rendered desirable. Some time ago the directors would not have been disposed to regard the proposal now made as sufficient, but, though the result of the last year's trading was insufficient by about £3,400 to meet the interest on the debenture stock, the circumstances of the Company had so much improved that they considered at the present time the course suggested was a satisfactory one. The directors would not have decided to leave £13,000 to be provided out of revenue if they had not felt that the Company was at last on the eve of earning profits sufficiently substantial to enable that sum to be provided out of profits without unduly delaying the liquidation of arrears on the "A" preference shares.

The resolution was carried.

MONTE VIDEO TELEPHONE.

The ordinary general meeting of the shareholders in this Company was held on the 29th ult. at Winchester House, E.C., Mr. Frank W. Jones presiding

The **Chairman**, in submitting the usual motion for the adoption of the report (*vide* issue of 23rd ult.), said that the past year had been one of continued progress, and the prospects for the future were satisfactory. The feature of the year had been the acquisition of the telephone system known as La Hispano Uruguaya. The Company had had a working agreement with the concern for a number of years, and had also been in negotiation for several years to acquire it. The property had been taken over on a fairly paying basis, and it was decidedly useful in regard to the Company's business in Monte Video. A general improvement was manifest in Uruguay, particularly in Monte Video, and it was hoped that a settled condition of affairs had been reached. The item "sundry creditors" in the balance-sheet stood at a high figure, but a portion of the amount to be paid for the system acquired was included. The value of the securities, taking the latest Stock Exchange prices, was 10 per cent. more than the amount shown in the balance-sheet. The directors had been fortunate enough to arrange for the expenditure for the year without issuing new capital. Continued expenditure, however, would be necessary, and in time a debenture issue would have to be made, but until it was necessary the expenditure would be kept within the bounds of the reserve.

The report was adopted.

BRITISH COLUMBIA ELECTRIC.

The annual meeting of the shareholders in this Company was held at Winchester House on the 30th ult., Mr. G. P. Norton presiding.

The **Chairman**, in moving the adoption of the report (which appeared in our issue for the 23rd ult.), characterised it as one of a thoroughly progressive character. The Company showed a highly satisfactory development of the business in all directions. In December next, when they hoped to have the advantage of the partial utilisation of the water-power installation, they had every reason to hope their progress would then be even more rapid than hitherto. From all the evidence they received from British Columbia they might safely assume that the undertaking of this Company would continue to develop and expand for many years to come. It would in all probability grow into a great business of considerable magnitude, and this would mean constant addition to the expenditure on capital outlay. In confirmation of those views he mentioned that since the close of the financial year the earnings for the three months to Sept. 30 last showed an increase of £3,647 over the corresponding period of last year. The undertaking had thus become thoroughly well established upon a strong and permanent basis, both financially and as a steady dividend-earning enterprise, and as an institution supplying public needs and rendering services indispensable to the comfort and prosperity of the people. The Board believed they had an organisation in British Columbia which it would be difficult to improve, and their reports, both as to the general equipment of the railway and the lighting plant, were of a highly satisfactory character. He directed attention to the proposed issue of £45,000 Vancouver Power Company debentures, which would be offered to the stockholders of this Company probably in December next. The directors considered these bonds an excellent investment, and they would first be offered to existing stockholders.

Mr. E. L. Evan-Thomas seconded the motion, which was carried.

CAPE ELECTRIC TRAMWAYS.

The report of the directors for the year ended June 30 last states that the profit and loss account, after provision for debenture interest and redemption of debentures, shows a net credit balance of £66,372, which, added to the balance of £14,540 brought forward from last year, makes a gross total profit of £80,912. Dividends amounting to 15 per cent. have been paid. The directors have also placed to the credit of reserve fund the sum of £8,000. These several sums aggregate a gross total of £80,000, and leave a balance of profit of £912 to be carried forward. The result of the year's transactions shows that the traffic on the tramway systems in South Africa has maintained itself at the high level of previous years. On the other hand, expenditure and maintenance have, owing to a variety of causes, shown a large increase over 1902, reducing the profit by about £15,000. Improvements and additions to the car-shed and power-house, with additional machinery in Cape Town, have at last been completed. The total cost of these new works has amounted to £84,919, which has exceeded the original estimate by £30,000; this increased expenditure is mainly due to the enhanced prices for all labour and material which obtained during the unsettled period of the war and immediately following the conclusion of peace. The reserve fund, which has now reached a total of £137,000, has met this expenditure, and consequently it has not been found necessary to raise further capital. The Port Elizabeth system also has not escaped increased expenditure, owing to the general rises in values and scarcity of labour before referred to, although these causes were not felt so acutely as in Cape Town. On Jan. 1, 1903, the directors leased from the Cape Town Consolidated Tramways and Land Company their Camps Bay tramline, to work the same for a period of three years, with an option of purchase at the expiration of the lease. The first six months' working by this company has shown a loss of £3,284, caused by the exceptionally bad weather prevalent in Cape Town during the greater part of this period. The directors anticipate, however, a satisfactory improvement on these figures as development progresses on the townships projected on the estates of the Cape Town Consolidated Tramways and Land Company at Camps Bay and Oranjezicht.

CONTRACTS FOR ELECTRICAL SUPPLIES.

Whitehaven.—The Guardians require tenders for the lighting of their infirmary. Tenders by Nov. 18.

Dublin.—The Corporation invite tenders for carbons. Tenders by 5 p.m. on 14th inst. See advertisement.

Bermondsey.—The Borough Council invite tenders for cables, arc lamp standards, and accessories, by Nov. 9.

Hornsey.—The District Council invite tenders for one 300-kw. steam dynamo to be delivered in October, 1904, and another in March, 1905.

Dudley.—The Guardians invite tenders for the supply and fixing of the various appliances for the electric installation to the laundry and boiler house.

Windsor.—The Town Council invite tenders for the supply of electricity or gas for the purpose of public lighting throughout the district for a period of five years.

Wood Green.—The Urban District Council invite tenders for the erection of a power station and the buildings in connection with the Council's electric lighting scheme.

Rangoon.—The Municipal Committee have decided to call for amended tenders for the electric lighting of the town on a continuous-current system. Five tenders were received for the first call.

Wisby (Sweden).—Tenders are invited for a private and public electricity supply estimated to cost 180,000 kroner. Particulars may be obtained from the Director of the Draetselkammaren at the above place.

Wakefield.—The City Council invite tenders for the supply and erection of one 400-kw. two-phase generator, comprising engine, alternator, exciter, and accessories. Tenders by Nov. 7. See advertisement in last issue.

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Kilmarnock.—The Corporation invite tenders for the supply, delivery, and erection of three Lancashire boilers, engines and dynamos, overhead hand travelling crane, storage battery, and switchboard, by Nov. 18.

Christchurch (New Zealand).—Tenders are invited for the complete installation of electrical tramways, other than buildings. Specifications, etc., may be obtained from the Agent-General for New Zealand, Victoria-street, S.W. See advertisement.

Blackpool.—The Electricity and Tramways Committee invite offers for various plant. Particulars can be obtained from the borough electrical and tramway engineer, Mr. Charles Furness, West Caroline-street, Blackpool. See advertisement in last issue.

Glasgow.—The Scottish Office of the May-Oatway Fire Appliances, Limited, invite tenders for the wiring of various installations. Full particulars from the Managing Director, 49, Queen-street, Glasgow. Tenders by Nov. 7. See advertisement in last issue.

Sydney (N.S.W.).—As will be seen from advertisement columns, tenders are asked for the supply of continuous and alternating current meters. Specifications, conditions, and forms of tender are obtainable from Messrs. Preece and Cardew, 8, Queen Anne's-gate, S.W.

Dartford.—The Metropolitan Asylums Board invite tenders for installing a complete system of telephones at the Darenth Asylum, Dartford, Kent. Specifications, etc., may be obtained at the office of the Board, Embankment, E.C. Tenders by 10 a.m. on Nov. 17.

Todmorden.—The Corporation invite tenders for one Lancashire boiler, two steam dynamos and balancer booster, two feed pumps and one injector, economiser, surface or jet condenser, switchboard and instruments, storage battery, cable work, and overhead hand crane.

Shanghai.—The French Colony propose to instal motor-propelled tramways. Tenders may be sent by Oct. 31, 1903, to Secrétariat de la Municipalité Française de Shanghai. Particulars may be obtained from l'Office National du Commerce Extérieur, Rue Feydeau, 3, Paris.

Blackadon (Devon).—The Corporation invite tenders for fitting up an electric light installation at the borough asylum. Specifications, etc., may be obtained from Mr. E. G. Okell, borough electrical engineer, Electricity Works, Prince Rock, Plymouth. Tenders by Nov. 14.

Barrow-in-Furness.—The Corporation invite tenders for the completion of the electric lighting installation at Hawcoat and Walney police stations and the pig slaughtering hall and lairage at the public abattoirs. Further particulars may be obtained from the Borough Engineer.

Swindon (Wilts).—The Corporation invite tenders for complete traction switchboard cables, etc. Specifications, etc., may be obtained from Messrs. Lacey and Sillar, 78, King-street, Manchester, and 2, Queen Anne's-gate, Westminster. Tenders by Nov. 23. See advertisement

Russia.—The Russian Minister of the Interior has sanctioned a plan for the reconstruction of three lines of municipal tramways—namely, those in Newsky, Sadovaïa, and Wassiliostrow districts. Each car is to provide for two classes of travellers, and will accommodate 52 persons.

Brighton.—The Council invite tenders for six water-tube boilers; a system of steam, exhaust, feed, blow-off, and suction pipes; and cast-iron storage tanks. Specifications, etc., may be obtained from Mr. Francis J. Tillstone, Town Hall, Brighton. Tenders by Dec. 7. See advertisement.

Kilmarnock.—The Corporation invite tenders for three Lancashire boilers, engines and dynamos, overhead hand travelling crane, storage battery, switchboard. Specifications, etc., can be obtained on and after 12th inst. from the Town Clerk. Tenders must be delivered at the Town Clerk's Office by Nov. 18.

Culiacan (Mexico).—Tenders are invited for lighting the town by electricity; 60 arc lamps of 1,200 c.p. and 110 incandescents of 50, 30, and 16 c.p. will be required. Propositions will be received by letter until Dec. 31 in the Secretaria del Ayuntamiento, Culiacan, where further information may be obtained.

Edinburgh.—The Lord Provost, Magistrates, and Council invite tenders for the wiring and fittings for the electric lighting installation at Gayfield-square police station. Specifications, etc., can be obtained at the office of the Resident Electrical Engineer, Dewar-place, Edinburgh. Tenders by 10 a.m. on 21st inst.

Blackpool.—The Electricity and Tramways Committee invite tenders for one new 450-kw. traction set (vertical triple-expansion engine and multipolar generator). Specification may be obtained from Mr. Charles Furness, borough electrical and tramways engineer, Electricity Works, Blackpool. Tenders by Nov. 14.

Hornsey.—The Urban District Council invite tenders for the supply of meters, indicators, and consumers' fuse boxes. Specifications, etc., may be obtained on application to Mr. Norman Staniland, Electricity Works, Tottenham-lane, Hornsey. Tenders by 4 p.m. on Nov. 30 to Mr. F. D. Askey, clerk, 99, Southwood-lane, Highgate, N.

Handforth (near Manchester).—The Guardians of Chorlton-upon-Medlock Union invite tenders for an electric motor for the new laundry at Styal Cottage Homes, Handforth, near Manchester. Specifications, etc., can be obtained from the consulting electrical engineer, Mr. G. R. Peers, A.M.I.E.E., 16, John Dalton-street, Manchester.

Swindon.—The Corporation invite tenders for the supply, delivery, and erection of steel poles, overhead line section boxes, arc lamps, and accessories. Specifications, etc., may be obtained from Messrs. Lacey and Sillar, 78, King-street, Manchester, and 2, Queen Anne's-gate, Westminster. Tenders by Nov. 16. See advertisement in last issue.

Radcliffe (Lancs.).—The Urban District Council invite tenders for the supply of the pitch and oil required in the construction of the tramways in the district. Specifications, etc., may be obtained on application to Mr. W. L. Rothwell, engineer, at the Council Offices. Tenders to Mr. S. Mills, clerk, Council's Offices, Radcliffe, by Nov. 14.

Chichester.—Tenders are invited for the installation of a system of electrical water-level indicators and recorder and telephones. Specifications may be seen and bills of quantities obtained at the office of the city surveyor and waterworks engineer, Mr. I. Pym-Jones, Lion-street, Chichester. Tenders by Nov. 6. See advertisement in last issue.

Radcliffe.—The Council invite tenders for the supply and completion of (Contract No. 12) lighting and traction switchboard and accessories; (14) rail bonds. Specifications may be obtained from Messrs. Lacey and Sillar, 2, Queen Anne's-gate, Westminster, and 78, King-street, Manchester. Tenders by Nov. 14. See advertisement in last issue.

Beckenham.—The Urban District Council invite tenders for the electric wiring of houses in their district under a free wiring scheme. Specifications, etc., may be obtained from the consulting engineer, Mr. Reginald P. Wilson, 66, Victoria-street, Westminster, or Mr. John A. Angell, surveyor, Council Offices, Beckenham. Tenders by 4 p.m. on Nov. 9.

Wednesbury.—The Corporation invite tenders for the electric wiring and fittings for the town hall, municipal offices, art gallery, public baths, public library, and electricity sub-station. Specification, etc., may be obtained at the offices of Mr. F. J. Warden-Stevens, A.M.I.M.E., A.M.I.E.E., 34, Victoria-street, Westminster, London, S.W. Tenders by noon on Nov. 20.

Harrogate.—The Corporation Electricity Department invite tenders for the supply and part laying of two high-tension concentric, paper-insulated, lead-covered trunk mains from the electricity works to the town. Specification may be oblained from Mr. Geo. Wilkinson, M.I.M.E., M.I.E.E., engineer-in-chief, Corporation Electricity Department, 33, Swan-road, Harrogate. Tenders by Nov. 16.

Sydney (New South Wales).—Tenders will be received at the office of the Deputy Postmaster-General, Sydney, New South Wales, up to 2.30 p.m. on Dec. 30, for the supply and delivery at the departmental stores, Sydney, of telegraph, telephone, and electric light material. Specifications, etc., may be seen and tender forms obtained at the General Post Offices, Sydney, Melbourne, Brisbane, Adelaide, Hobart, and Perth.

Wednesbury.—The Corporation invite tenders for the electric wiring and fittings for the following public buildings: town hall, municipal offices, art gallery, public baths, public library, and electricity sub-station. Specification, etc., may be obtained between 2 and 5 p.m. on and after the 23rd inst. at the offices of Mr. F. J. Warden-Stevens, A.M.I.M.E., A.M.I.E.E., consulting engineer, 34, Victoria-street, Westminster. Tenders by 12 noon on Nov. 20.

Manchester.—The Commissioners of H.M. Works and Public Buildings invite tenders for erection of a telephone exchange and engineer's office and store at Quay-street, Manchester. Specifications, etc., may be seen at H.M. Office of Works, New Bridge-street, Manchester. Forms of tender may be obtained at H.M. Office of Works, etc., Storey's-gate, S.W. Tenders before 12 noon on Nov. 11 to the Secretary, H.M. Office of Works, etc., Storey's-gate, London, S.W.

Harrismith (South Africa).—The Town Council invite tenders for the supply, f.o.b. British port, of the galvanised iron buildings required for a small electricity generating station. Drawings, specifications, etc., may be seen at the offices of, or obtained from, the Council's consulting engineers, Messrs. Mordey and Dawbarn, 82, Victoria-street, Westminster, S.W. Tenders to Messrs. Webster Steel, and Co., 5, East India-avenue, Leadenhall-street, E.C., by noon on Nov. 9.

Derby.—The Directors of the Midland Railway Company invite tenders for the supply of stores for 12 months from Jan. 1, 1904, including telegraph instruments, telegraph stay rods, bolts, insulators, etc., telegraph and signal wire. Samples may be seen at the General Stores Department, Derby, on and after Nov. 2, between the hours of 10 a.m. and 4 p.m. (Saturday, 10 a.m. and 1 p.m.) Forms of tender on application to Mr. Alfred Derry, stores superintendent, Derby. Tenders to the General Stores Committee, Midland Railway, Derby, by 9 a.m. on Tuesday, Nov. 10.

Colombo (Ceylon).—The Government of Ceylon invite proposals from persons willing to enter into a contract for the supply of electrical energy to the various offices, buildings, and premises of the Government, within the Municipality of Colombo, for a term of years commencing on or about Aug. 1, 1905. Proposals must be delivered at the office of the Colonial Secretary, Colombo, by Dec. 1. The *Ceylon Government Gazette* containing above notice may be seen on application at the Commercial Intelligence Branch of the Board of Trade, 50, Parliament-street, S.W.

RESULTS OF TENDERS.

Hull.—It is reported that the Ericsson Bell Telephone Company are to supply the municipal telephone instruments.

Nelson.—A tender for the supply and erection of a 400-kw. engine and dynamo by Messrs. Bruce Peebles and Co., of Edinburgh, has been accepted.

Arbroath.—The Council have accepted the tender of the Empire Electric Light and Power Company, Limited, for the lighting of the town by electricity.

Brierley Hill.—The Urban District Council have accepted the tender of Mr. John Williams for supplying electric light wiring, etc., at the new technical school, his price being £63, 12s.

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Bridgend.—The Guardians have accepted the tender of Singer and Brown, Bridgend, Glam., at £148. 16s., for wiring in connection with the installation of electric light at the workhouse, Bridgend.

Wood Green.—The Urban District Council have accepted the tender of Henley's Telegraph Works, at £7,678. 2s. 5d., for electricity supply works in connection with the Council's electric lighting scheme.

Shoreditch.—The Borough Council have accepted the tender of F. Willmott, Ilford, at £1,120. for pulling down and rebuilding 5, Hoxton-square, N., to be used as stores for the electricity department.

Holyhead.—The Urban District Council have accepted the tender of the Alphons Custodis Chimney Construction Company, Limited, 119, Victoria-street, S.W., at £617, for erection of a chimney shaft in connection with their proposed destructor and electricity works.

Dewsbury.—The Council have accepted the following tenders: British Schuckert Company, London, for the supply to the electricity works of three automatic cut-outs and slate panel; Messrs. Crompton and Co., of London, for the supply of a new armature for the 50-kw. engine; and Messrs. William Scott and Sons, of Dewsbury, for the setting of the new boiler at the electricity works.

Swindon.—The Corporation have accepted the tender of J. G. White and Co., 22A, College-hill, Cannon-street, London, at £24,675. 6s. 4d., for the supply, delivery, and laying of all the rails, points, crossings, and accessories for the permanent way of the Corporation's tramways, and all material and labour for the construction of the underbed and for the paving of the tramways.

London.—The Highways Committee of the London County Council have received the following tenders for the supply of four 5,000-h.p. engines, required for the electricity generating station now being established at Greenwich in connection with the electrical working of the Council's tramways:

Fullerton, Hodgart, and Barclay, Limited, Paisley (incomplete)	£36,817	0	0
Maschinenfabrik Buckau Aktien-Gesellschaft, Magdeburg (not to specification)	58,871	3	0
Cole, Marchent, and Morley, Limited, Bradford	84,921	10	0
Wallsend Slipway and Engineering Company, Limited, Wallsend-on-Tyne (German steel)	88,525	0	0
Ditto (English steel)	92,525	0	0
A. Borsig, Berlin (incomplete)	92,995	0	0
Davey, Paxman, and Co., Limited, Colchester	96,693	0	0
J. Musgrave and Sons, Limited, Bolton	96,713	0	0
Ferranti Limited, Hollinwood, Lancs.	99,250	0	0
Allis-Chalmers Company, London	99,750	0	0
Yates and Thom, Blackburn	100,680	0	0
Aktieselskabet Burmeister and Wains, Copenhagen	105,683	0	0
Gourlay Bros. and Co., Dundee	107,168	0	0
D. Stewart and Co. (1902), Limited, Glasgow	109,068	0	0
Ditto (alternative)	105,492	0	0
Willans and Robinson, Limited, Rugby	131,857	0	0

The tender of J. Musgrave and Sons has been accepted, with the following sub-contractors: J. Brown and Co., Sheffield, heavy forgings; J. Webb and Co., Bury, light forgings; W. Jessop and Sons, Sheffield, steel castings. The report of the committee on these tenders appears in another column. The Council have accepted the offer of Messrs. F. J. Cooleby and Co. to continue to maintain until Dec. 31, 1903, the electric bells belonging to the fire brigade, and the telephone installation at the chief station, on the same terms and conditions as are contained in the existing contract with the firm—viz., at the rate of £315 per annum, in addition to certain stipulated small amounts for additional bells fixed from time to time.

BUSINESS NOTES.

TRACTION.

St. Annes.—Plans have been approved for a new tram shed.

Aberdeen.—The Tramways Committee are adopting, by way of experiment, the Thermit process of welding rails.

Luton.—The Corporation have decided to apply for a provisional order for laying down a system of electric tramways in the borough.

Devonport.—The tramway extensions from St. Budeaux to Salthouse Passage, and from Milehouse to Tor-lane, were opened on Saturday.

Rowley Regis.—The Urban District Council are raising a loan of £21,000 for the construction of tramways from Old Hill to Blackheath.

Altrincham.—A special meeting of the Urban District Council has decided to apply for a provisional order for the construction of tramways in the district.

Chobham.—The Parish Council have approved the plans of the light railway proposed to be constructed by the West Surrey Light Railway Company.

Dalton-in-Furness.—The British Electric Traction Company have been requested by the Urban District Council to extend their tramways from Barrow to Dalton.

Dunfermline.—It is proposed to construct a tramway between Dunfermline and Rosyth, the new naval base on the Firth of Forth, the distance being four miles.

King's Norton.—The District Council on Wednesday decided to borrow £30,000 for the purpose of the King's Norton and Northfield Urban District Tramways Act.

Belfast.—A proposal has been launched for an electric tramway between this city and Bangor, about 12 miles away on the sea coast. Bangor is a fashionable watering-place.

St. Kilda.—After some discussion at the last Council meeting it was resolved to approve of the amended order in Council in relation to the construction of electric tramways in the borough.

Portmadoc.—An electric railway is projected from Portmadoc through the Gwynant Pass on through Bettws-y-coed to Corwen. Engineers are at present engaged in surveying the land.

Accrington.—The tramways company have submitted an offer to the Corporation by which they propose to electrically equip their lines provided they are not disturbed for a period of seven years.

Hull.—The city engineer has been authorised to proceed with the laying of the tramway in Clarence-street continuation from Great Union-street to Holderness-road, and with the paving of the street.

Cleckheaton.—The matter regarding the alleged failure of the British Electric Traction Company to construct the proposed tramway in the Westgate district was referred to the Council's solicitors at the last meeting.

Gloucester.—The City Council have decided to advertise for a general manager at a salary of £300 per annum, rising by annual increments of £25 to £450, to supervise the construction of the proposed light railways.

Kingsbridge.—On the subject of the proposed light railway, the clerk at the last meeting of the District Council said he was in a position to say that if the order was obtained, all the money was ready to be subscribed—*i.e.*, £300,000.

Litherland.—At the monthly meeting of the District Council reference was made to the opening of the Litherland tramway route. It was stated that everything was in readiness to be inspected, and in a short time the line would be opened.

Southampton.—Having made a further inspection of the curves at the top of Four Posts-hill and at the Stag Gates, the Tramways Committee recommend that tenders be invited for a new section of rails, with ½in. lip, for use at curves throughout the tramway route.

Salford.—The Town Council have adopted a recommendation of the Tramways Committee to apply for sanction to borrow £3,417 to cover the cost of the overhead equipment of the tramways in Middleton-road from the Manchester boundary at Cheetham Hill to the Middleton boundary.

Folkestone.—A special meeting of the Town Council has decided to adopt the G.B. system of electric traction for the proposed tramways from Cheriton-road boundary to central station and from central station to the harbour. An expert is to be engaged to advise the Corporation in the matter. The estimated cost is £30,000.

Heath Town.—On Wednesday the Urban District Council approved recommendation urging the Wolverhampton Tramways Committee to complete the tramlines to Heath Town at the earliest possible date; and that they be asked if they would pave the road opposite the public buildings with wood blocks, on the condition that Heath Town paid half the cost.

Tramcar Brakes.—In reference to the Westinghouse magnetic brake, we are informed that the large addition recently erected by the Westinghouse Air-Brake Company, Wilmerding, for the magnetic brake department has been worked to the utmost extent, and the plant is now about to be enlarged, having been found inadequate for the requirements.

Darwen.—In reply to questions at the last meeting of the Town Council, the Chairman of the Tramways Committee said that enquiries had been made, and it was ascertained that only four tramways departments in the whole of the United Kingdom reported favourably on the issuing of season tickets. The Darwen committee therefore could not see their way to institute the system.

Lincoln.—The Board of Trade have appointed an arbitrator to fix the price to be paid for the tramways undertaking by the Corporation, who have decided to purchase the system as a prelude to adopting electric traction. The Corporation offered the company about three-fourths of the paid-up capital, and this the directors refused. The arbitrator is Colonel Sir Colin Scott-Moncrieff.

Walsall.—On Thursday last week a trial car was run over that portion of the Corporation tramways which has been newly laid. The system is now quite ready for the Board of Trade inspection, which will probably be held in about a week's time, and everything will then be in order for the Corporation to commence the working of the trams on the date which has been already fixed—Jan. 1.

Kirkcaldy.—The Corporation tramways continue to show successful results, but the proposal to increase the number of ½d. stages is being warmly discussed. The extended route is expected to come into operation about four weeks hence. As a result of the extension of the system a large addition to the car-sheds has been decided upon, for which Mr. Masterton has been instructed to prepare plans.

Batley.—Last week two sections of the Corporation electric tramways (leased to the British Electric Traction Company) were opened for public service. They are the Healey and Mount Pleasant routes, both starting near the centre of the town, and connecting with the company's Dewsbury and Spen Valley tramway. The cars are of the Westinghouse type, and electric energy is supplied from the Corporation power station.

South Hams Light Railway.—Colonel Boughey and Mr. H. A. Steward have held an enquiry at Kingsbridge into the proposed light railways, which are embraced in a scheme for linking up the Great Western Railway branch at Yealmpton with that which runs down to Kingswear, and providing or improving railway communication for Modbury, Kingsbridge, Salcombe, Newton Ferrers, Dartmouth, and other centres in the South Hams.

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Camberwell.—The question of an additional tramway to that already sanctioned, from Denmark-hill *vid* Champion-hill Fields to Green-lane, and Townley-road to Lordship-lane, was raised at the last meeting of the Borough Council, and after some discussion the matter was referred to the General Purposes Committee. It was stated that as regarded the sanctioned tramway to Dulwich, the London County Council had served notice to treat.

Nidd Valley Light Railway.—Notice is given that application is intended to be made to the Light Railway Commissioners by the Corporation of Bradford for an order to amend the Nidd Valley Light Railway Order, 1901, and to transfer to the Corporation all or some of the powers conferred by the order of 1901. It is proposed by the order to extend the time limited by the order of 1901 for the compulsory purchase of the lands for one year until March 30, 1905.

West Bromwich.—Colonel von Donop on Tuesday visited West Bromwich for the purpose of inspecting the electric tramlines which have been laid by the Corporation in Spon-lane and Bromford-lane. The lines are intended to connect West Bromwich with Oldbury and Smethwick, and will join up with the tramways between Dudley and Birmingham, in the Market-place, Oldbury, and Spon-lane. Trial trips were made along both sections, and everything passed off satisfactorily.

Richmond.—The local residents are petitioning the Town Council to invite the London United Tramways Company to promote a Bill for the extension of their system to Richmond. So far the local authority have rejected the company's proposals in respect of this district, but the matter will come up for reconsideration at Monday's meeting of the Town Council. The company want to lay a double line over the new bridge at Kew, and for this they must obtain the sanction of the local authority.

Durham.—At Wednesday's meeting of the Town Council attention was drawn to the continued delay in commencing the work of laying the tramlines between the city and Brandon. It was stated that powers were granted to the electric tramways company in November, 1901, but nothing had been done, and next year the powers would lapse unless something were done. It was decided to write to the Local Government Board and ask them to press the company to get on with the work.

Stretford.—The District Council have instructed the Parliamentary Committee to include in their Bill now in course of preparation powers for the construction of additional tramways in Warwick-road, Seymour-grove, and Talbot-road. The chairman of the Electricity and Tramways Committee stated, in answer to a question, that the committee had begun to supply electricity to the Manchester Corporation on one of the tram routes in the Stretford district, and that there would be current for the other two routes next week.

Preston.—At the last meeting of the Town Council the Tramways Committee asked to withdraw the following recommendation which it was said had been agreed to in committee under a misapprehension as to who were to be the sub-contractors for the special steelwork: "That the tender of Messrs. Dick, Kerr, and Co., Limited, for permanent-way construction and overhead equipment (with the Lorain Company's special work), according to plans and specification, for the sum of £80,582, be accepted." After a long discussion the necessary leave was obtained by 32 votes to 7, and the recommendation was withdrawn.

Proposed Electric Railway.—A meeting of the guarantors of the Bristol, London, and South Counties Railway, which failed to obtain parliamentary sanction last session, has been held in Bristol to consider an alternative scheme, the chief features of which were the provision of electric traction for passengers between Bristol and Trowbridge, and the erection of a separate station at Basingstoke. After careful consideration, it was decided that, although the promoters could see their way to considerable support, it would be impossible to complete the work of survey and reference in time to deposit a Bill next session. Action is therefore necessarily delayed for a year.

Paisley.—A start was made on Monday with the laying of the new Paisley and district electric tramways. The work has been commenced at the east terminus on the Glasgow-road, and after the main line has been constructed in Paisley it is intended to have the system extended to Johnstone. The new system will connect Paisley with Johnstone, Renfrew, and Glasgow. A dispute has arisen between the Corporation and Mr. Murphy, the promoter, as to the quality of the granite setts to be used in the laying of the track, and an injunction was on Tuesday obtained by the former restraining Mr. Murphy proceeding further with the work pending an appeal to the Board of trade.

Rochdale.—At the last meeting of the Town Council a letter was read which the Negotiating Sub-Committee had sent to the legal advisers of the tramway company. In this the sub-committee expressed regret at the inability of the parties to come to a working agreement, and declared that they were still desirous of completing a working agreement, based on the original agreed heads, to take effect at the end of the company's next half-year's working. If the company cannot see their way to co-operate in this and do not reply in four days, the sub-committee will ask the arbitrator to at once proceed with the arbitration under the 1881 order, and leave any contentious question under the 1882 order to be decided hereafter.

Christchurch (N.Z.).—That practical operations will soon be commenced in connection with the reconstruction of the tramways at Christchurch, New Zealand, for electric traction will be gathered from the advertisement which we publish this week calling for tenders for carrying out the works. Tenders are to be all in by March 17, 1904, so that operations will probably begin in the spring. There will be 36 miles of single track converted for electrical working, which includes about 2½ miles of double track. The engineer in charge of the scheme is Mr. F. Hubert Chamberlain, formerly with the General Electric Company of America, and, until the present engagement, chief assistant electrical engineer to the New South Wales Government in Australia.

Buenos Ayres.—The electric tramway companies, in view of the numerous taxes imposed upon them by the Buenos Ayres Municipality, decided to protest against those for levels and cables, as well as for the tax of £3 for every permit to open the streets. The solicitor of the Corporation is of the opinion that the taxes are perfectly legal, and the companies will now be called upon to pay same. The Committee of Public Works of the City Corporation have reported on the petition of the City of Buenos Ayres Tramways Company for the electrification of their line. They recommend that a 99 years' concession be granted, to count from the date of the primitive concession, which would give it another 64 years.—*Review of the River Plate.*

Competition at Glasgow.—At the half-yearly meeting of the Cathcart District Railway Company the competition offered by the Corporation cars was referred to. A shareholder gave it as his opinion that so long as they had these municipal cars running cheaper and cheaper day by day, they would have the greatest difficulty in earning any dividend at all. It looked as if, from the present trend of events, they would by-and-by have free Corporation cars, and then they could make a present of their undertaking to the Corporation. He hoped the Council would endeavour to look at the matter from a public point of view, and see that they were pushing out private enterprise, and keep the fares more in accordance with what they should be commercially.

Additional Traffic Returns.—Anglo-Argentine, £2,113 increase; Barcelona Ensanche y Gracia, £117 increase; Barcelona, £209 decrease; Brisbane, £185 increase (month of August, £11,736, increase £294), British Columbia Electric (month of March), gross earnings £10,352, net income £2,659; Buenos Ayres and Belgrano Electric, £89 decrease (month of October, £14,055, increase £1,002); Calcutta, £366 increase; Cape Town (month of September), receipts £15,174, expenditure £8,503; Isle of Thanet Electric, £23 decrease; Lisbon Electric (month of September), receipts 89,636 milreis, expenses 51,231 milreis; Mexico Electric (month of August), receipts £48,600, expenses £27,900; Perth Electric, £220 increase; Port Elizabeth (month of September), receipts £3,730, expenditure £2,767.

Crystal Palace.—Speaking at the ordinary half-yearly meeting of the shareholders of the Crystal Palace Company, the chairman said the plans for the tramways authorised to the Penge entrance from Croydon were in course of preparation, and their construction would, no doubt, be commenced at an early date. He looked to a considerable increase in revenue from this direction, but far more important would be the extension of the County Council tramways from the London side. He had the pleasure, with the rest of the Board, of meeting a committee of the London County Council quite recently upon this question, and so unanimous was the opinion that the extensions should be made that he was satisfied that they would have all the electric tramway feeders they required in the near future.

Central Wilts Light Railway.—Colonel G. F. C. Boughey, R.E., C.S.I., and Mr. Henry Allan Steward sat as Light Railway Commissioners at Marlborough, on Wednesday last week, to enquire into the expediency of granting the application of a syndicate for an order to authorise the above-named light railway. The arguments having been heard, and the Commissioners having consulted, the Chairman delivered their decision as follows: "The omissions to give the necessary notices have been proved in respect of a considerable length of the railway. It appears that without compulsory powers to acquire these lands the promoters could not carry out their scheme. The Commissioners do not consider that they could give such powers under the circumstances, and they will therefore not proceed further with the application."

Portsmouth.—Application is to be made to the Board of Trade for sanction to borrow £736 for the laying of a double junction at Bradford-road, and £150 for the laying of a cross-over in Commercial-road between Edinburgh-road and the station. At the last meeting of the Town Council a member asked the chairman of the Tramways Committee if, in view of the recent fatalities, any experiments had taken place in testing the efficiency of the guard in front of the cars, and if they were tested in systematic manner from time to time, to see if they were in working order? Mr. Kimber said that the guards they had now were practically recommended by the Board of Trade, and were in almost universal use throughout the country. They had been very fortunate in Portsmouth with regard to accidents as compared with other towns.

Manganese Steel.—Hadfield's Steelfoundry Company, Sheffield, have during the past month obtained the following new tramway contracts for points and crossings in their patent "Era" manganese steel: Paisley tramways, through Messrs. Murphy and Sons; King's Norton tramways, through Messrs. Blackwell and Co. (contractors); Scarborough tramways, through Edmundson's Electricity Company—all special junctions, etc., for this work are also being built by Messrs. Hadfield; Aston Manor tramways, through Mr. G. Trentham (contractor); Edinburgh Tramways Company; Liverpool Corporation tramways, for 12ft. points, etc.; and Sheffield Corporation, for 12ft. points, etc.; Brighton tramways, for points and crossings for their new extensions lines. This is Brighton's first manganese work, all the existing special track work being in crucible cast steel.

Derby.—At the conclusion of the Council meeting on Wednesday last week, at which an adverse vote was given against the Burton-road scheme, as reported in our last issue, the members of the Tramways Committee held a meeting to consider their position. The Chairman (Mr. Alderman Duesbury, J.P.) expressed a desire to tender his resignation, and the other members of the committee were also of opinion that it would be best for them to retire, considering the decision of the Council with respect to the Burton-road scheme. The matter was discussed at some length, but it was felt that in view of the undertaking just entering upon a

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practical stage, it would be a great pity to leave it, even for a short period without any committee or body of administration. This was the general feeling of all present, and under these circumstances the committee decided to adjourn the meeting. They agreed to act in a body, and if the chairman retires his colleagues will follow his example.

Bushey and Barnet Light Railways.—Sir Herbert Jekyll on the 30th ult. heard an appeal from the Light Railway Commissioners, who have granted the Hertfordshire County Council running powers for the Barnet and Bushey Light Railway over the proposed lines of the Watford and District Tramways. Mr. C. C. Hutchinson, on behalf of the latter, objected to these running powers of the County Council, but if they were granted, then his clients asked for reciprocal running powers. Mr. Danckwerts, K.C., objected, and stated that the policy of the Hertford County Council was to get the people from the crowded districts into the country, and the Watford and District Tramways, whose powers expired in another year, merely wanted the running powers which the Light Railway Commissioners had refused the company, to enhance the value of its undertaking, in order to sell it. Sir Herbert Jekyll said the Board would very carefully consider the point, but he did not think they were likely to reverse the decision of the Light Railway Commissioners.

Barrow.—It has been a matter for conjecture what system of supplying the current for that portion of tramways crossing the high-level bridge would ultimately be adopted. A difficulty was expected in this direction, but, so far as can be ascertained, the matter will be overcome in a very simple way. The plans provide for a continuation of the overhead wires over the bridge, each wire being supported in the centre by fixed brackets. At either end of the bridge there will be fixed special poles or standards, and also immediately on the roadway. On the top of the latter will be arranged a kind of cup and socket, so that when the bridge is being raised the bar containing the wires will automatically become disconnected and will return into position again when the bridge has been lowered. It is expected the trolleys will be a little higher when running over the bridge than on the roadway, and in order to get over this difficulty a simple coupling arrangement has been devised. When the bridge is raised the current will, of course, be cut off, but immediately the bar returns into position the circuit will be renewed. The electric mains to Barrow Island are laid at the bottom of Devonshire Dock, and, therefore, although the bridge may be "off" and the circuit disturbed, the cars running on the island will be assured of a supply of current, and there will be no temporary stoppage of the service.

Wolverhampton.—A long and animated discussion took place at the last meeting of the Town Council on a report of the Tramway Committee, which brought forward recommendations that the electrical engineer be instructed to forthwith invite tenders for the supply of six double-deck cars, and that the chairman and deputy-chairman of the Tramways Committee and the electrical engineer be authorised to accept such tenders as they might deem advisable. The cars will be required for the laying down of the Dudley-road track, which it is expected will be completed before the end of the year. Several of the members objected to the matter being left in the hands of the gentlemen mentioned in the resolution, while others contended that the whole of the members of the committee should have a voice in the selection of the tenders. There were other members who contended that the tenders should not be confined to double-deck cars. A number of amendments were proposed and discussed, but ultimately the original resolution was adopted. The Council confirmed the promotion of a Bill for the extension of the tramway system to Wednesfield. The Tramways Committee have announced by a printed notice placed inside the New Hampton-road cars that the service of trams from Coleman-street to Newbridge will be discontinued "until further notice." The reason for this step is that the line does not pay.

Brighton.—The recommendation mentioned in our last week's issue, that the tramways engineer should be instructed to prepare specifications and detail drawings for a public shelter and tramway room at the Old-steine terminus of the tramway system, has been rejected by the Town Council. Arising out of the recent action of the Tramways Committee in disqualifying a tender for cars on the ground that the firm quoted only for British trucks instead of American as specified, the employés of the truck shop at Falcon Works, Loughborough, have held a meeting and passed the following resolutions unanimously: "That this meeting, having heard that in several towns it is the custom to exclude British firms from putting in tenders for trucks in competition with foreign makers, respectfully appeals to members of tramway committees and other buyers of cars to give fair play to an industry on which the welfare of so many of their countrymen—not only ourselves and our families, but other workers concerned in the preparation of the material—is absolutely dependent. That, while having no right or wish to interfere with the actual placing of orders, we urge that in our own country it is unjust that British truck makers should be barred from opportunities of selling goods which are the product of British labour. That we protest against any suggestion that foreigners can claim superiority or even equality in any branch of steelwork, and we are confident that with fair and open competition foreign-made electric traction trucks would soon fail to find any market whatever in this country, and that employment would then be provided for a large number of additional men in this industry."

Sunderland.—On the 25th inst. a special meeting of the Town Council will be held to approve an application to the Board of Trade for a provisional order authorising the Corporation to construct new and additional tramways within the borough. At the last meeting of the Tramways Committee an important report respecting the depreciation and renewals fund was presented. It stated that from the experience of the working of the Sunderland tramways, and from the experience of tramway engineers, managers, and accountants in other towns, the probable life of the works had been ascertained, and the committee was asked to set aside as a depreciation and renewals fund such an amount annually as would depreciate or renew the assets at the end of the period they had laid down. Already £27,426 had been set aside, whilst the sum required on the basis now presented was £23,854, so that a substantial balance was left in hand over and above the estimate. Five thousand pounds had also been invested as a further reserve fund in accordance with the provisions of the Act of Parliament, and an accident reserve fund of £2,000 was now being built up, £911. 3s. 9d. having been contributed during the last two years. The report continued: "We have no hesitation in saying that there is every indication that the life we have allotted to many portions of our plant will be greatly exceeded, but it is better to err on the side of caution, and, therefore, the fund may be considered quite equal to any demand that may be made upon it. Probably it is unnecessary to deal with the statement in detail, but we should like to direct your attention to the fact that there is a large scrap or surrender value in much of our plant, even when the plant is useless for its present use. Rails, bonds, trolley wires, and cables will all realise a large sum when sold, and the amount gained in this way will be taken into account when dealing with the depreciation question. There are many portions of the undertaking that will appreciate rather than depreciate in value. The land we have is certain to be worth much more in 30 years' time, but within this period the debt will be paid off, and, so far as we can foresee, the tramways will be enjoyed by the inhabitants of the borough at that time free from debt." The report is signed by Thomas Summerbell, chairman; T. E. Bryers, vice-chairman; H. England, general manager; John F. C. Snell, borough electrical and tramways engineer; and Haswell Brown, borough accountant. Appended to the report is a detailed statement showing the capital expended on each portion of the tramway works, the estimated life of each, etc.

Leith.—A special meeting of the Town Council has been held to consider matters connected with the tramways undertaking. In a report by the town architect and the burgh electrical engineer as to additional buildings and plant in connection with the possible introduction of electric traction in the burgh, it was stated that, judging from the present progress of the undertaking, an addition to the existing station buildings and plant would have to be provided within two years, and they recommended that the first addition should comprise generating and steam plant, with auxiliaries, to the extent of 1,000 h.p. This addition would suffice for both electric tramcars and the general supply of electricity for public and private lighting then connected to the undertaking. They also recommended that the future extensions of the plant should be in units of 1,000 h.p., and either of the plans they submitted showed a completed station of 7,710 h.p. The first plan showed the extension of the electric station by the absorption of the whole of the site presently occupied by the cleansing department. The cost of the site would be about £10,060, and to erect the new buildings would cost about £10,986, giving a total cost of £21,046. The report stated that if this plan was adopted the whole scheme would require to be carried out at one time, and that the cost of the plant under it would be about £11,000. The second plan showed the extension of the station by the acquisition of Mr. Young Pentland's ground adjoining the station, and under it the extensions could be carried out in sections by erecting bays from time to time as each engine and boiler was added. To erect all the new buildings in accordance with this plan would cost about £8,200, and to erect only a portion—viz., a bay of engine and boiler house, chimney flue, economiser building, pump and tank room, workshops, etc., would cost £5,400. The plant to be laid down in the first instance would cost about £12,000. The initial cost of the two plans was given as: No. 1, cost of site, buildings, and plant, £29,540; No. 2, cost of site, buildings, and plant, £25,400. Final cost of site and buildings: No. 1 plan, £21,046; No. 2 plan, £16,200. The final cost of the plant would be almost identical for either No. 1 or No. 2 schemes. The Council decided to accept Mr. Pentland's offer for the purchase of his land. The following are the proposed heads of agreement which it is proposed to enter into with the lessees of the Edinburgh tramways: (1) On the acquisition of the tramways in Leith by the Council, the Council to immediately proceed to convert the whole system, doubling the lines throughout where practicable, for electric traction; (2) the whole tramways and any alterations or extensions thereof to be now agreed upon by the Council, and what is known as the Morton-place property, to be leased from the date of acquisition of the tramways by the Council to the lessees of the Edinburgh tramways; (3) no claim to lie by the lessees against the Council consequential on the said process of conversion or extension; (4) the lessees to take electric energy from the Council at 1½d. per unit; (5) fares and service to be subject to arrangement; (6) the lessees to take over the horse plant of the present owning company at cost to the Council; (7) the lessees, for the purpose of through traffic with the city of Edinburgh, to equip their electric cars so that these electric cars may be taken from Pilrig over the cable system in Edinburgh up to St. Andrew-square, or other point which may be agreed on by the parties, unless the City Corporation agree to electrify that portion for the like purpose of through traffic; (8) the lessees to state what percentage and rent they are prepared to offer; (9) in the event of an arrangement under these heads, an agreement on these and on other relative matters to be negotiated on the lines of the previous provisional arrangement with the Edinburgh lessees.

London County Council.—Mr. A. L. C. Fell, of Sheffield, has been appointed chief officer of tramways to the London County Council at a salary of £1,500 a year. Further reference to this appointment will be found in our "Personal" notes. The tramway item that raised most discussion at the usual weekly meeting of the London County Council on Tuesday was probably the recommendation of the Highways Committee not to purchase the undertaking of the London

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Southern Tramways Company. The lines in question run from Vauxhall to West Norwood, with a branch to Camberwell-green, where they join up with the Council's system. The committee reported that the latest information available showed that the company's undertaking was not at present remunerative. The Council would not, the committee thought, make the new line pay. They stated that, with street widenings, the total capital sum which would have to be provided was estimated at over £450,000. Having regard to the present capital commitments of the Council, they did not feel justified, in the circumstances of the case, in recommending the Council to take any steps at the present time for the compulsory purchase of the undertaking. This course would not preclude the Council from purchasing the lines at the expiration of the next statutory period—seven years—when the development of the Council's existing tramways south of the Thames, under the conditions which obtained with the use of electrical traction, would have probably reached a stage which would justify the Council in undertaking all the further developments in the locomotive requirements of London, which were undoubtedly demanded, and would enable it to formulate those requirements with more accuracy. In addition, the Council might then be in a better position, with reference to its other capital commitments, to undertake the service, even should the position of affairs outlined in the present report remain unchanged. After a long discussion the Council referred the report back, the opinion being that there should be no break in the Council's policy of becoming the sole tramway authority within their area. The same committee brought up an important report with reference to the tenders received for the supply of four 5 000-h.p. engines for the Greenwich generating station. Sixteen tenders were sent in in response to the Council's advertisements, and the full list will be found in our "Tenders" columns. It will be seen from the following report of the committee that they recommended for acceptance the tender of Messrs. John Musgrave and Sons at a price which is nearly £12,000 higher than the lowest tender sent in, which they were able to take into consideration. Their reasons for adopting this course are given in the report. It reads as follows: "The tenders have been carefully examined by the Council's electrical engineer, and we have had before us his report upon them. As the result of our consideration of the matter, we are of opinion that the tender of Messrs. John Musgrave and Sons, Limited, amounting to £96,713, should be accepted. It was not possible to consider the first two tenders, as that of Messrs. Fullerton, Hodgart, and Barclay, Limited, was incomplete, while the second lowest tender was not in accordance with the Council's specification. The next lowest tender amounts to £84,921. 10s., or £11,791. 10s. below that of Messrs. Musgrave and Sons, which, it is suggested, should be accepted. As the difference between the two tenders is about 12 per cent., we have given very careful consideration to the course which should be taken in the matter. Certain details of construction of the engines were left to the tenderers to decide, and we have, therefore, in considering the matter, borne in mind the relative advantages of the various proposals submitted by the firms who have tendered having regard to the Council's requirements. Moreover, in view of the vital importance of the engines to the success of the tramways undertaking, we have also felt compelled to take into account the experience and qualifications of the firms submitting tenders to undertake so large a work, as it involves the largest order for engines which has ever been given by a municipal body. In order that there should be no risk of failure, and that the best possible form of construction should be secured, we are of opinion that the extra expenditure involved by accepting the tender of Messrs. Musgrave and Sons is fully justified, as it is essential to the successful completion of the large and costly tramway works which the Council has in hand that the most satisfactory results should be obtained from the engines. Messrs. Musgrave and Sons have submitted the names of certain firms to whom they propose to sublet different portions of the work, and we are advised that no objection need be raised to that course. The necessary expenditure is provided for in the estimate approved by the Council on July 21, 1903, for the provision of plant at the Greenwich generating station." A discussion took place on the report, in the course of which Mr. Torrance said he would like more reasons to be given for the committee declining to accept the lowest tender. He was getting alarmed at the growing capital expenditure of the Council. He was very reluctant to move an amendment, but was afraid he would have to do so unless a satisfactory explanation was forthcoming. Mr. D. S. Waterlow said there was a great difference in machinery, and it was very necessary that they should be extremely cautious. The firm recommended by the committee had a very high reputation. They had to consider how serious it would be if these large engines gave trouble at any future time. Sir William Collins said that the objections offered by Mr. Torrance had not been answered, and he saw no reason why they should depart from their usual practice of accepting the lowest tender. Mr. Benn, chairman of the committee, pointed out that the engines were the biggest ever ordered by any municipality. He proceeded to read a document prepared by the electrical engineer, showing why other and lower tenders had been rejected. The firm now recommended had built similar engines for the Glasgow Corporation and for the City of London Electric Lighting Company. Mr. Torrance said he was quite satisfied. The recommendation of the committee was then agreed to. Another report which the Highways Committee had on the agenda referred to the temporary supply of electrical power in connection with the working of the New Cross and Greenwich tramways. The reconstruction of these tramways is now almost completed, and the arrangements with regard to the erection of the necessary plant at the London Electric Supply Corporation's generating station are nearly completed, and it is hoped that it may be practicable to commence the electrical working of the tramways early next year. The agreement entered into with the company with regard to the matter provides for the payment by the Council at a rate to be agreed, but not exceeding 1½d. per unit of electricity generated. The Council's plant at Deptford will be in the same engine-room as that of the company, and the question has arisen as to the advisability of having two separate staffs in the same building under different control. It has been suggested that the company should take over the running of the mechanical plant and be responsible for all repairs, maintenance, and stores for an inclusive charge of 1·65d. per unit, including the supply of steam. The committee think that it would be advisable, however, for the Council to employ a charge engineer to give instructions as to the running of the plant, to supervise the working of the switchgear, and also to make necessary repairs to the electrical plant. Having regard to the circumstances, they are of opinion that this arrangement would be the most economical and convenient one to be made, and it is probable that the extra cost involved in the increased charge of 0·15d. per unit would not exceed the expenditure incidental to the establishment by the Council of its own staff of workmen. The rate of pay for charge engineers employed at temporary electricity generating stations of the London County Council Tramways was fixed by the Council at from £3. 10s. to £4. 10s. a week, and the charge engineer proposed to be employed at Deptford will be paid according to this rate. The Improvements Committee presented a report in which they asked for authority to spend £21,500 for the purchase of property needed for the widening of Brook Green-road and Scrubbs-lane authorised by the Tramways and Improvements Act of 1903. During the meeting Mr. Collins asked if the Council's inspectors had been to Belgium to see the tramrails made, and if the employers paid fair rates of wages and observed reasonable hours of labour. Mr. Benn said he must ask for notice of such a question. He would reply to it next week.

LIGHTING AND GENERAL.

Nuneaton.—The Electric Committee made a profit during September.

The New Mall.—The processional road in the new Mall is to be lighted by electricity.

Dudley.—The Guardians are arranging for the installation of electric light and power at the workhouse.

Lincoln.—The Council propose to apply for power to borrow £11,500 for extensions at the electricity works.

Swansea.—The electrical engineer in his last report recommends that 48 gas lamps be replaced by Nernst electric lamps at a cost of £28. 16s.

Exeter.—The City Council have informed the Heavitree Council of their willingness to entertain a proposal to supply that district with electric light.

Batley.—A satisfactory start has been made by the electricity department, the generating station having now a load already equal to 3,124 8-c.p. lamps.

Bedford.—The charges for the supply of electricity for motive power and heating purposes are to be reduced from 2d. to 1½d. per unit from April 1 next.

Bourne (Lincolnshire).—The Post Office telephone system was opened on Tuesday. There are 23 subscribers, and further additions are to be made shortly.

Shoreditch.—The Borough Council propose to raise the pressure from 120 volts on a two-wire system, to three-wire system at 240 volts for lamps and 480 volts for motors.

Yardley.—The Rural District Council propose to apply for a provisional order enabling them to supply electricity for public and private purposes within the area of the rural district.

Cirencester.—The Council have resolved not to assent to the application intended to be made by the Southern District Electricity Corporation for a provisional order to supply electricity.

Heanor.—The National Telephone Company intend to instal a telephone service. It is at present proposed to connect Heanor with Langley Mill, where there has been a public call office for some time.

Hull Telephones.—It is stated that the design of the switchboard will in no way be affected by the modifications necessary for intercommunication with the National Company. The extra cost is £200.

Sutton-in-Ashfield.—The Urban District Council have decided to apply for a provisional order enabling the Council to produce and to supply electric energy for public and private purposes within the urban area.

Huddersfield.—The proposed extension of the electric cables up Victoria-road, along Burley-street, and on to Dempster's works will necessitate a further loan, as this extension was not included in the estimates.

Stafford.—The experiment of throwing open the gas and electric lighting works for public inspection on the previous Friday and Saturday proved very successful, from 500 to 600 persons being admitted on the latter day.

Alfreton.—The Urban District Council have approved a report by the Water Sub Committee upon the Overton water supply at Ashover. The cost is estimated at £14,226. The motive power is electricity.

Italy.—The Minister of Public Works has been authorised to acquire, without the formalities of calling for tenders, a permanent lighting apparatus for the central lighthouse service, at a cost of about £383, set up.

Golcar.—A special meeting is to be held on Dec. 8 to consider an application to be made for a provisional order authorising the Corporation to supply electricity for public and private purposes within the urban district.

Kirkcaldy.—The demand for electric lighting is gradually increasing, and in a few weeks' time there will be as many as 104 arc lamps on the public streets of the burgh, nearly half the number being on High-street.

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Steyning East.—The Rural District Council have granted permission to the Brighton Corporation to supply electricity in the parishes of Preston Rural and Patcham, conditional upon an agreement being entered into.

Woolwich.—The new electric lighting station erected on Plumstead Marshes by the Woolwich Borough Council at a cost, including the dust destructor, of £90,000, has been opened. It contains four engines of an aggregate of 1,000 h.p.

Redditch.—The District Council will apply for sanction to raise a new electricity loan of £8,500. Of this sum £5,581 is required to cover expenditure already incurred in anticipation of the loan, the remainder being required for extensions.

Limerick.—The Electric Lighting Committee of the Corporation announce that they will be very soon in a position to supply intending consumers of electricity with a supply for lighting, heating, and cooking, and also for motor power.

Leith.—The Town Council have resolved to purchase, in view of additional buildings and plant being required after the possible introduction of electric tramway traction, a piece of ground adjoining the present electrical station, at £7,500.

Sandringham.—The electric lighting has just been completed. Every room in the house is now lighted by electricity, also York Cottage and the stables and other outbuildings, and Park House, the residence of Sir Dighton Probyn.

Agency.—Messrs. W. H. Allen, Son, and Co., Limited, Queen's Engineering Works, Bedford, have appointed Messrs. Inniss and Riddle, City-chambers, 82, New-street, Birmingham, as their representatives for Birmingham and neighbourhood.

Coventry.—At the last meeting it was proposed that the Council instruct the Electric Light Committee to discontinue the further purchase of slack or smudge for use as fuel at the electric light station. After discussion the proposition was defeated by a large majority.

Dublin.—Under the new schedule for electric current private consumers are to be charged 6d., places of worship 4½d., and theatres and music halls 4d., in order to induce theatres where they had at present their own installation to come to the Corporation installation.

Wrexham.—Application is to be made for sanction to the borrowing of £4,500 for the purpose of extending the electric lighting cables. The Electricity Supply Committee in their last report state that out of 12 applications for the post of dynamo attendant and engine driver no suitable person has been found.

Acton.—At a recent special meeting of the District Council the question of the proposed dust destructor and electricity works was discussed. It was agreed that steam power be used for the generation of electricity, and that the question of the dust destructor be referred to Mr. W. H. Trentham to report upon.

Carlisle.—The Lunacy Committee of the Cumberland and Westmoreland Asylum at Garlands have framed a scheme for extensions which have received the approval of the Lunacy Commissioners and the Secretary of State, and which is estimated to cost £53,000. They include £8,000 for an installation of the electric light.

West Bromwich.—The Electric Lighting Committee in a report issued on Tuesday recommend that a new feeder cable be laid from the works to Bull-street, a distance of 1¼ miles, at a cost of £1,433. They further report that application has been made for permission to borrow £12,217 for further extension of the electricity plant.

St. Austell.—The electric lighting undertakers have served notices on all their consumers that the supply would be discontinued on the 31st ult. This is greatly to be regretted, and the question is being raised by the Council with the Board of Trade as to whether electric lighting undertakers have the right to discontinue supply on such short notice.

Teignmouth.—The District Council have decided that application be made for a provisional order to enable the Council to transfer the undertaking created by the order to Messrs. Crompton and Co., Limited, upon such terms and conditions as, subject to the approval of the Board of Trade, might be arranged between the Council and the company.

Caerphilly.—The Council, after consultation with Mr. Preece, on Tuesday decided to proceed this year with the application for a provisional order if the result of the vote to be taken immediately throughout the district showed that the inhabitants would take 1,000 lights. It was also decided not to consider the question of the generating powers till the result of the vote be known.

Ramsgate.—We understand that the Corporation have consented to the promotion by the Ramsgate and District Electric Supply Company of an electric lighting order for the borough of Ramsgate, subject to the insertion therein of special terms as to purchase by the Corporation and other matters, and also subject to the agreement now laid before the committee being duly entered into.

Wandsworth.—The General Purposes Committee in their last report state that they had come to the conclusion that the Brush Electric Lighting Company's price had been 5·77d. per unit for current sold during 1902. It was difficult to fix the amount exactly, as the company did not keep separate accounts for this district. The Board of Trade is to be asked to require the company to keep separate accounts.

Arbroath.—The Town Council have agreed to accept the offer of the Empire Electric Light and Power Company, Limited, for the electric lighting of the burgh. Under the conditions agreed upon between the company and the Council, the Council will have the option of taking over the undertaking at the term of Martinmas of 1909, and at the expiry of every subsequent period of five years on terms arranged.

Llanelly.—At a meeting of the Estates Committee of the Urban District Council on Monday, the question of electric lighting and traction for the town was further considered. The Board of Trade had threatened to revoke the provisional order for the electric lighting of the town, and it was decided to recommend the Council to go to Parliament to compel the specific performance of the contract with the British Insulated Wire Company.

Hull.—At a meeting of the Coltman and Albert Wards (Hull) Ratepayers' Association on Tuesday a resolution was carried that the association should send a deputation with the Myton Ward Ratepayers' Association to the Chamber of Trades, and support them in their endeavour to induce the Electric Light Committee to reduce the cost of the current, and, as a means of encouraging the use of the current during the daytime, to lend out motors to small users.

London Gazette.—The partnership subsisting between Frederick William Walker and William Robert Gray, carrying on business as electrical engineers at 124, Putney Bridge-road and 39, Page-street, Westminster, under the style or firm of Gray and Harris, has been dissolved from Oct. 1, 1903. The estate of Walter Morton and Trevitt Walter Sampson, lately trading as Morton and Sampson, electrical engineers, Ash Cottage, Bush Green, Lymm, Cheshire, has been released from the trustees.

Deal.—As the order granted to the Kent Electric Power Syndicate contained a clause providing that the order should be inoperative so far as Deal and Walmer were concerned if a provisional order were applied for by the local authorities of those places during the current Board of Trade session, and obtained, the town clerk placed the matter on the agenda for decision at the last Town Council meeting. It was thought that as the town had executed a very favourable agreement with the syndicate, it was unnecessary to apply for an order.

Wolverhampton.—The Town Council have decided to extend the electric lighting mains at a cost not exceeding £1,300. An amended wiring scheme for houses at rentals of £40 to £65 per annum, in streets where the mains are laid, has been agreed to. If this should prove successful, the Electric Lighting Committee will ultimately bring before the Council a scheme to extend it to houses at lower rentals. The capital outlay will amount to £26, and the revenue to £9. 3s. 4d., including cost of current, hire of wiring, and fittings for 20 lamps.

Glasgow.—The introduction of electric light into the new court has been suggested, but Mr. George Bell, the architect, states that, looking to the condition of the buildings, and the remits that had at various times been made to committees upon matters involving an alteration of the construction of the buildings, the introduction of electric light now could not be properly dealt with. If it were introduced, some alteration of the building in the immediate future might involve a great part of the work being thrown away. Consequently nothing will be done in the matter at present.

Stock Exchange.—Applications have been made to the Stock Exchange Committee to appoint a special settling day in and to grant a quotation to Dick, Kerr, and Co.'s 61,000 6 per cent. cumulative preference shares of £5 each, fully paid, Nos. 1 to 61,000, and £300,000 4½ per cent. debenture stock. The committee have been asked to allow Bath Electric Tramway's 59,394 5 per cent. cumulative preference shares of £1 each, fully paid, Nos. 1 to 59,394, and 75,606 preferred ordinary shares of £1 each, fully paid, Nos. 75 001 to 150,606, to be quoted in the official list.

St. Marylebone.—The municipal election turned on the policy of completing the purchase of the local property of the Metropolitan Electric Supply Company, and getting a new Act of Parliament to enable the Borough Council to borrow the requisite money for this purpose, and also for providing a self-contained system of electric lighting. Six of the nine wards were contested, with the result of an aggregate poll of 6,941. All the leading members of the old Council were re-elected. The upshot of the election increases the majority pledged to this policy by five, making the total majority 48. The Progressives now count 22—an increase of 5. The rest of the Council of 60 are either Moderates or Independents.

Wood Green.—The Urban District Council have decided to invite tenders for the erection of a power station and the buildings in connection with the Council's electric lighting scheme, and to accept the tender of Henley's Telegraph Works at £7,678. 2s. 5d. for electricity supply works in connection with the Council's electric lighting scheme. It is proposed to borrow £43,200 to cover the estimated cost, and, further, to erect a dust destructor. The electrical engineer has been instructed to prepare plans and specifications for the provision of plant in connection with the generating station. The Council have accepted the tender of Messrs. Hill and Smith, of Brierley Hill, Staffordshire, for the supply of wrought-iron fencing, gates, etc.

Luton.—The electrical engineer in his last report states that since Sept. 11 12,273 units had been generated; an equivalent of 372 8-c.p. lamps and six motors of 22 h.p. connected, making a total of 128 consumers with 8,459 lamps and 30 motors of 92 h.p., and that at the present time over 600 additional lamps and four motors of 16 h.p. were being wired. The number of units generated showed an increase of 64 per cent. over the number generated during the corresponding period of last year. Upon receipt of the report at the last meeting, it was resolved that the best thanks of the committee be presented to the chairman, Councillor Wilkinson, for the efficient and excellent services rendered by him during the past year.

Beckenham.—The Urban District Council at their last meeting adopted a report recommending the laying of services in cases where new houses have been wired by builders. Applications for the wiring of certain houses in course of erection having been submitted, it was agreed that, until the further order of the Council, proposals for wiring new houses may be accepted subject to the builder indemnifying the Council to some extent for the outlay until the buildings are let. It was referred to the officers to consider and report as to what this indemnity should be. The subject of electric current of the tramways was referred to the officers, with instructions to communicate with the British Insulated and Helsby Cables, Limited, and report.

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Clyde Valley Electric Power Co.—We regret to learn that last week a serious accident befell the works of this company, which are at present in course of construction at Motherwell. It is stated that the large structure collapsed without any warning, and hundreds of tons of girders, columns, and beams are lying in one huge heap, the girders and beams being twisted and bent like so much tin. The collapse is supposed to have been due to the wind. The erection was bolted to the concrete foundations, and supported by guy ropes. Fortunately, the accident occurred after the workmen had ceased work for the day.

Swindon.—With regard to a petition signed by residents in Durham-street and Belgrave-street, the Council have resolved that, on the owners of the property agreeing to pay the cost of providing and erecting the lamp columns, etc., and laying the electric light mains for lighting those streets, the Corporation will light the same; also that in the event of the Education Committee deciding to light the Euclid-street Schools with electricity, the electric mains be extended to the schools. Alderman Skurray, the chairman of the Electric Light and Tramways Committee, said at the last Council meeting that it would be possible to reduce the cost of current at least 20 per cent. within the next 12 months if the present rate of progress continued.

Ealing.—Since the last meeting applications have been received from 46 consumers for 2,006 lamps. These figures constitute a record in two ways. The greatest number of applications ever previously received between two meetings was reported on June 15 as 34; the present 46 is thus a long way ahead. The 2,006 lamps applied for exceed the previous record of 1,350, which was reported at the meeting of May 25, by 656. The total number of lamps now applied for is 67,536, representing 1,661 consumers; 1,812 lamps, representing 44 consumers, have been connected since last meeting, the total now connected being 66,349. The connections keep pace with the applications, the number of lamps waiting to be connected being only 1,187, or about 1·75 per cent. of the total applications.

London County Council.—On Tuesday sanction was given to the borrowing by the Kensington Borough Council of £27,098 for erection of a dust destructor. Notices under Electric Lighting Acts and Orders were agreed to as follows: from the Charing Cross and Strand Electricity Supply Corporation of intention to lay mains along portions of Chandos-street and Bedfordbury, and also along May's-buildings or Hop-gardens to St. Martin's lane; the City of London Electric Lighting Company, across and along a portion of Upper Ground-street; and the Metropolitan Electric Supply Company, across and along a portion of North Wharf-road, and also along a portion of Clifton-hill. The receipt of a notice from the Stepney Borough Council of intention to lay mains along portions of Broad-street and Medland-street was also reported.

Gloucester.—After considering the application of the Council for sanction to borrow £25,000 for the purposes of their electricity undertaking, the Local Government Board have sanctioned the borrowing of £24,673, an item of £285. 12s. 7d. having apparently been deducted by mistake, as although the cost of the provisional order was included in the particulars furnished, it was shown that the same had been paid out of the general district fund, and therefore the mistake would probably be corrected. The electrical engineer has done a large amount of additional work in preparing the particulars required for the Local Government Board, most of such work having been carried out in his own time, and a fee of £15. 15s. has been paid for this additional work. It has been resolved to supply electricity to the Gloucester Infirmary at the rate charged for churches.

Portsmouth.—Application is to be made for sanction to borrow £24,000, the estimated cost of laying new mains during the next three years. In presenting the annual report and balance-sheet of the Electric Lighting Committee last week, Alderman Ellis did not go into details, but declared that the results had been eminently satisfactory. The committee reported that they had again had under their consideration the question of sinking a well at the electric light station, and in order to save, if possible, an expenditure of about £500 per annum for water, they thought that it would be desirable to endeavour to sink a well so as to get the requisite supply of water at the station. They now recommended that a well should be sunk, at an estimated cost of £762, but with an arrangement that, in the event of water not being found, the contractors should remove the tubes and apparatus, the charge in that case being about £500. In either case, however, the whole expenditure would be met out of income, as they could very well afford to do so. This was agreed to.

Cape Colony.—The following regulations and tariff have been framed by the Table Bay Harbour Board for the use of electric cranes at the docks—viz.: "At those quays where electric cranes are installed, the masters or agents of all vessels desiring to discharge or ship cargo must, if required by the dock superintendent, use these cranes exclusively for loading or unloading their vessels." The following is the scale of charges: for the use of each crane during ordinary working hours, 5s. per hour; for the use of each crane out of working hours, 7s. 6d. per hour; minimum charge for each crane during working hours, 12s. 6d.; ditto out of working hours, 20s. If cranes are required during the dinner hour 2s. 6d. extra will be charged. The charge will commence from the time stated in the requisition handed in to the quay superintendent by the master of the ship (or if the crane is not ready, from such time as it is ready) till the work is finished for the day or night, exclusive of stoppages caused by defects in the electric service. All requisitions for the use of the crane must be made in writing to the quay superintendent.

Hove.—The new electric lighting works of the Hove Electric Lighting Company, which are situated just inside the boundaries of Aldrington, will probably be opened in the course of the week. The generating sets, by Messrs. Crompton and Co., are being erected whilst the boiler-house is complete. The extension of the mains has been carried out wherever possible on the existing system of bare copper in culverts, paper cables being connected for the road crossings and other places where there has been insufficient room for the larger construction. Outside of the central station a large water-cooling reservoir has been built, with a system of spray inlet pipes. The water supply will be taken from a well dug in the vicinity of the station, and the advantage of the reservoir will enable the engines to be worked on condensers. The approach to the station is somewhat difficult to find—it is built close to the Brighton and Shoreham branch railway, but stands back some little distance from the main road. The chimney is, however, almost the only one of its kind in the town, and is sufficient guide to those in search of the generating works.

Chilworth (Surrey).—The Chilworth Gunpowder Company, Limited, has placed with the British Schuckert Electric Company, Limited, a contract for the complete electric lighting and driving of their gunpowder mills at Chilworth. The estate covers an area of 40 acres, and the 18 buildings, as well as the roads, are to be lighted by means of 142 32-c.p. incandescent lamps and four outside arc lamps. Special precautions are to be taken to ensure safety, and the buildings in which explosives are manufactured or stored will be lighted by outside lanterns provided with special reflectors. Eight shunt motors—viz., two each having an output of 25 b.h.p., two of 3¼ b.h.p., and four of 1¼ b.h.p.—are to be employed in the manufacturing processes, and five ventilating fans will be supplied for expelling explosive gases. The generating plant consists of two belt-driven machines, one of 75 kw. and the other of 30 kw., both of which generate current at a pressure of 220 volts. The switchboard is so arranged that either generator may supply the lighting circuits or motor circuits separately, or, if desired, the two generators may be run in parallel and supply the total combined load conjointly.

Birmingham Tame and Rea District Drainage Board.—With regard to the electrical power transmission scheme of the Board, which we noted in our last issue, we have received the following further particulars: In the last session of Parliament, authority was granted to the Board to sell two acres of land in the city of Birmingham for the purpose of constructing a refuse destructor thereon. In payment for this land the city of Birmingham has undertaken to generate steam condensing 24 hours a day in sufficient quantity to develop 175 b.h.p. when utilised in a high-speed engine. The Drainage Board propose to utilise this power in generating electric power in the form of three-phase current at the generating station, which will be erected at Saltley, near Birmingham, and transmit the power a distance of five miles over the Drainage Board's outfall works and irrigation lands at a transmission pressure of 2,300 volts. There will be two generating sets, consisting of two high-speed engines by Bellis and Morcom, each of which will be direct connected to one British Thomson-Houston revolving-field type of generators, the latter generating three-phase current at 50 cycles and 2,300 volts. This current will be led direct to the overhead transmission line, which line will be tapped at eight points along the route, at each of which a sub-station will be erected, containing the necessary step-down transformers for transforming the high-tension current from 2 300 to 200 volts. At four of the sub-stations centrifugal pumps direct connected to British Thomson-Houston standard type of induction motors will be installed for pumping purposes, replacing separate installations of steam-driven pumps, the transport of fuel and water to which is necessarily an expensive item, these pumps being placed at different positions on the Board's estate, where the level of the land is such as to necessitate pumping the water on to the land from the main culvert, which runs throughout the length of the estate. There are 14 motors in all, ranging from 2 h.p. to 28 h.p., a number of which are used for operating machinery on the different farms situated on the Board's estate, and also for operating distributors and such machinery of a special nature as is used in connection with the treatment of sewage. The lighting of the principal buildings situated on the Board's estate will also be carried out from the same generating station. This scheme, which, in its comprehensive nature, might almost be called a pioneer scheme, and as applied to pumping in connection with sewage disposal is undoubtedly a pioneer scheme, is entirely due to the initiative and enterprise of the engineer, Mr. John D. Watson. The contracts, as already stated, have been provisionally placed with the British Thomson-Houston Company, Limited, of Rugby, and work will be commenced immediately the Local Government Board have sanctioned the necessary loan.

Kingston.—The Town Council are raising a loan of £7,784 for electric lighting purposes at 3¼ per cent. interest, the charge for all legal and other expenses (excluding stamp duty) being 5s. per cent. Messrs. Burstall and Monkhouse, in their last report, stated: "All the plant, etc., is in good order. The motor for driving the stokers has been running, and has now been permanently fixed. Work has commenced on the mechanical stokers, and we understand that there is a probability of the small condensing plant being delivered about the end of the month. Mr. Edgcome has sent us weekly reports as to the costs, which we think are most encouraging. Comparing these with the figures of the corresponding weeks of last year, the number of units generated has increased 14 per cent., while the maximum load has only increased 10 per cent. The works costs per unit generated are nearly 20 per cent. lower than the corresponding period of last year. It will be some little time before the alterations we recommend can be made, but we anticipate a further reduction when the new machinery is at work." A week later they say: "The costs, we are glad to say, still continue to show the improvement mentioned in our last report; the units generated show an increase of about 13 per cent. on the month, while the works costs show a reduction per unit generated of about 20 per cent. in comparison with the corresponding period of last year. The maximum load is increasing more rapidly. As far as can be judged from the station results, the present plant at the station should be just sufficient to carry the undertaking over the present winter with a proper provision of spare plant, but will

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not be sufficient for the winter load of 1904-5. For this we are of opinion that one new steam alternator will be required with the necessary steam and other pipes, switchboard gear, etc. We consider that a plant of the same size as the largest at present installed would in all probability be sufficient for the purpose, as it would allow of an extra load of 200 kw., beyond what may be expected this winter to be put on to the station. We do not expect that more than this will come on in the ordinary course of events, and any abnormal demand would most probably be known of in sufficient time to allow of proper arrangements being made. We would advise a new set by the same maker as those at present installed, so as to reduce the number of spares, etc. A set of this size would be quite economical. We do not think any extension will be necessary in the boiler-house, as in our opinion you have sufficient boiler and condenser power for the enlarged station. The new steam alternator should be arranged so that no extension of the buildings is necessary." Further particulars have been asked for. Several extension of mains have been agreed to. The Electric Light Committee have had under their consideration the charges for meters and indicators, and hope to make some reductions in the near future.

River Plate.—We have recently seen a copy of a very readable English paper, called the *Review of the River Plate*, published at Buenos Ayres, from which we purloin the following paragraph: "The Compañia Alemana Transatlantica de Electricidad recently issued bonds to the value of eight million marks, so as to enable it to acquire the works of the River Plate Electricity Company and the Primitiva Gas Company, and from the prospectus we take the following information: The station of the former company stands on a property of 5,217 square metres; the capacity is 1,800 h.p. alternating current, the price including all the cables, accessories, contracts, etc., counting from April 1, 1903, for the sum of £2,500 cash, and £150,000 in 5 per cent. bonds to be redeemed at par before 1943. The contract with the Primitiva Gas Company dates from Aug. 12, 1903, by which the company rents all the electrical properties of the company, its contracts, etc., equivalent to 69,000 lamps of 16 c.p., the contract to commence June 1, 1903, and to last for 41 years; the price to be paid being £30,000 per annum. On the last payment being made all the property will pass over to the Compañia Alemana without further expenditure. The yearly sum of £30,000 will be paid to the trustees for the debenture holders. By this new arrangement the debentures will be amortised by Nov. 30, 1943. In the eventuality of the Compañia Alemana being more than six months behind hand in any yearly payment, the Primitiva Company has reserved the right of immediately demanding of payment of the remaining capital, and can also declare the contract as rescinded without having to pay back any of the sums received for rent, and can take over the works again. The Compañia Alemana is now the sole provider of electricity in the city of Buenos Ayres. The capacity of its stations is 16,050 h.p. The revenue of the company for the first six months of the year was 555,879dol. gold, as against 418,850dol. gold in the same period of 1902. The working expenses were 222,164dol. gold, as against 192,585dol. gold, so that the gross profits on the first six months of 1903 amount to 333,715dol., as against 226,265dol. for 1902, an increase of 107,450dol. The current sold during the first six months of the year was 6,877,576 kilowatt-hours, as against 4,773,483 in the same period of 1902. The following table shows the progress made by the company:

	1,000 kilowatt-hours		
	1902.	1901.	1900.
Private lighting	3,416	3,264	2,944
Public lighting	1,041	1,081	962
Power (motors)	1,041	667	483
Tramways	4,618	4,175	2,865
Own use	165	177	216
	10,281	9,364	7,470

PROVISIONAL PATENTS, 1903.

Oct. 26.

23102. Improvements in and relating to the application of electricity for the production of scenic effects at theatres and other places of entertainment. John Francis Carey, 6, Oriel-road, South Hackney, London.

23103. Improvements in and relating to the application of electricity for the production of scenic effects at theatres and other places of entertainment. John Francis Carey, 6, Oriel-road, South Hackney, London.

23110. Improvements in electric potential governors. Thomas Large Boyden, The Elms, Newbridge, Wolverhampton.

23129. Storage battery plates. Joseph Bijur, 28, New Bridge-street, London. (Complete specification.)

23151. Improved method and apparatus for producing a suitable circulation of the electrolyte in electrolytic processes. Hugo Koller and Paul Askenasy, 46, Lincoln's-inn-fields, London. (Complete specification.)

23161. Improvements in electrically-heated handles. Robert Anton Fliess, 53, Chancery-lane, London. (Complete specification.)

23173. Improvements in protecting devices for parallel feeders used in the distribution of electrical energy. Leonard Wilson, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

23181. Improvements in and relating to electric traction systems. John Mannheim, 18, Southampton-buildings, Chancery-lane, London.

23182. Improvements in connection with vacuum brake apparatus and mechanism for use therewith on electrical and other railways. James Gresham and Henry Albert Hoy, 18, Southampton-buildings, Chancery-lane, London.

Oct. 27.

23192. Improvements in or relating to dynamo-electric generators and motors. Adrian Denman Jones and the Jandus Arc Lamp and Electric Company, Limited, Hartham Works, Hartham-road, Holloway, London.

23224. Improvements in electrically-illuminated signs. John Henry Goehst, 65, Chancery-lane, London. (Complete specification.)

23225. Improvements in electric lamp sockets. John Henry Goehst, 65, Chancery-lane, London. (Complete specification.)

23226. Improvements in electrically-illuminated signs. John Henry Goehst, 65, Chancery-lane, London. (Complete specification.)

23260. Improvements relating to receiving instruments of printing telegraphs. Philip Arthur Newton, 6, Bream's-buildings, Chancery-lane, London. (Eltypic Manufacturing Company, United States.) (Complete specification).

23285. Improvements in telephone relays or repeaters. Gustavus Emerel Sundquist and Albert Henry Wahl, 6, Lord-street, Liverpool. (Complete specification.)

Oct. 28.

23318. Improvements in devices for suspending the overhead conducting wires of electric tramways and railways. Archibald John Howard, Clifton House, Cheddon-road, Taunton.

23333. Improvements in magnetic separators for ores or like materials. Joseph Mansell Moss, 4, Clayton-square, Liverpool.

23337. The adjustable arm rest for the telephone. Edith Moore, 13, Peel-road, Douglas, Isle of Man.

23355. Improvements in electrically-operated valves. The Warwick Machinery Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

23359. Improvements in sparking plugs and the like for electric ignition. Frederick Henry de Veulle, 9, Exchange-chambers, New-street, Birmingham.

23375. Improvement in electric silent discharge apparatus. August Schneller and Dirk Koeleman, 4, South-street, Finsbury, London.

Oct. 29.

23406. The electric automatic twin-wire switch. Walter Parkinson, 18, Fife-road, Kingston-upon-Thames.

23443. Improvements in electrical instruments. Crompton and Co., Limited, and William Arthur Price, The Arc Works, Chelmsford.

23444. Improvements in electrical instruments. Crompton and Co., Limited, and William Arthur Price, The Arc Works, Chelmsford.

23461. Improvements in or relating to electric generating apparatus. Paul Alfred Reubens, 111, Hatton-garden, London.

23469. Automatic switch for control of starting electric motors. Frederic Collyer Newton, 30, Clovelly-road, Hornsey, London.

23478. Improvements in and relating to the electrical transmissions of energy through space. Alessandro Artom, 45, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents Act, 1901, Aug. 23, 1903, being date of application in Italy.) (Complete specification.)

23482. Improvements in or relating to secondary batteries. Georges Rosset, 70, Chancery-lane, London. (Date applied for under Patents Act, 1901, Nov. 24, 1902, being date of application in France.) (Complete specification.)

23488. Improvements in and relating to the electrical transmissions of energy through space. Alessandro Artom, 45, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents Act, 1901, Sept. 12, 1903, being date of application in Italy.) (Complete specification.)

23490. Improvements in electric storage battery plates. Oliver Imray, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Carroll Potter, United States.)

Oct. 30.

23521. Improvements in and relating to loose handle automatic magnetic blow-out circuit breakers. Samuel Whipp, Old Market-chambers, Yorkshire-street, Rochdale.

23523. Astatic magnet, and process for the making of same. Johannes Zacharias and Emanuel Lasker, 15, Water-street, Liverpool. (Complete specification.)

23540. Improvements in electric resistance boxes. Arthur Henry Adams and Arthur Herbert Curtis, 11, Southampton-buildings, Chancery-lane, London.

23545. Improvements in or relating to electric batteries. Alfred Blackman, 20, Bucklesbury, London.

23546. Improvements in telephone mouthpieces or receivers. Arthur Benjamin Cruickshank, 33, Cannon-street, London.

23557. Improvements in electrical clutch and brake mechanism. Abram Peters Stockel, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

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23574. Improvements in wireless signalling systems. Harry Shoemaker, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

23585. Improvements in electrical signalling apparatus for fire calls and the like. Edward Lawley Pinching and Walter Henry Walton, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

OCT. 31.

23592. Improvements in electric circuit controllers. George Joseph Philpot and George Herbert Alderton, 37, Ditchling-road, Brighton.

23603. Improvements in electric switches. John Tomlinson and Henry Lomax, 57, Barton-arcade, Manchester.

23630. Improvements in connection with overhead wiring, spans, ears, circuit breakers, frogs, and trolley heads for electric traction. Albert James and the London Motor Engineering Company, Limited, 87A, Wellesley-road, Chiswick, London.

23636. Improvements in raising and lowering electric arc lamps. William Anderson Brown, 40, Chancery-lane, London.

23647. Improvements in and relating to electric arc lamps. James McLaughlin, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

23652. Improvements relating to electric meters. Société Anonyme des Ateliers de Mecanique de Precision de Territet, 45, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents Act, 1901, Nov. 10, 1902, being date of application in Switzerland.) (Complete specification.)

23663. Improvements relating to telpherage. Siemens Bros. and Co., Limited, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (The Union Telpherage Company, United States.) (Complete specification.)

23664. Method of and means for automatically starting and breaking motors. Siemens Bros. and Co., Limited, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Siemens und Halske Actien-Gesellschaft, Germany.) (Complete specification.)

COMPLETE SPECIFICATIONS ACCEPTED.

To be published Nov. 19, 1903.

1902.

16354. Electric accumulators. Danzer.

20645. Means for regulating the consumption of current by electromotors. Siemens Bros. and Co., Limited. (Siemens und Halske Actien-Gesellschaft.)

21021. Poles or electrodes of electrolytic apparatus and the like. Atkins.

23243. Insulating material for electrical purposes, and process for manufacturing the same. Sefton-Jones. (Isola Werke A.-G. in Oerlikon.)

23288. Alternating-current dynamo-electric apparatus. Winter and Eichberg.

23333. System of telegraphing or telephoning to or from a railway vehicle. Edgar.

23565. Electrically-actuated musical instruments. Dickson.

23842. Electric telegraphy. Hesse and Heurtley.

24707. Electric arc lamp hangers. Carolan. (General Electric Company.)

25840. Means for conducting electricity to tram and like cars on the underground system. Howarth.

25906. Phase modifiers and systems of electrical distribution. Carolan. (General Electric Company.)

26658. Means for guiding tramway vehicles and their trolley wheels at rail and conductor points. Holmes and Holmes.

26735. Electric light pendants and electroliers. Kemp.

27056. Automatic electric signalling apparatus for railways. De Labarthe.

27161. Electricity meters. Evans. (Allgemeine Electricitäts-Gesellschaft.)

27232. Rotary electric contacts for high-tension circuits. Blake.

27253. Apparatus for selective electric signalling. Lake. (Stone.)

27295. Apparatus for amplifying electromagnetic signal waves. Lake. (Stone.)

27486. Means for controlling or regulating the supply of electricity in installations subjected to considerable fluctuation in the demands thereon. Johnson. (Elektrizitäts Actien-Gesellschaft vorm. W. Lahmeyer und Co.)

27628. Electric ignition devices for explosion motors. Thézard. (Date applied for under International Convention, Dec. 16, 1901.)

27739. Means for transmitting and receiving electric signals. Lake. (Stone.)

27742. Method of transmitting and receiving electrical signals. Lake (Stone.)

27746. Method of determining the direction of magnetic waves. Lake. (Stone.)

27753. Bearings for electric or other measuring instruments. Carolan. (General Electric Company.)

27763. Means for varying the voltage of alternating electric currents. Carolan. (General Electric Company.)

27764. Systems of electric phase transformation. Carolan. (General Electric Company.)

27781. Apparatus for determining the direction of magnetic waves. Lake. (Stone.)

28039. Apparatus used as standards or brackets for gas or electric light. Morrall.

28446. Polarised electric bell. Brander.

1903.

1529. Insulating material for dynamo-electric machines, electric motors, and conductors. Oliver and Philpott.

2976. Electric switches. Knipping.

12032. Electrolytic apparatus such as secondary batteries. Johnson. (Ford.)

13750. Electro-deposition of gold. Kington.

19877. Electromagnetic relay apparatus. Siemens Bros. and Co., Limited. (Siemens und Halske Aktien-Gesellschaft.)

20102. Bracket attachments for telegraph and like posts. Gray.

20401. Electric switches. Hunter and Warren.

20497. Electric plant for the synthetical production of nitric products by means of discharges of electricity in gaseous mixtures. Kowalski and Moscicki.

20655. Process for the electrolytic production of metals of the earthy alkalies and more especially of metallic calcium. Evans. (Elektrochemische Werke G. m. b. H.)

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.		Last price
Commercial and Industrial.—	£		£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1	..	¼-⅜
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1	..	⅛-¼
British Insulated and Helsby Cables, Ord., 1-100,000	5	..	6-6¼
—— 6 per cent. Cum. Pref., 1-100,000	5	..	5¼-5⅜
—— 4½ per cent. Mortgage Debentures	100	..	102-105
British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red.	100	..	103-105
British Westinghouse Elec. and Manuf., 6 per cent. Pref., 275,001-375,000	5	..	5⅜-5⅞
—— 4 per cent. Mortgage Debenture Stock	100	..	100-102
Brush Electrical Engineering, Ordinary, Nos. 1-105,751	2	..	¾-1¼
—— Non. Cum., 6 per cent. Pref.	2	..	1-1½
—— 4½ per cent. 1st Debenture Stock	100	..	97-100
—— 4½ per cent. 2nd Debenture Stock	100	..	85-90
Callender's Cable, Debentures	100	..	106-110
—— Ordinary	5	..	11-12
—— 5 per cent. Pref.	5	..	5¼-5⅜
Crompton and Co.	3	..	2-2¼
—— 5 per cent. Debentures	100	..	100-104
Edison and Swan United, "A" Shares, 1-99,261	3	..	¼
—— "A" Shares, 01-017,139	5	..	1¼-2¼
—— 5 per cent. Debentures	100	..	76-81
—— 4 per cent. Deb. Stock, Red.	100	..	72-77
Electric Construction, Limited, Nos. 1 to 112,100	2	..	1¼-1⅜
—— 7 per cent. Cumulative Pref.	2	..	2¼-3
—— 4 per cent. Perp. 1st Mort. Deb.	100	..	97-100
Ferranti Limited, 5 per cent. 1st Mort. Deb. Stock, Red.	100	..	90-95
General Electric Company (1900), 5 per cent. Cum. Pref.	10	..	9⅜-10¼
—— 4 per cent. 1st Mort. Deb. Stock	100	..	96-99
W. T. Henley's Telegraph Works, Ordinary	5	..	14-15
—— 4½ per cent. Preference	5	..	5-5¼
—— 4½ per cent. Debentures	100	..	108-112
India Rubber, Gutta Percha, and Telegraph Works	10	..	18¼-19¼
—— 4 per cent. Debentures	100	..	100-103
Parker, Thos., Limited, Ordinary	10	..	14¼-15¼
Telegraph Construction and Maintenance	12	..	34-37
—— 5 per cent. Bonds	100	..	100-103
Electric Lighting and Supply.—			
Blackheath & Greenwich District Ordinary 1,201-101,200	1	..	⅝-¾
—— 4½ per cent. Deb. Stk. Certs., Red. and Conv.	100	..	116-119
Bournemouth and Poole, Ordinary	10	..	12½-13½
—— 4½ per cent. Cum. Pref., 7,501-15,000	10	..	10-11
—— 6 per cent. Cum. Second Pref., 15,001-22,500	10	..	11-12
—— 4½ per cent. Debenture Stock, Red.	100	..	103-106
Bromley (Kent) Electric Light and Power Co., 4½ per cent. 1st Debenture Stock, Red.	100	..	100-103 xd
Brompton and Kensington, Ordinary	5	..	10¼-10⅜
—— 7 per cent. Preference	5	..	10-10¼
Calcutta Electric Supply Corp., Ordinary, Nos. 1-40,000	5	..	6½-7¼
—— Nos. 20,001-30,000	5	..	7-8
Cambridge Electric Supply Company, Ltd., £10 Ord.	8	..	14½
—— " " £10 Ord.	6	..	10⅜
Central Electric Supply, Ld., 4 per cent. Guar Deb. Stock	100	..	107-110
Charing Cross and Strand, Nos. 1-70,000	5	..	9-9½
—— 4½ per cent. Cum. Pref.	5	..	5¼-5⅜
—— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000	5	..	4⅜-5
—— 4 per cent. Debenture Stock, Red. (Prov. Certs.)	100	..	104-106
Chelsea Electricity Supply	5	..	5¼-6
—— 4½ per cent. Debentures	100	..	108-111
City of London, Ordinary	10	..	9⅜-10¼
—— 6 per cent. Cumulative Pref.	10	..	13-14
—— 5 per cent. Debenture Stock	100	..	122-127
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100	..	102-105
County of London and Brush Provincial, Ordinary	10	..	7½-8¼
—— 6 per cent. Cum. Pref.	10	..	11¼-12¼
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	100	..	107-110
Edmundsons' Electricity Corporation, Ordinary, 1-50,000	5	..	6¼-6⅜
—— 6 per cent. Cum. Pref.	5	..	6-6¼ xd
—— 4½ per cent. First Mort. Deb.	100	..	105-108
Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-30,000	5	..	3¼-4¼
—— 5 per cent. Debenture Stock, Red.	100	..	96-98
Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000	5	..	5¼-6
—— 4½ per cent. First Deb. Stock, Red.	100	..	100-103
Hove Electric Lighting, Limited, Ord., 1-13,000	5	..	7¼-8¼
Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000	5	..	10¼-11¼
—— per cent. Debenture Stock Red.	100	..	100-105

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Name.	Amount paid.		Last price.
	£		£
Kensington and Knightsbridge and Notting Hill	100	..	101-104
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	..	9⅜-10½
London Electric, Ordinary	3	..	1¾-2⅛
—— 5 per cent. Pref.	5	..	5½-5⅝
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	..	100-102
Metropolitan, Ordinary	10	..	17½-18½
—— ½ per cent. First Mortgage Debenture Stock	100	..	110-114
—— ½ per cent. Mortgage Debenture, Red.	100	..	97-100
Newcastle-upon-Tyne Electric Supply, Ordinary	5	..	98-101
—— Preference	4	..	100 103
Notting Hill Electric Lighting	10	..	12½-13⅛
—— 4 per cent. First Mort. Debs., Nos. 1-500 (Reg.)	100	..	98-101
Oxford Electric, Ordinary, 1-96 and 407-14,310	5		5½-5⅝
—— 4 per cent. Debenture Stock	100		98-101
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	10	..	98-100
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5	..	3-3½
—— 4 per cent. Debenture Stock	100	..	85 90
South London, Ordinary	5	..	3½ 4
St. James's and Pall Mall, Ordinary, 101-20,080	5	..	14½-15½
—— 7 per cent. Pref.	5	..	8-9
—— 3½ per cent. Deb.	100	..	97-100
Urban Electric Supply Co., Ordinary, 8-30,007	5	..	4⅞-5⅛
—— 5 per cent. Cumulative Preference, 50,001-80,000	5	..	4⅞-5
Westminster, Ordinary	5	..	12 13
—— 5 per cent. Cum. Pref., 110,101-138,251	5	..	6-6½

Electric Railways.—

Central London, Ordinary	100	..	95 98
—— 4 per cent. Pref.	100	..	99-102
—— ,, ,, deferred	100	..	99-102
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100	..	116-119
City and South London, Consolidated Ordinary	100	..	51-53
—— 4 per cent. Debenture Stock	100	..	115-118
—— 5 per cent. Pref. Stock '91	100	..	127-130
—— ,, ,, ,, '96	100	..	126-129
—— ,, ,, ,, '01	100	..	122-127
Liverpool Overhead, 5 per cent. Pref.	—	..	13-13½
—— Ordinary, 1-50,000	—	..	7⅞-8
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	—	..	102-104
Waterloo and City, Ordinary	100	..	93-96

Electric Tramways.—

Anglo-Argentine, 1-260,007	5	..	4½-4⅝
—— Permanent 6 per cent. Debenture Stock, 1888	100	..	125-130
Blackpool and Fleetwood Tramroad	10	..	13½-14½
Brisbane Tramway Invest., Lim., Ord., 1-75,000	5	..	2-3
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5	..	3½-4½ xd
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100	..	98-102
British Columbia Electric Railway Co., Ord., Nos. 1-20,000	100	..	84-87
—— Non-Cum. 5 per cent. Pref., Nos. 25,001-38,600	100	..	93-96
—— 4½ per cent. 1st Mt. Debs., Nos. 1-6,250, of £40 each	40	..	102-104 p.c

Name.	Amount paid.		Last price
	£		£
British Electric Traction, Ord. 1-300,000 & 60,001-80,000	10	—	11½-12
—— 6 per cent. Cm. Pf., 30,001-60,000	10	—	11-11½
—— 5 per cent. Perpetual Debenture Stock	100	—	120-123
Buenos Ayres and Belgrano Tram., Ord., 1-100,000	5	—	2⅜ 2⅝
—— "A" 6 per cent. Cm. Pf., 1-40,000	5	—	5-5½
—— "B" 6 per cent. Cm. Pf., 1-27,500	5	—	4½-5
—— 5 per cent. Deb. Stock, Red.	100	—	107-110
—— Prov. Cert., all paid	100	—	99-102
Cape Electric Tramways, Nos. 1-480,000	1	—	2-2½
City of Birmingham Tramways, 5 per cent. Cum. Pref.	10	..	5-5½
—— 4 per cent. 1st Mortgage Deb., 1-3,000 (1917)	100	..	98-101
Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red.	100	..	100 103 xd
Cork Electric Tramways and Lighting Co., Ordinary	10	—	13-14
—— 5 per cent. Cum. Pref.	10	—	11-12
—— Debentures	100	—	96-99
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10	—	12-13
—— 6 per cent. Pref., Nos. within 1-60,000	10	—	15-16
—— 3½ per cent. Mort. Debs., 1-3,000, Red.	100	—	94-97
Imperial Tramways Ordinary	all	—	22-22½
—— 6 per cent. Cum. Pref.	all	—	14½-15½
—— 4½ per cent. Deb Stock	100	—	112-114
Isle of Thanet Electric Tramways and Lighting, 5 per cent. Cum. Pref., Nos. 30,001-60,000	5	..	3½-4½
—— 4 per cent. Debenture Stock	100	..	92-95
Kidderminster and District Lighting and Traction, Pref.	5	—	3½-4
London United Trys. (1901), 5 per cent. Cum. Pref.	10	—	11½-12
—— 4 per cent. 1st Mt. Db. Stock, Red.	100	—	104-106
Metropolitan Electric Trams., Deferred, 1 000 001-1,314,016	1	—	3/16-5/16
—— 5 per cent. Cum. Pref., 500,001-814,016	1	—	⅝-1⅛
New General Traction, Ordinary	5	—	1½
—— 6 per cent. Cum. Pref.	5	—	2-3
—— 5 per cent. Mortgage Debentures, 1-1,713 (Regd.)	100	—	88-93
Oldham, Aston, and Hyde Tramway, Ordinary	10	—	10½-10⅝
—— 5 per cent. Cum. Pref.	10	—	11½-12½
Perth Elec. Tramways (W.A.) 5 per cent. 1 Mort. Deb. Stk.	100	..	99-102
Potteries Electric Traction, Ordinary, 20,001-40,000	10	—	9-10
—— 5 per cent. Cum. Pref., 1-20,000	10	—	8½-9½
—— 4½ per cent. Debenture Stock	100	—	104-107
South Lancashire Electric Traction and Power Company—			
—— £250,000 Ordinary	1	—	1
—— £101,132 6 per cent. Preference	1	—	1
—— £528,093 4½ per cent. Debenture Stock	100 p.c.	—	100 p.c.

Telephones.—

National Telephone, Preferred	100	—	99-101
—— Deferred Stock	100	—	74-76
—— 6 per cent. Cum. First Pref.	10	—	13-14
—— 6 per cent. Cum. Second Pref.	10	—	13-14
—— 5 per cent. Non. Cum. Third Pref.	5	—	4½-5½
—— 5 per cent. Deb. Stock, Red.	100	—	93 95
—— 4 per cent. Deb. Stock, Red.	100	—	102-104
United Telephone and Electric Company	1	—	⅛ 1 xd

TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line	Traffic Returns for week			Increase or decrease.		Miles of single track open.		Accounts for past year.						Cost per car mile.
												Receipts per		
	Ending	1903.	1902.	Week.	Current year.	1903.	1902.	Ending	Total receipts	Passengers carried.	Car miles run.	Pas-s'nger	Car mile.	Mile of track.	
		£	£	£	£				£			d.	d.	£	d.
Aberdeen Corporation	Oct 31	1,226	873	+ 352	+ 4,495	19½	17½	May 31	37,931	9,099,715	794,641	0·98	13·02	1,970	6·14
Ayr Corporation	,, 24	201	194	+ 10	—	8	6	Sept. 25	12,503	2,979,276	290,099	1·00	10·34	1,560	4·7
Birmingham Tramways	,, 31	5,207	5,198	+ 9	+ 9,103	6½	6½	—	—	—	—	—	—	—	—
Blackburn Corporation	,, 30	783	728	+ 60	+ 808	24	24	March 25d	40,964	7,234,106	826,558	1·36	11·87	1,705	7·44
Blackpool Corporation	,, 29	386	365	+ 20	— 149	17½	16½	,, 31	211,168	6,169,121	784,443	1·52	10·8	—	—
Blackpool-Fleetwood Tramways	,, 31	272	252	+ 14	— 136	16½	16½	Dec. 31	30,923	2,049,677	584,989	3·62	12·68	1,832	6·99
Bolton Corporation	Nov. 1	1,790	1,702	+ 88	+ 7,342	38	25	March 31	85,704	17,761,605	1,896,247	1·15	10·75	3,430	5·67
Bournemouth Corporation	Oct. 28	877	—	—	—	10½	—	—	—	—	—	—	—	—	—
Bradford Corporation	Nov. 1	3,717	3,412	+ 305	+14,518	41	—	—	—	—	—	—	—	—	—
Brighton Corporation	,, 1	861	797	+ 64	+ 6,131	6½	—	,, 31	—	10,432,508	1,031,928	1·00	10·10	—	—
Bristol Tramways Company	,, 30	4,625	4,452	+ 173	—	51½	51½	Dec. 31	223,480	41,192,899	5,724,114	1·30	9·38	4,348	—
Burnley Corporation	,, 31	820	679	+ 141	—	—	—	—	—	—	—	—	—	—	—
Burton Corporation	Nov. 1	336	—	—	—	—	—	—	—	—	—	—	—	—	—
Cardiff Corporation	Oct. 31	1,931	1,551	+ 376	+17,756	—	—	—	—	—	—	—	—	—	—
Carlisle Tramways Company	,, 31	200	170	+ 30	+ 623	—	—	,, 31	—	2,216,583	320,129h	—	—	—	—
Central London Railway	,, 31	6,754	7,155	— 403	— 5,999h	6	—	,, 31	367,225	45,305,110	1,276,971a	1·87	66·6a	58,076	35·6a
City and South London Railway	Nov. 1	2,799	3,284	— 485	— 7,110	6⅜	—	,, 31	165,003a	19,069,319a	—	—	—	—	—
Cork E. T. and L. Company	Oct. 29	480	718	— 238	— 3,338	—	—	—	—	—	—	—	—	—	—
Darwen Corporation	,, 30	230	219	+ 11	— 203	7·23	—	March 31g	12,341	2,360,735	254,279	1·25	11·65	1,707	9·36
Dover Corporation	,, 31	184	201	— 17	+ 80	3	—	—	—	—	—	—	—	—	—
Dublin & Lucan Electric Railway	Nov. 1	94	109	— 15	+ 142h	—	—	Dec. 31	5,796	364,796	102,087	3·81	13·62	159	7·68
Dublin U. T., electric cars	Oct. 30	3,622	3,774	— 82	} —	46	46	March 31	126,121	24,553,133	3,429,356	1·23	8·82	2,741	5·06h
Dublin S. District, Electric	,, 30	741	768	— 27											
Dundee City Tramways	,, 28	833	765	+ 68	—	22	22	May 15	35,874	9,084,522	752,814	0·93	11·276	1,630	—
East Ham Corporation	,, 31	612	454	+ 158	+ 6,323	10·75	7·52	March 31	25,341	9,971,337	650,224	0·61	9·35	2,357	—
Farnworth U.D.C.	,, 21	150	143	+ 7	—	—	—	—	—	—	—	—	—	—	—
Glasgow Corporation	,, 31	13,996	12,759	+1,237	+32,902	124	101	May 31g	656,572	177,179,549	14,008,750	0·88	11·25	5,489 b	7·40d
Halifax Corporation	,, 22	1,305	1,139	+ 166	+ 1,754	30½	27½	—	—	—	—	—	—	—	—
Huddersfield Corporation	,, 31	1,225	1,029	+ 196	—	34	35	March 31	55,631h	9,738,213	1,218,539	1·4	11·14	1,618	6·38
Hull Corporation, E. S.	,, 31	1,935	1,733	+ 202	+ 3,002	19	19	,, 31	87,707h	21,065,999	2,218,696	1·00	9·49	5,004	5·07
Ilkeston Corporation	,, 28	180	—	—	—	—	—	—	—	—	—	—	—	—	—
Kirkcaldy Corporation	,, 28	147	—	—	—	—	—	—	—	—	—	—	—	—	—
Leeds Corporation	,, 31	5,307	5,051	+ 256	+10,935	77	—	March 25	262,656	57,239,779	5,773,651	1·11	10·91	3,283	—
Liverpool Corporation	,, 24	10,031	9,919	+ 112	+14 183	101	95	Dec. 31	504,304	108,906,472	11,705,425	1·11	10·34	5,000	6·88
Liverpool Overhead Railway	Nov. 1	1,588	1,527	+ 61	+ 1,585	15½	15½	June 30	79,252	10,466,726	986,185a	1·82	19·30a	5,110	— a
Lowestoft Corporation	Oct. 31	175	—	—	—	—	—	—	—	—	—	—	—	—	—
Nelson Corporation	,, 31	92	—	—	—	3	—	—	—	—	—	—	—	—	—
Newcastle-on-Tyne Corporation	,, 31	3,664	3,066	+ 598	—	38½	36	March 25g	150,334	33,474,122	3,379,119	1·08	10·93	4,175	6·17
Portsmouth Corporation	,, 31	1,494	1,376	+ 118	—	29	29	Sept. 30	47,651	9,168,137	868,157	1·24	13·17	1,643	—
Rochdale Corporation	Nov. 2	117	121	— 4	—	4½	..	March 31	5,416	925,281	127,456	1·38	10·27	—	7·66
Rotherham Corporation	Oct. 15	457	—	—	—	—	—	—	—	—	—	—	—	—	—
Salford Corporation	Nov. 2	3,875	2,890	+ 985	+36,188	—	—	—	—	—	—	—	—	—	—
Sheffield Corporation	,, 1	4,499	—	—	—	53½	46½	Mar. 25g	216,709	56,812,019	4,926,083	0·904	10·428	7,510	7·0
Southampton Corporation	Oct. 29	969	964	+ 5	—	11	11	,, 31	35,874	9,084,522	752,814	0·946	11·436	3,760	—
Sunderland Corporation	Nov. 1	1,072	1,063	+ 9	+ 1,357	18·48	17·18	,, 31	59,930	13,987,121	1,270,957	1·03	11·3	3,243	6·43
Wallasey U.D.C.	Oct. 31	634	549	+ 84	+ 2,830	10 5	10·5	,, 31g	31,307	5,690,378	654,550	1·32	11·47	2,981	6·97

* Including maintenance of permanent way and proportion of profits paid to the tramway companies for term of unexpired lease. a Train mile.
b Per mile of single track. c Include rail and tram. d including depreciation. f Including one section of horse traction. g 1903. h Half-year's figures.

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NOTES.

Faraday House.—Prof. C. A. Carus-Wilson, M.A., M.I.E.E., commenced a special course of lectures to the senior students of the Electrical Standardising, Testing, and Training Institution, entitled "Direct-Current Motor Construction," yesterday (Thursday).

Wilkinson Overhead Tramway Accessories.—In our article under this heading in our last issue we named Messrs. Player and Mitchell, of Birmingham, as the makers of the fittings and accessories described. This is correct so far as it goes, but we should have added that Messrs. Brecknell, Munro, and Rogers, of Bristol, are also manufacturing and placing these articles on the market.

Electro-Harmonic Society.—We have received the programme of the "Ladies' Night" concert to be held by the above society at the Holborn Restaurant to-night under the chairmanship of Mr. R. Kaye Gray. It reveals an attractive array of talent, the artists including Miss Gertrude Maxted, Miss Lilian Gardner, Mr. Harry Dearth, Mr. Alf. E. Izard, Mr. T. E. Gatehouse, and others. The orchestra will play selections.

American Institute.—A most valuable volume has been issued by the American Institute of Electrical Engineers, covering part of the transactions of the society at the Niagara Falls Convention from June 29 to July 1. The papers and discussions of July 2 and 3, the last days of the meeting, will appear in the next issue. The present volume runs into some 460 pages, and contains a very large percentage of the papers read at the convention, together with the discussions thereon, as well as the independent discussions on engineering topics. The whole forms a very complete and exhaustive book of reference.

The Metric System.—The secretary of the Decimal Association has received from the Premier of New Zealand a copy of a Weights and Measures Act which was passed by the House of Representatives at Wellington on July 28 last. This measure contains a clause rendering it lawful for the Governor at any time by proclamation to declare that from and after the date named in the proclamation, being not sooner than Jan. 1, 1906, the metric system shall be the only system of weights and measures recognised for use in New Zealand, and thereafter it shall not be lawful to use any weights and measures other than those.

International Electrical Congress, 1904.—In connection with the above congress, about which we gave some particulars in our last issue, we understand that one of the most important and far-reaching efforts of the organising body will be in the direction of starting a movement favouring international standardisation in things electrical. Expression of opinion on this proposal will be specially invited from the representatives of England, Germany, France, Italy, and other countries attending the congress, and if matters can be taken far enough at the time, it will be suggested that a permanent committee on international electrical standardisation be appointed which would, from time to time, report to properly accredited electrical bodies in the participating countries.

The St. Marylebone "Purchase."—As an alternative to seeking parliamentary powers enabling the St. Marylebone Borough Council to complete the purchase of the local property of the Metropolitan Electric Supply Company, a newly-elected member of that body suggests that a committee shall be appointed "to confer with the company with a view to an arrangement being arrived at to remove the present deadlock." We would remind that member that the question of raising the purchase money does not rest with the company any more than it does with the Borough Council, and that having failed to induce either the Board of Trade or the Local Government Board to lend their assistance in obtaining a loan, the only alternative for the local authority is to take parliamentary proceedings. This has already been decided upon as "expedient."

Edison's Storage Battery.—The American technical Press reports a successful trial run of an automobile equipped with the new Edison storage battery. A 68-cell battery was used, and the carriage was equipped with two 80-volt motors. The route was from Boston to New York, and some stiff hills were encountered. When climbing one of the steepest the battery gave out 100 amperes of current during a greater part of the time, and at the discharge reached 102 amperes. The total distance traversed was 249⅛ miles, and the cells had to be recharged several times during the run. No information, however, is given on the important point as to the ground covered on one charge At the end of the run there was a little trouble through one of the motors heating, but otherwise there were no mishaps. The actual running time was 24 hours 56 minutes, making an average speed of 10 miles an hour.

Marconi's Experiments.—Mr. Marconi has returned from his cruise to Gibraltar on H.M.S. "Duncan," but his experiments do not seem to have turned out so successful as was anticipated. He was unable to hold communication with Poldhu, in Cornwall, from Gibraltar, although messages in the reverse direction are stated to have been received with ease by Mr. Marconi. The distance is over 1,000 miles. The reason that is given for the failure to transmit messages from Gibraltar to England is that the instruments used were not sufficiently powerful. To this same cause has been attributed Mr. Marconi's inability to communicate with America from his Poldhu station, and he is supposed to be installing more powerful apparatus on this side. From reports received, Mr. Marconi is shortly to turn his attention to overland wireless telegraphy. His company is erecting a station at Fraserburgh, on the Aberdeenshire coast, and experiments will be carried out between this place and Cornwall.

Line Voltages in South Africa.—Mr. H. J. S. Heather, A.M.I.C.E., engineer to Moodie's Gold Mining and Exploration Company, Limited, sends us some noteworthy figures on the performance of an electric generating plant of which he has charge for supplying the company's mines with power at Barberton, in the Transvaal. Current is generated at 220 volts, and is transformed up to 11,000 volts on the overhead transmission line. As showing the reliability of such voltages, even in a district where thunderstorms are notoriously severe and frequent, Mr. Heather mentions that before the war he obtained a record uninterrupted run of 88 days. Operations were restarted on Sept. 15, 1902, and since that date uninterrupted runs have been recorded of 82, 77, and 108 days. The engineer is to be congratulated on having obtained such successful working, especially under the climatic conditions he mentions. It is scarcely necessary to add that the plant is run 24 hours per day and seven days a week.

Electric Power in New Zealand.—It will be remembered that we recently stated that an engineer was to be called in by the New Zealand Government to report on the proposal to utilise the Haku Falls for power purposes. This has now been done, and the engineer, Mr. Allo, has issued his report, which may be accepted as favourable to the scheme. He estimates that 39,000 h.p. could be obtained by harnessing the falls even in a dry season. The idea is to work the whole of the present

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steam railways in the North Island by electricity, and the engineer thinks that 9,000 h.p. would be sufficient for this purpose, leaving 30,000 h.p. to be distributed for general industrial uses. According to Mr. Allo's figures, there will be a great saving ultimately in changing from steam to electric traction on the railways. Thus he says that steam power at present costs £7 to £7. 10s. per horse-power per annum, while under the proposed scheme electrical power could be supplied at from £4 to £5 per horse-power per annum.

Society of Arts.—This society opens its one hundred and fiftieth session on Nov. 18 with an address by the vice-president, Sir Wm. Abney, K.C.B., F.R.S., etc. Among the papers to be read at ordinary meetings during the session are: "The Universal Exposition at St. Louis, 1904," by Mr. Geo. F. Parker; "Fiscal Reform," by Sir Chas. Malcolm Kennedy, K.C.M.G., C.B.; "Science and Industry," by Sir Wm. H. Preece, K.C.B., F.R.S.; "Thermit," by Prof. Chas. Vernon Boys, F.R.S.; and "Steam Motors," by Mr. Thomas Clarkson. The arrangements for the Cantor lectures are as follows, so far as they are of interest to engineers: "The Mining of Non-Metallic Minerals," by Mr. Bennett H. Brough (four lectures), Nov. 23, 30, Dec. 7, 14; "Oils and Fats—their Uses and Applications," Dr. J. Lewkowitsch (four lectures), Jan. 25, Feb. 1, 8, 15; "Recent Advances in Electro-Chemistry," Mr. Bertram Blount (three lectures), March 7, 14, 21. The annual conversazione of the society will probably be held on Thursday, June 30, 1904.

Birthday Honours.—There are just one or two names in the birthday honours list which arrest our attention. The first is that of Prof. Clement Le Neve Foster, F.R.S., who is created a Knight Bachelor. As our readers know, Prof. Foster is professor of mining at the Royal School of Mines, London, having held that office since 1890. He was an inspector of mines from 1873 to 1901, and at the present time is editor of the general reports and statistics relating to mines and quarries at the Home Office, and is also an examiner in mining for the Board of Education. The new knight was born in 1841. The name of Mr. Chas. Scarisbrick also figures in the list of new knights. He will be chiefly remembered by scientists for the active part which he took in connection with the British Association meeting at Southport this year. He is a large property owner in Southport, and was mayor of that town in 1902. Among the appointments to the Imperial Service Order are those of Mr. H. Hatfield, chief examiner at the Patent Office; and Mr. Cecil West Darley, engineer-in-chief for public works in New South Wales.

Wireless Telegraphy in Italy.—A message from Rome reports some important extensions in wireless telegraphy development in Italy. The work of constructing a station at Bari with a capacity to operate over a radius of about 320 miles is far advanced, and will shortly be completed, so that the station may be opened for working towards the end of the present year. This station will be able to communicate with the other stations established along the Italian coast, with vessels in the Adriatic, and with the Montenegrin station at Antivari, where the work of installation will be commenced very soon. The site for the largest Italian station contemplated has been definitely chosen. It is at San Rossone, where the Villa Royale has been selected. This station, according to Mr. Marconi's expectations, will be able to communicate not only with Argentina, but also with the stations at Table Head (Canada), Cape Cod (United States), and Poldhu. The rate for wireless telegrams between Italy and England when a commercial service is started is expected to be 10 centimes (or 1d.) per word; and for telegrams to Canada and the United States 30 or 40 centimes (3d. or 4d.) per word.

New Books.—"Electric Lighting and Power Distribution," by W. Perren Maycock, M.I.E.E. (Whittaker and Co. 7s. 6d.). This work by Mr. Maycock is in two volumes, the present publication being the second. It is of principal interest to students preparing for the preliminary and ordinary grade examinations of the City and Guilds of London Institute, and to such is well worth study. The value of the book is enhanced by the inclusion of numerous questions and exercises, embracing all those set for the preliminary and ordinary grade examinations in 1890, and the pages are embellished by over 400 illustrations.—"The Practical Engineer's Electrical Pocket-Book and Diary," and "The Practical Engineer's Pocket-Book." The first of these two little annuals has now reached its fifth edition, while the second is in its sixteenth year. The present issues for 1904 are no exception to their predecessors, in that they are replete with the latest information, and should be an invaluable acquisition to the equipment of the practical electrician and engineer.—In our notice of "Tube, Train, Tram, and Car" (Geo. Routledge and Sons, Limited. 6s.) in our last issue we regret that a slight error occurred in the spelling of the author's name. He is Mr. Arthur H. Beaven, *not* Bevan as appeared.

German Electrical Industry.—During the past week the amalgamation of the Siemens and Halske Company with the Schuckert Company in Vienna has been carried through, and matters are so far advanced that on Jan. 1 next the united working of the concerns will commence. This fusion is only a natural sequence of the previous amalgamation of the Berlin firms of Siemens and Halske and the Schuckert Company. The Berlin correspondent of the *Financial Times* states that in this amalgamation are included not only the works of Siemens and Halske at Vienna and Leopoldsan, and the branch establishments at Budapest, Graz, Larbech, Lemberg, and Olmütz, but also the Vienna establishment of Schuckert and the entire plant of the new Viennese Electric Tramway Company. The Schuckert establishment represents a value of about 30,000,000 Austrian crowns, and the Siemens and Halske concern, according to the last balance-sheet, has a capital of 20,000,000 Austrian crowns. Another rather important fusion in the electrical line is reported as having been accomplished. This is the amalgamation of the Bitterfeld Electro-Chemical Works with the Rheinfelden Electro-Chemical Works. The arrangement was made by the Bank for Electric Enterprises at Zürich, called for brevity the Electrobank, which is in possession of most of the shares of both of the concerns in question.

Kelway's Sound-Locating System.—For a number of years Mr. C. E. Kelway has been experimenting with a range-finding apparatus which depends for its accuracy on the difference in the rate of transmission of light and sound waves. He has recently introduced a somewhat similar system for locating the position of ships at sea when, owing to fogs or atmospheric conditions, it is impossible to obtain direct bearings. In this case the sound signals are worked in connection with wireless telegraphy messages. The idea is that lightships or lighthouses should send out simultaneously a foghorn signal and a Hertzian wave signal. This being done, the officer on watch could, by noting the interval between receiving the Hertzian wave signal and the foghorn signal, tell at once his distance from the signalling source. For this purpose a Kelway range-finding watch which is direct reading would be used. Further information as to the bearing of the lighthouse or lightship could be obtained by taking the distance again after the ship had run over a known

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course. It is obvious that this could be done, as it only involves the solution of the construction of a simple triangle, the three sides of which are known. It would be interesting to find how accurate the system would be in actual use, but this can only be done by means of a series of practical trials. It would seem, however, that the system may be a valuable adjunct to warnings given by lighthouses in heavy fogs.

Coal Storage under Water.—In our issue for Sept. 25 last we recorded the beneficial results obtained by Mr. John Macaulay, general manager of the Alexandra Docks and Railway, Newport, Mon., in some experiments upon the sub-aqueous storage of steam coal. It appeared from these that coal thus stored loses an inappreciable amount of calorific value—if under certain circumstances it does not actually gain value—compared with that lost by the alternative method of storage with access of air. Mr. Macaulay has since published some notes, in which he offers some reasons or suggestions for this result. He finds in the first instance that the saving of calorific value and gain in working power of coal stored under water is probably due to the retention more completely by the coal of its original chemical and physical properties lost in storage in air by (*a*) the dissipation of natural volatile constituents; (*b*) oxidation; and (*c*) the weathering effects of sun, wind, rain, and frost. Also, there may possibly be some increase in the working power of submerged coal due to its permeation by the salt of sea-water. In considering the question Mr. Macaulay has limited the practical application of the system to the navy, but it applies widely to every manufacturer throughout the world who has to store coal in small or large quantities. He estimates that at present at least a fifth of the coal power is lost unnecessarily owing to the method of storing. The alternative method of storage under water is simple and cheap, and readily practicable everywhere.

Mechanical Road Vehicles.—In No. 4 of his Cantor lectures on mechanical road vehicles, which is published in the current number of the *Journal* of the Society of Arts, Mr. W. Worby Beaumont deals in part with the various forms of engines or motors which may be used in automobiles. It would seem that the internal-combustion motor is likely to retain the place which it has now among the different forms of motor for propelling vehicles. On the other hand, the author thinks there is little doubt that the field of the electrically-propelled vehicle is one that will rapidly widen. There is a limit which will affect the electric vehicle, and leave the others in the position which they now relatively occupy. A very important direction of progress which the author urges lies in the development of the simplest arrangement of motor and gear which will best suit the parcels and light vehicles, for loads from 5cwt. up to about 25cwt. With regard to the omnibus of the future, he refers to the electrically-propelled vehicle operated by a current received from a wire either overhead or by the side of the road, as is the case with the tramways. His comment on this form of vehicle is that it has all the advantages of the tramways without any of their numerous disadvantages, the chief among the former being that it requires no rails in the streets, but, of course, like other vehicles, it will work best on good roads. Concerning the motor wagon for heavy traffic, these vehicles are the requirements of great manufacturing centres. If, however, the motor wagon for carrying heavy loads is to be successful for distributing goods mainly on the same roads day by day, we shall have to meet these vehicles half way, and recognise the necessity for tram plates which will not interfere with other traffic, or tramways of some form off the beaten track of other traffic, so that the motor wagons shall be able to run from docks and railways stations to the mills or other loading or unloading destinations.

Tube Railways and Fire Risks.—In one light the recent disastrous fire on the Paris Metropolitan Railway may be looked upon as a blessing in disguise. It has served to call attention to the totally inadequate precautions taken on certain underground electric railways against the fire fiend. Before its occurrence the management of such railways were content to go on in the old ways and methods, which in nine cases out of ten spell disaster. One of the immediate results of the Paris casualty is to be found in the investigation which the German Government has caused to be made into the position of affairs on the Berlin Elevated and Underground Electric Railway, especially on the low-level portion of the railway. The result of this enquiry is that various alterations and improvements are to be made on this system. These comprise a more adequate tunnel lighting system which shall be independent of the power circuit, and efficiently protected from such external influences as overheating of the tunnels or mechanical damage. Arrangements are to be made whereby each official accompanying a train will be able immediately to switch off the working current at any point in the tunnel. It is also proposed to arrange for the porters' barrier at the platform exit being easily pushed on one side, and to increase and improve the existing fire-extinguishing appliances. In addition to these proposals experiments are to be made to ascertain whether the establishment of air shafts with extractors would render it possible in case of necessity to remove smoke and afford quicker access to the permanent way for the fire brigade, and whether the arrangements for a rapid clearance of the passengers from the cars are capable of improvement. The existing regulations governing employés are to be amplified with a view to coping more successfully with any case of emergency, while a short intimation is also to be published for the guidance of the public as to the attitude to be observed by passengers in the event of an accident occurring on the railway.

Electrical Progress in the Nineteenth Century. The Royal Philosophical Society of Glasgow has arranged for the delivery of a special centenary series of lectures during the coming session in connection with the advancement of science during the existence of the society. The first of the series was delivered by Prof. Andrew Gray at the opening meeting of the session on the 4th inst., and he chose for his subject "Electrical Progress in the Nineteenth Century." The lecturer traced the progress of electricity from the time of Galvani and Volta up to the present day, passing in review the work of leading scientists and physicists who had been chiefly responsible for this development. Thus, the achievements of Cavendish, Davy, Oersted, Nicolsin, Carlile, Ampère, and Faraday were individually described and commented on by the lecturer, who, in his reference to the electro-chemical industry, deplored the fact that an electrical discovery made in this country had, through the apathy of our manufacturers, been allowed to become the foundation of what was mainly a German industry. In connection with Faraday's work, Prof. Gray showed Lord Kelvin's reflecting galvanometer for the observation of induced currents, and made some experiments with it during the evening. Lord Kelvin's papers on the voltaic cell were mentioned, and a short account was given of his theory of the oscillatory discharge of a condenser, and the bearing of this result on the present-day experiments in electric wave telegraphy. Prof. Gray next sketched the work of Gauss and Weber and the British Association Committee on Electrical Units and Standards, and gave a

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short history of the earlier researches on the determination of the ohm carried out by Thomson, Maxwell, and more lately by Lord Rayleigh. The lecturer also referred to Dr. John Hopkinson in connection with improvements in electric generators and motors, and went on to give a short exposition of Clerk Maxwell's great generalisation—the electromagnetic theory of light—and of its direct verification by the experiments of Hertz. He concluded with references to the experiments in Hertzian wave telegraphy, and to the astonishing results that have followed the discovery of radioactivity. As to the progress made in the next century, he said it would be based on the knowledge gained in the past 100 years, and those who by spending laborious days and nights had built it up would be held in imperishable renown.

High-Speed Work at Zossen.—In view of the record speeds in electric traction recently obtained on the Berlin-Zossen military railway—the highest recorded being at the rate of $130\frac{2}{5}$ miles per hour—it will not be out of place to give some general details as to the improved methods that have yielded such highly successful results. The first experiments on this railway were made some two years ago, but since then the track from Marienfeldt to Zossen has been relaid with new steel rails weighing 86·1lb. per lineal metre, resting on heavy spruce ties 22in. from centre to centre, and heavily ballasted with broken basalt. The rails are set on each tie in a steel chair, strongly bolted down, and are joined perpendicularly by bevelled joints 7in. in length, held firmly together by bolts passing horizontally through the fishplates, so that the effectiveness of a continuous rail is practically secured. The old light rails, which had failed in 1901, and were, therefore, taken up, have been laid down flat as guard rails, resting horizontally on special cast-iron chairs in such a way that the flat bottom flange of the rail stands vertically along the inside line of each heavy rail, and about 2in. distant from the inner edge of its face. The track is a nearly level air line throughout its length, except one curve of 2,000 yards radius near its southern extremity, and is in all respects up to the highest standard of modern railway construction. The motors have been likewise improved in various minor details, but the cars are substantially the same as when first constructed. Each is 72·18ft. in length and weighs 90·5 metric tons, or about 200,000lb. avoirdupois. Of this weight 48 metric tons comprise the body and running gear, and 42·5 tons are made up by the motors, transformers, and other details of the electrical equipment. Each end of the car rests on a six-wheel bogie truck of the American type, and the motors are four in number, one attached to the front and rear axle of each truck, the middle pair of wheels in each group running free. The wheels are 49in. in diameter and are equipped with pneumatic brakes of the standard type. The transformers, which are hung beneath the middle section of the car, weigh 12 tons, besides which a storage battery of 631lb. weight supplies the current for lighting purposes. The interior of the car is provided with upholstered seats lengthwise along the sides, and an open railing encloses at each end the space occupied by the driver, who, standing behind a curved front of plate glass within easy touch of volt and ampere meters, gauges which show the resistance of the air, and a dial that indicates and registers the speed, controls its movements by turning a pilot wheel. We understand that in due course the engineers and technical committee in charge of the trials are to report the results in detail.

Glasgow Local Section Dinner.—The Glasgow Section of the Institution of Electrical Engineers opened its winter session this year with the annual dinner, with a view to bringing the members into closer union at the start. There was a large attendance, and among those who supported the chairman (Mr. Wm. A. Chamen) were Mr. R. Kaye Gray and Mr. W. G. McMillan, president and secretary respectively of the Institution, Mr. M. B. Field, Mr. John Young, and Mr. Geo. Tidd, hon. local secretary. In responding to the toast of "The Corporation of Glasgow," the Lord Provost naturally referred to the electrical development of the city, pointing particularly to the electrical tramway system as evidence of what had been done in this direction. He thought electrical science might come to their aid in solving the smoke problem, and, speaking of the domestic use of electricity, he reminded his hearers that the electricity department had reduced the rate for heating purposes to the level of the power rate. Mr. W. R. Copland proposed the toast of "The Institution," and Mr. R. K. Gray, in acknowledging the sentiment, testified to the favour with which the parent institution viewed the development of the local sections. He claimed for the profession of electrical engineers that it was as well equipped as any other profession in Great Britain. Other branches of engineering had to contend against certain disadvantages, amongst which was the difficulty of freeing themselves from past practice. Mr. Gray also referred to the work of Lord Kelvin, and in this connection characterised Glasgow as the cradle of the electrical industry. Mr. W. G. McMillan gave the toast of "The Glasgow Local Section," putting the local sections in the relation of colonies to the parent institution. The interests of the profession would be advanced by the development of the local sections, and the parent institution was anxious to keep the "colonies" together, and assist them in every way. He congratulated the Glasgow Section in particular on the excellence of its work, and referred in praiseworthy terms to Mr. Chamen, the present chairman, and Mr. Tidd, the hon. secretary. In his reply Mr. Chamen pointed out that the work of the sections differed in some respects from that of the parent institution. There were in the local sections a large number of members of a less highly technical character, and it became the duty of the sections, therefore, to encourage the reading of papers of a less technical kind than were presented before the London body. But if the local sections did no more than keep the members together and provide them with pleasant evenings, they would accomplish a great deal in the way of banding together the outlying branches of the Institution and encouraging young engineers to join the local sections. The dinner proved a highly successful affair, and for all of those present a very interesting evening was spent.

Peat Fuel by Electricity.—Of the many attempts that have been made to employ electricity in the conversion of peat into a fuel which should compete with the best steam coal, scarcely one has resulted in any practical measure of commercial success being obtained. The principal objections which have been common to all such processes, have been the high cost of production and the length of time occupied in the drying and manufacturing. Now, a Mr. J. B. Bessey claims to have perfected an electrical process which satisfactorily overcomes both of these difficulties, and in a demonstration last week at the works of Messrs. Johnson and Phillips at Charlton, Kent, he attempted to show that he has achieved practical success. Unfortunately, the facilities for witnessing the "demonstration" were not such as to induce an intelligent idea of the essential features and inner working of the process, and, moreover, no reliable data were forthcoming. We were, however, furnished at the works with a printed description of the process setting forth the claims made by Mr. Bessey for his invention, but if the demon-

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stration was intended in any way to substantiate these important claims, it must be regarded as a regrettable failure. We gather from the printed matter that the *modus operandi* is, shortly, as follows: Virgin peat, said to contain from 70 to 80 per cent. of water, is packed tightly in rotary iron cylinders, which are rotated at high speeds in order to expel the water from the peat. An electric current of 220 amperes at 200 volts is then passed through the peat, which is claimed to give the objective result aimed at—viz., a perfectly disintegrated or pulverised material, operating freely in particles, without loss to any of the valuable properties primarily contained in peat. The disintegrated peat is afterwards passed through a set of rollers on to a kneading apparatus, where it is reduced to a putty-like condition. By an automatic process the mass is passed on to the moulder, and the material is then formed into briquettes or any other form required. A great deal of hand labour is at this stage employed in the process, which occupies about 2½ hours throughout, but we were informed that in practice automatic operation would be used almost entirely. From the scanty figures we were able to elicit as the result of our enquiries, we understand that 24 units of electricity are consumed in treating one ton of virgin peat, and that the resultant yield of fuel is about 15cwt. 10lb. This means a loss in operation of just under 25 per cent., and this in spite of the fact that virgin peat contains from 70 to 80 per cent. of water, which, we are told, is extracted in the process. We were unable to get a satisfactory explanation of this curious contradiction. Moreover, we were seriously informed that the total cost of producing one ton of peat fuel by this invention is about 5s., which seems remarkably low when considered in the light of the comparatively large amount of electricity used in the process, the cost of handling, etc. Another fact we gathered was that a complete plant to treat 100 tons of virgin peat per day costs about £4,000. We understand that an initial plant is to be erected in Ireland immediately, and if it is then found possible, as claimed, to produce a ton of peat fuel equal to the best South Wales steam coal at 8s. 4d. a ton at the pit's mouth at an inclusive cost of 5s., we shall be ready to admit that the Bessey process is a distinct advance on previous inventions; but all we can say at present is that on Thursday the inventor completely failed to produce any proof whatsoever in support of the claim. Messrs. Johnson and Phillips kindly lent their works for the purposes of the demonstration, but, so far as we could discover, they are not the proprietors of the process.

Financial Aspect of Electric Traction.—This important question is dealt with by Mr. D. N. Dunlop, a member of the Tramways and Light Railways Association, in a long statistical paper which is published in the association's October circular. The author has gone into the subject in a very thorough manner, and the great mass of valuable data he is able to present must be the result of much arduous work. The figures he gives relate to the development of electric traction in this country, on the Continent, and in America, and an interesting comparison is thus afforded. The States are dealt with first, and the author shows that the average operating expense percentage of a group of 18 of the largest electric tramway companies in that country is 52·44, which, including taxes, is increased to 60 44 per cent. The gross receipts per passenger work out at 1·99d., and per car mile 10 69d., or about the same as in England, where the gross receipts per car mile vary between 9d. and 13d. In Germany the receipts per passenger for the electric tramways of the 11 largest cities average 1·16d. An income account of the street railway or electric tramway companies of the States for the year 1902 is given, from which it seems that the gross earnings from operation were £49,510,799, while the operating expenses amounted to £28,462,519, leaving net earnings to the total of £21,048,280. To this is added a sum of £590,125, income from other sources, making a total of £21,638,405. After allowing for interest on loans, etc., amounting to £15,519,010, the net income was £6,119,395, from which dividends on stock amounting to £3,176,422 were paid, leaving a surplus for the year of £2,942,973. Incidentally Mr. Dunlop throws an interesting light on the effect of the electric lines on the steam railways in the States. For example, in Massachusetts last year the electric lines carried four times as many passengers as the steam, and in seven years the works of the trolley in America has doubled, whereas that of steam has decreased. Since 1894 the electric tramways and railways of Massachusetts have increased annually from 9 to 10 per cent. In Connecticut the electric lines in 1901 carried 20 per cent. more than the steam roads. In promoting new lines, American practice has always been to make the electric tramway development the forerunner of the population, and in nine cases out of ten the population has followed. Another example of this to which the author refers is the electrification of steam lines in Italy. On the line connecting Bologna and St. Felice the speed and frequency of the trains were both doubled with the introduction of electric traction, and the fares reduced to 40 per cent. of the original amount. This has produced the notable result of increasing the passenger traffic five-fold. In England, under similar conditions, to make up for the increased capital cost of electrification, the passenger traffic would have to increase 61 per cent. if fares remained unaltered. Comparing the cost of running electric and steam lines in Italy and England, in pence per train mile, it is found that in Italy the total with steam is 20·69 as against 12·71 with electric, and in this country 13·04 with steam and 18·16 with electric. In some further statistics the author shows that the City and South London, the Waterloo and City, and the Central London Railways paid dividends of 2¾, 3¼, and 4 per cent. respectively for the first half of the present year. The total capital involved in London tubes is stated to be £50,277,000, thus apportioned: lines in operation, £7,158,000; in construction, £18,493,000; authorised, £3,680,000; in contemplation and extensions, £20,586,000. The author then turns his attention to the development of electric traction on the Continent, showing that the majority of the undertakings in Germany, both under municipal and private control, are worked profitably. In France, with the exception of Paris, electric traction is backward. An interesting comparison is made between the conduit and trolley system as operating in Brussels. The total comparative working expenses of the two systems are 2·197d. per car mile with conduit lines, and 1·941d. per car mile with trolley lines. In other words, the complete cost of working in Brussels is 1¼ farthings more for conduit than overhead, or ·3125d. per mile. In Paris, in 1902, the average working expenses stood thus per car mile: trolley lines, ·1914d.; conduit lines, ·6505d.; showing a difference of ·459d.—roughly 1¾ farthings per car mile in favour of trolley. From the facts and figures thus brought together the author concludes that in those countries in which electric traction is allowed to develop freely the trolley tramways, with few exceptions, prove, under adequate management, to be safe and profitable investments. Tube railways, in spite of enormous initial cost, hold their own in the face of competition, and the dividends show a slow but steady upward tendency.

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SWANSEA MUNICIPAL TELEPHONES.

On Thursday, Nov. 5, the Mayor of Swansea formally opened the municipal telephone exchange, which adds another to the rapidly growing list of telephone undertakings in the hands of municipal corporations. The history of the Swansea scheme and the details of the work are briefly as follows: On May 3, 1901, upon the Watch Committee of the Swansea Corporation reporting that the police telephone lines were very unsatisfactory and the fire calls were ineffective, the Council appointed a special committee to consider the whole question of telephonic communication. The committee met on several occasions, and eventually recommended the Council to request Mr. A. R. Bennett to act as their consulting engineer and to prepare a report. This report was considered by the committee at several meetings, and adopted by them on Jan. 22, 1902, and by the Council on Feb. 19, 1902. Application was made on Feb. 20 to the Postmaster-General for a license, and to the Local Government Board for sanction to borrow £20,500 to cover cost of building and construction of routes; the license was granted and sanction to borrow the money was obtained on Nov. 5, 1902, just a year from the date of the formal opening. The amount which has been expended to date is £12 036.

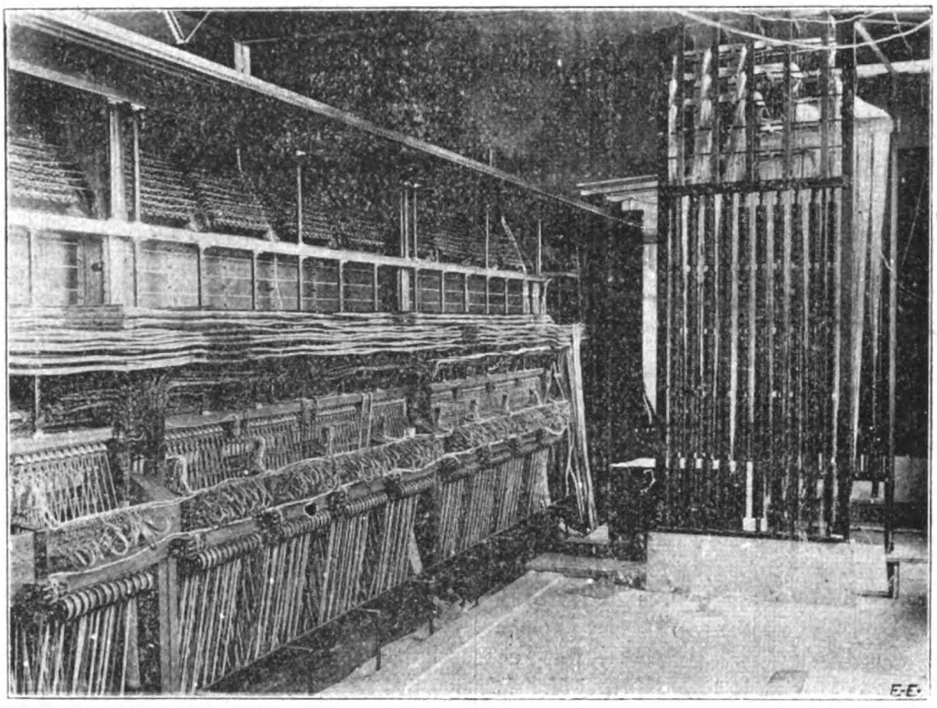

FIG. 1.—Back of Switchboard.

The scheme provides fully for 750 lines, and spare accommodation is also arranged for 750 more lines. All the main routes within the borough are carried out with underground cables. For these 5 miles 907 yards of trenching, together with 10 manholes, have been excavated in the streets. In these has been laid 6 miles 1,557 yards of 3in. iron pipes, and 5 miles 1,610 yards of multiple-core paper and air insulated cable. These cables contain 742 miles of copper wire. The central exchange switchboard (Fig. 1) has already accommodation for 700 subscribers, and may be extended to 1,000 without alteration. Since the first subscriber was connected to the central

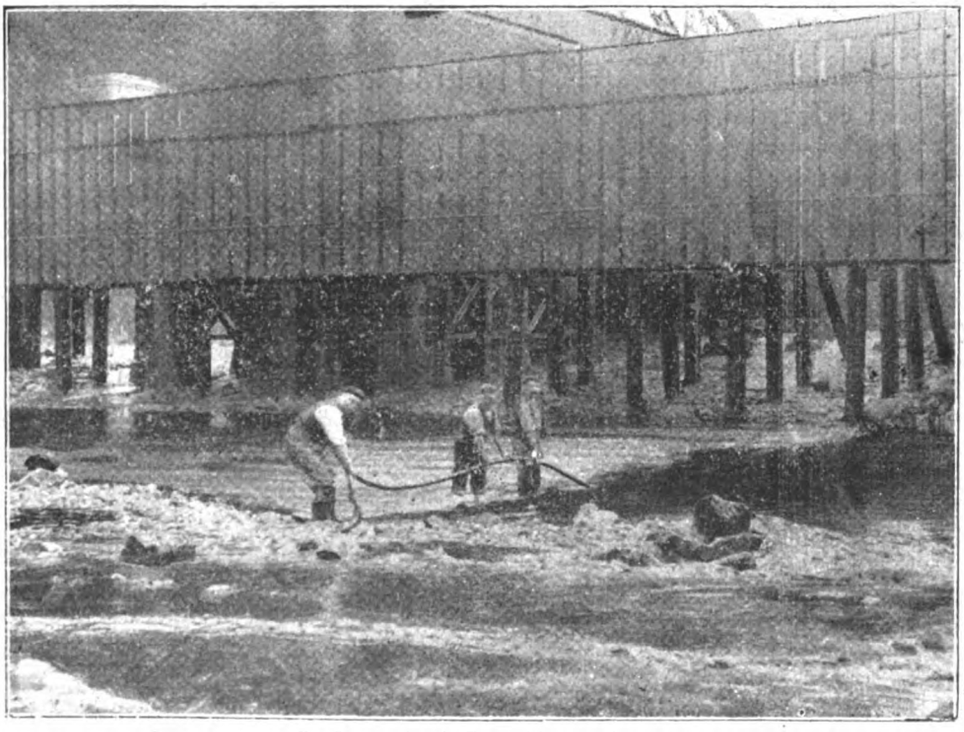

FIG. 2.—Crossing the Tawe with a Telephone.

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exchange, exchanges have been opened at Morriston and Mumbles, the number of subscribers actually connected being 366, and the number of orders in hand 258. The Government trunk lines were available on Aug. 19, 1903, and every Corporation subscriber from that date has been able to speak to all the other exchange systems in the kingdom.

The exchange at Swansea is unique amongst municipal telephone undertakings, in that a special building was erected for the office, switch-room, and stores. This building was designed by Mr. George Bell, the borough engineer, and is admirably suited for its purpose. It is so arranged that it can be conveniently extended, as the demand for telephony exceeds the capacity of the present building. One advantage of the separate edifice for a telephone exchange is that there was no need to carry the heavy lead-covered cables up to the top of a high building in order to get immunity from sound disturbances. The work of laying the cables in Swansea also involved some novel problems. For instance, the configuration of the town rendered two submarine crossings necessary. The first of these is illustrated in Fig. 2, which shows the cable being laid across the River Tawe. The other crossing was at the north dock. For this work the cable used was of the dry-core type, but it is protected by two distinct lead sheathings, the one over the other. It is then armoured with steel tape, and finally protected with a jute serving steeped in preservative compound. A unique incident in telephone work is illustrated in Fig. 3, which shows a diver working in a manhole. In constructing the manhole, the contractors inadvertently broke into an old culvert having connection with two of the dock basins. The water immediately filled

FIG. 3.—Diver working in Wind Street.

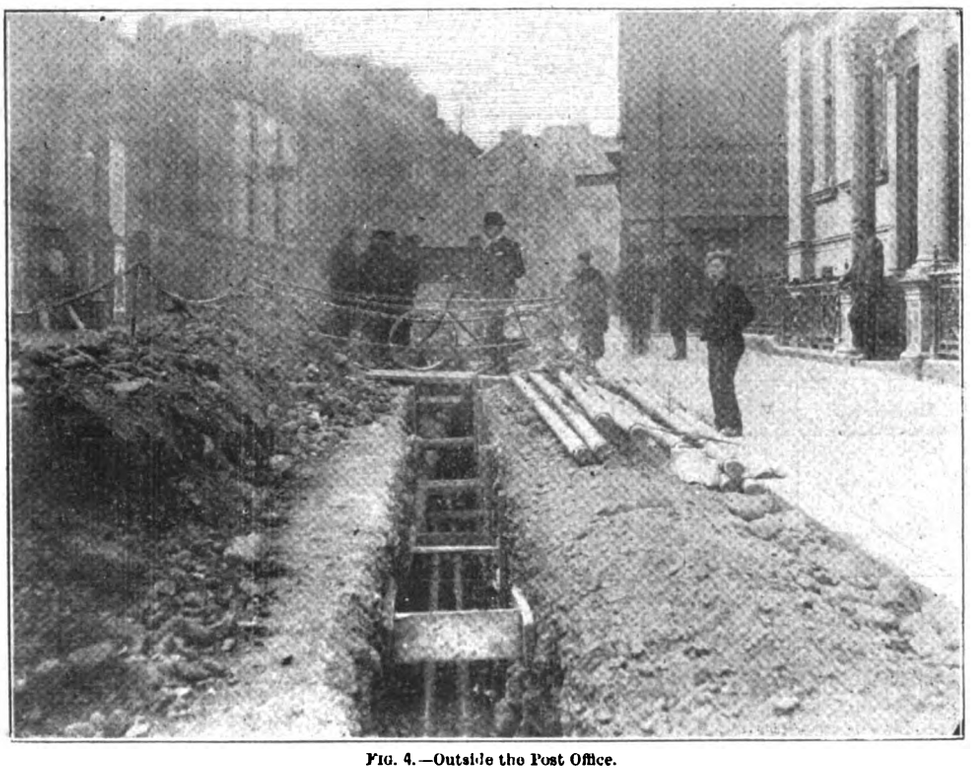

FIG. 4.—Outside the Post Office.

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the manhole, and all efforts to stop the flow were entirely fruitless until the harbour diver was requisitioned, when, after hours of submerged labour, the leak was repaired sufficiently to admit of the manhole being pumped out.

Fig. 4 shows the ordinary process of laying the pipes outside the Swansea Post Office. The whole of the work has been carried out under the supervision of the consulting engineer, Mr. A. R. Bennett, M.I.E.E., Glasgow. With the exception of the erection of the poles, fixing instruments, and wiring subscribers' premises, which have been done by direct labour under the supervision of the manager, Mr. A. G. Mackie, the work of construction has been carried out by contract, Messrs. W. T. Henley's Telegraph Works Company, Limited, supplying the cable and carrying out the construction of the underground work; the switchboards were supplied and fixed by the British Insulated and Helsby Cables, Limited; the test-jacks and lightning and high-voltage guards by the International Electric Company; the instruments by the Ericsson Bell Telephone Company, Glasgow.

MR. A. G. MACKIE, TELEPHONE ENGINEER TO THE SWANSEA CORPORATION.

At the opening ceremony last week the Mayor, Mr. Griffiths Thomas, was presented with a gold key with which to open the switchroom, whereupon the working of the exchange was explained to the company present by Mr. A. Mackie, the telephone engineer. The subsequent function was held at the Guildhall, when the Mayor, in an able speech, wished the undertaking success. Councillor H. G. Solomon, the chairman of the Swansea Telephone Committee, then traced the history of the undertaking, and dealt with the vexed question of competition between the Corporation exchange and that of the National Telephone Company. He said that directly the municipal subscribers amounted to half those on the National Company's system, the Corporation could insist on intercommunication, but that he was yet to be convinced of the advisability of that course.

Mr. A. R. Bennett also spoke of the admirable quality of the work, and referred to the fact that all the materials used, even the switchboard, were of English manufacture.

The annual charges for telephone connections to the municipal exchange are either at the rate of £5 per annum for unlimited service, or £3 per annum with a charge of 1d. for every call made We wish the undertaking every success.

INDEPENDENT TELEPHONY IN GREAT BRITAIN.

BY GARDNER AND HOLME.

(Continued from page 609.)

(4) Management and Switching Systems.

(*a*) *Management.*—The management of construction work will be given in the various articles dealing with that portion of the subject, and an outline of the method of treating faults has already been given. The only remaining section of the subject is the book-keeping necessary to give a general idea as to the financial condition of the undertaking. But the fact that with good construction and perfect internal management a system will fail through lack of courteous treatment of subscribers should never be forgotten. An undertaking so largely depending on the goodwill of the customers, both as regards the renting of telephones and the granting of wayleave facilities for running the wires, will slowly diminish, or tend to public ill-will, unless a good and efficient service and courteous treatment is rendered in return. A manager, therefore, should bear in mind that what suits one subscriber will not suit another, and the system, while being based on general principles, should be as flexible as possible, and a customer's wants personally enquired into and met as far as possible.

Works Order.

To Chief Foreman and Inspector.

Please execute the following work:

.....

.....

.....

Hours spent (Foreman).....

" " *(Inspector).....*

.....

Manager.

N.B.—All material used on this order to be filled in on the back. No work to be done without an order.

Fig. 8.

As regards the internal management, as soon as an order is received, it should be entered into an order book and a works order made out for same. A form of works order is shown in Fig. 8. This should then be handed to the outside superintendent, who will, when the men are in the particular district to which the order refers, give instructions to the foreman to run the line. The foreman should be supplied with a duplicate perforated requisition book, so that on entering the stores required for the works order he can obtain same on presentation of the requisition slip to the storekeeper. As the storekeeper takes the stores from the racks on which they are placed, he should enter the various quantities in one column of the card fastened to the racks; similarly, on receiving stores, he should enter them in the other column on the card, so that at any moment the quantity of stores can be ascertained.

The various stores received should be entered in a stores inward book, as shown in Fig. 9. On the completion of the line, the stores used on that particular work should be entered on the back of the works order by the foreman,

STORES INWARDS BOOK.

Date.	No.	Description.	Empties.	Suppliers.	Carriers.	Carriage paid.	Carriage due.	Remarks.
						£ s. d.	£ s. d.	

Fig. 9.

Material Used.

Foreman.	Inspector.

Fig. 10.

and the outside superintendent should then return the finished works orders to the office. Here they are dealt

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with as required by each individual case; if an exchange line, a telephone number is allocated, and the order given to the inside superintendent to have the inside work and instrument fixed. On completion of the whole work, the various stores used will be entered on the back of the works order in the columns as shown in Fig. 10, and as the time of the men and fitters is entered on the front of the works order, the actual cost of any line can easily be ascertained. The stores requisition slips used by the foreman and fitters, and shown in Figs. 11 and 12, should be sent up each day by the storekeeper to the office, where they should be entered in a stores analysis book, totalled monthly. These totals are then transferred into an ordinary stores ledger, which should agree with the cards at the store. The stores analysis book should be so ruled that the quantities of stores per line are analysed, as this proves a very useful source of information for estimating the cost of extension work; also an engineer can quickly tell if material is being used recklessly, as the quantities per line remain very constant in a well-organised system. The works orders on completion are entered into the rental register, or sales and removals book, and the various bills sent out. The toll and telegram accounts are entered into books arranged in telephone number order, and the totals of these books transferred to the general ledger.

CORPORATION TELEPHONE DEPARTMENT.

To Storekeeper, *Date* *190*

Please supply the undernoted Stores for use on W.O. No.....

Manager

Quantity.	Size, No., or pattern.	Description.	Quantity issued.	Quantity.	Size No., or pattern.	Description.	Quantity issued.
		Poles				Rafter swivels ..	
		Pole roofs				Bolts	
		,, steps				Screws	
		Oak arms				Ditto	
		O.A. combiners ...				Nails	
		Standards				Staples	
		C.I. arms				Spikes	
		Climbing clips ...				Copper wire ...	
		Cast-iron chairs...				Binding ,, ...	
		Insulators				Stay wire, 7 ply	
		Ditto				Ditto 5 ,,	
		Ditto				Iron wire.....	
		Chimney brackets				V.I.R.	
		Right angle ,,				Bronze wire	
		Stay rods					
		Outriggers					

Issued to Foreman..... .....Storekeeper

.....190

Posted to stores analysis book, folio No.....

FIG. 11.

CORPORATION TELEPHONE DEPARTMENT.

To Storekeeper..... *Date*.....*190*

Please supply the undernoted Stores for use on W.O. No.....

Manager

Quantity.	Size, No., or pattern.	Description.	Quantity issued.
		Nails	
		H.V. guard	
		Wall instrument	
		Table instrument.....	
		No. 2 Leclanché cells ...	
		Solder	
		Staples	
		Soft copper wire	
		Inside wire	
		Straps	
		Screws	

Received by .....

Issued by .....

.....Storekeeper

.....190

Posted to stores analysis book, folio No.....

FIG. 12.

CONSTRUCTION WAGES AND EXPENSES.

Name.	Wages.	Expenses.	Exchange.	Instrument.	U/G.	O/H.
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....

FIG. 13.

REVENUE WAGES AND EXPENSES.

Name.	Wages.	Expenses.	Outside repairs.	Inside repairs.	Office.	Operators
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....

FIG. 14.

The wages paid are analysed under various headings, as it must be remembered that the same staff are partly employed on constructions and partly on maintenance. The wages book is made up from an analysis of the men's and fitters' time, as shown on the time-sheets. Figs. 13, 14, 15, and 16 give an idea as to these.

A statement giving the number of lines working, and other interesting data, income, and expenditure, receipt per station, and capital cost per station, also percentages of working costs per station, should be prepared at least once per quarter. From these books an accurate statement as to the capital cost, income, and expenditure of any single exchange in the system can be laid before the committee for their information, and any chance of unremunerative work being proceeded with obviated.

(*b*) *Switching System.*—There are various methods of switching which can be adopted, and four will be described as giving an all-round idea of the best methods at present in use—viz.: (1) magneto call and ring-off; (2) central battery signalling and ring through; (3) common battery; (4) call wire.

1. Fig. 17 is a diagram of the magneto call and ring-off suitable for small exchanges and adopted for large ones in several countries. It is less liable to faults than battery systems, and does not need the same skilled attendance. The subscriber calls the exchange by turning the handle on his instrument. This drops the indicator at the exchange, and to reply the operator inserts an answering plug into the corresponding jack, and throws over the combined

BOROUGH OF ——.

CORPORATION TELEPHONE DEPARTMENT.

Gang's Time-Sheet.

Date.....*190*

Name.	Works order numbers.						Total.
.....							
.....							
.....							
.....							
.....							
.....							

REPORT OF WORK DONE.

FIG. 15.

BOROUGH OF ——.

CORPORATION TELEPHONE DEPARTMENT.

Weekly Time-Sheet.

Name ..... *Week ending* *190*

Works order No.	Fri.	Sat.	Mon.	Tues.	Wed.	Thurs.	Total.
.....	.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....	.....

REPORT OF WORK DONE.

FIG. 16.

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speaking and listening key to the speaking position. This cuts the indicator out of circuit, and places the operator's phone in direct metallic contact with the subscriber. On

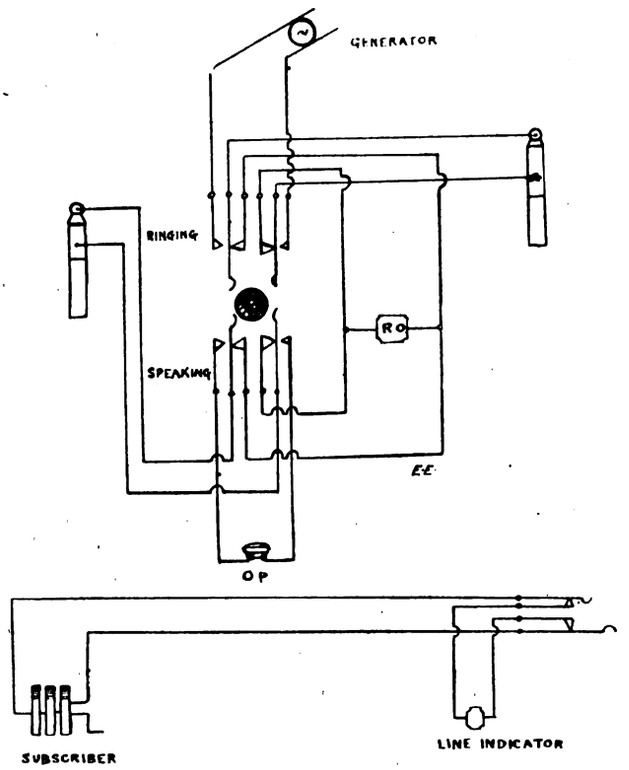

FIG. 17.—Magneto Call and Ring off. R.O., ring-off indicator; O.P., operator's set.

ascertaining the number required, the operator lifts the corresponding calling plug, and inserts it into the jack of the called subscriber, thereby cutting out the corresponding line indicator, and pulls over the lever of the key to the ringing position, which rings the bell on the instrument of the required subscriber. On releasing the key a high-resistance ring-off indicator is bridged across the plugs, so that on the termination of a conversation either of the sub-

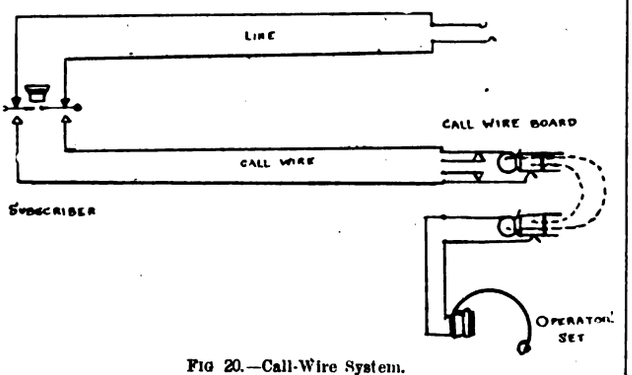

FIG 20.—Call-Wire System.

scribers turning the handle of their instrument will drop the ring-off. The operator then disconnects by taking out the plugs, and everything is restored to normal.

maintenance, compared with the magneto, but, as it simplifies the subscriber's end, is a better system to adopt. A general idea as to the method of working can be

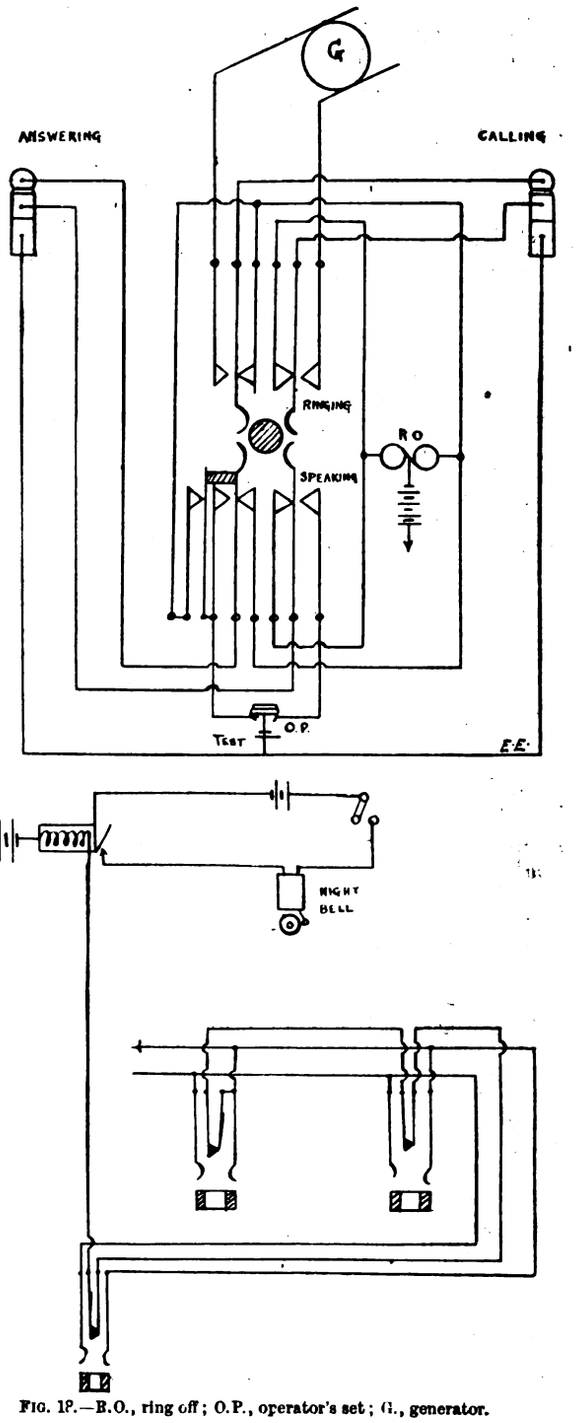

FIG. 18.—R.O., ring off; O.P., operator's set; G., generator.

gained on a reference to Fig. 18. To call, a subscriber momentarily touches a button on his instrument, which drops the corresponding indicator at the exchange.

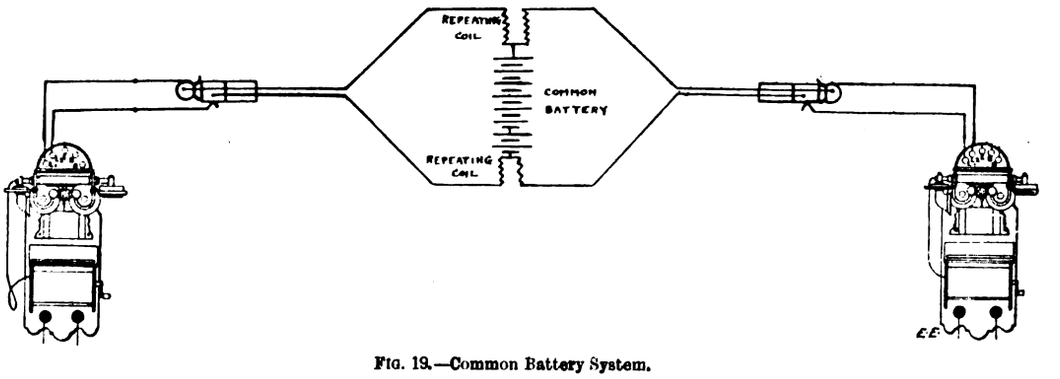

FIG. 19.—Common Battery System.

2. *Central Battery Signalling and Ring Through.*—This is a more expensive system, both as regards first cost and

The circuit which effects this can be traced on reference to the diagram: a current flowing from the central

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battery through the indicator, the inner springs of the home jack, the inner springs of the multiple jacks, to the first multiple, where the inner spring is connected to the earthed side of the line, whence there is a return to the earthed side of the battery. In answer to a call the operator lifts the answering plug and inserts it into the corresponding local jack, and throws over the combined listening and speaking key to the speaking position. This breaks the contact of the inner springs, thereby cutting the battery circuit, mechanically restoring the indicator, and at the same time connects the operator's phone to line. On ascertaining the number required, the operator lifts the corresponding calling plug and touches the bush of the wanted subscriber's jack, and if the line be engaged hears a click in her receiver. The circuit which causes this is from the bush of the jack touched by the tip of the calling plug to the bush of the jack on the multiple where the line is already engaged, thence to the barrel of the plugs which are connected to one side of the test battery, the other side being joined to the key and tip of the plug through the operator's receiver, thereby causing a click or engaged test. If the line is not engaged the operator pushes the plug home, and pulls over the lever of the key to the ringing position and calls the wanted subscriber. On releasing the key a "ring-through" indicator is bridged across the plugs. This indicator is wound so that a current passing through both coils in series will not work it, but if a current enters between the coils the shutter falls. From a point between the two coils a connection is made to the negative side of a clearing battery, the positive side of the battery being connected direct to earth. On the termination of a conversation either of the subscribers momentarily pressing the button on the instrument will drop the ring off, as a current will flow from the clearing battery to the centre point between the two coils, through one of the coils, one side of the line, which is momentarily earthed, and thence to the earthed side of the clearing battery. Subscribers can thus ring through to one another without being cut off, as they would be in the magneto ring-off system, and consequently listening at the telephone while information is sought at the other end is entirely done away with, and the subscribers' time saved. The central battery ring-through system necessitates excellent construction work and insulation, and so subscribers are, at least, ensured an efficient system as regards speaking.

3. *Common Battery.* — This is similiar to the central battery ring through, with the exception that lamps and relays are used in place of the indicators, and no battery is required at the subscriber's end. The current for speaking is supplied from accumulators at the central in shunt across the cord circuit as shown in Fig. 19, the transmitter and receiver being in series. This system reduces a subscriber's instrument to receiver, transmitter and polarised bell, condenser, and switch-hook, thereby saving a considerable sum of money, which, however, is expended on the switchboard. To call, the subscriber takes the receiver from the hook, thereby closing the line circuit, which when not in use is disconnected at the instrument, a condenser being joined in series in the bell circuit. This lights a lamp through the closing of the line relay circuit. In answer to a call the operator lifts an answering plug, and inserts same in the jack immediately under the lamp, thereby disconnecting the central battery from the lamp, and at the same time shunting it across the plug, as shown in Fig. 19. Two ring-off lamps are used, one in each plug circuit, so they act as a guide to the operator that the called subscriber has replied as well to notify the termination of a conversation. It will be seen that if lines are run overhead, the liability of false signals is very great, and consequently the common battery system should only be used where an entirely underground system is installed. One advantage of the system is the compactness of the lamp signals, and the consequent large boards which are capable of being worked in one exchange, and so the system readily lends itself for installation in the capitals of the world where a complete underground system is possible, and where the grouping of thousands of lines on one board is economical.

4. *The Call Wire.*—In this system all indicators are done away with, several subscribers' instruments being bridged across a common call wire, in addition to the ordinary line wires, which is joined to an operator's position at the exchange end. On depression of the call-wire button instant communication with the operator is obtained, as shown in Fig. 20. As the operator does not know who calls, it is necessary for the subscriber to give his own number as well as the one required. The operator then inserts a pair of plugs into the corresponding jacks. It will thus be seen that the system is eminently adapted for rapid switching, provided too many subscribers are not placed on the one call wire. The traffic can also be quickly regulated, as the call wires can be transferred from one operator to another at the call-wire board. The abolition of line indicators also reduces the risk of switchboard faults to a minimum.

(To be continued.)

SOME POINTS THAT DETER THE SPREAD OF ELECTRIC LIGHTING.

BY F. H DAVIES.

The strenuous rivalry between the advocates of electric light and gas has been responsible in the past for many schemes and novel ideas to attract the consumer on the one side and to keep him on the other; and although electrical engineers may fairly congratulate themselves upon having done well, it is still obvious in practically every town that by far the greater part of the lighting is in the hands of gas men, and that a tremendous amount of work has yet to be done by the former before he can even claim equality in output with his rival.

The question arises, What is left for the electrical engineer to do? He has cut down his price per unit, in many cases to the lowest margin; he has invented lamps of marvellous efficiency that can compete with the much-vaunted Welsbach of the gas engineer; he has put forward free-wiring schemes, good, bad, and indifferent, to entice the small householder; and yet practically everywhere he is still decidedly in the minority. It is obvious that for the present there is little more to be effected in this direction, and that things have arrived at a pass where it would almost seem to be only possible to contentedly wait for the coming of some great invention that will considerably reduce the cost of generating electrical energy, or until time and observation have convinced the gas user of the error of his ways.

While it is difficult to point out anything new that the electrical engineer should do to further the interests of his undertaking, it is comparatively easy to find faults and to say what he should *not* do; and although most of these faults are small, and to his credit be it said not universal, they undoubtedly *do* have a bad effect upon his business.

It is an axiom with the successful trader that he must first of all please and make things easy for his customers. If he does this, his profit is bound to show up in time. But in electric lighting work generally this axiom does not appear to be at all appreciated. Start at the very beginning, and take the case of a new householder who is wavering between gas and electric light. He goes to the gas company, and is informed plainly that gas is so much a thousand, less, perhaps, a certain simple discount, plus a small meter rent; the service is probably already in, and if he says the word and writes a short note to the effect that he requires a supply, his meter will be fixed and the supply started without any further bother. He now journeys to the electricity works, and we must admit is very probably met with a different reception.

He is informed that the charges are based upon the maximum demand system, or a complicated sliding scale, and perhaps there is also an alternative flat rate offered him. The engineer talks maximum demand for half an hour, leaving the prospective consumer somewhat dazed, and too frequently with the idea, carefully fostered by the gas company, that this is an elaborate system for doing him. He is then told that if he wishes he can take the alternative flat rate, but, although he understands this, the engineer's maximum demand diatribes have left him with a lurking idea that he may on that system get his current a halfpenny a unit cheaper. The result is

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doubt and perplexity, which frequently drives him to—gas, as being a thing he understands, and one that does not offer two systems of charging and a large element of uncertainty as to their comparative results. But supposing, however, he perseveres, and, despite its intricacies, decides on the maximum demand system, with its problematic halfpenny in the background, or the flat rate with its known quantity, but perhaps higher cost—the next blow he gets is that the meter rent is 2s. or 2s. 6d. per quarter, against possibly 6d. with the gas company. Say he survives this, he is now called upon to fill up a more or less legally-worded and formidable application form, in some cases binding himself to pains and penalties that he has not the slightest idea how to avoid. To the educated man the usual application form is not a thing of terror, but it must be remembered that all consumers are not educated men, and that many of the small shopkeeper class—who, by the way, are often excellent consumers—would be deterred from taking the light by the necessity of putting their names to a document beginning with "Whereas" and ending "Dated this —— day of ——."

It is difficult for an educated man to lower himself to this level of intelligence, but it is no exaggeration to say that cases such as the above do happen, and any engineer who has had personal dealings with prospective consumers in a provincial town must have met with them. Obviously this is not the way to secure every bit of custom that is to be had. The function of an electricity undertaking is to sell current, and to do this thoroughly it is necessary, especially in the provinces, to start with the assumption that the public generally is not endowed with either brains or time to solve intricate electrical or economic problems, and does not wish for a sword of Damocles over its head in the shape of a wordy agreement adorned with a sixpenny stamp reposing in the coffers of the supply authority. It may be truly argued that without such an agreement risks out of proportion with those of the gas company are incurred; but risks have to be run at times, and years of experience in gas supply do not afford any great instance of disaster in this direction.

Decidedly some sort of application and agreement form is necessary, owing to the great expense of service laying, but beyond the necessary data of the installation it should be as concise as possible, and so worded as to be within the comprehension of the meanest intellect, instead of, as is too frequently the case, a field for some small legal light to display his knowledge of the law's technicalities. A clause that is frequently seen in agreements, and one that has done as much harm to the popularity of the light as anything, is the minimum charge. It was, of course, based upon sound commercial principles when incorporated in the Electric Lighting Acts, but in these days of strenuous competition there must be grave doubts whether its use is advisable. It pays a gas company, on the whole, to put in a service for a couple of lights, and they do not penalise a consumer with a minimum charge for shutting up his house for a quarter. In a like manner it must pay an electric lighting concern, although, perhaps, in a lesser degree. What we have to look to is the moral effect of this sort of thing, not the present monetary return. A progressive policy that neglects minimum charges and such like petty annoyances is one that pushes the light into all sorts of unexpected quarters, thus advertising it and loading up mains that do not bring in a satisfactory return on their capital outlay. Fining a consumer to the tune of 20 units at, say, 7d., because he has had the audacity to suit his own convenience and make small or no use of the light, is a proceeding that interferes too much with the liberty of the subject to produce good results in this country. Legally it may be right, but economically it is a mistake—a mistake that appears to be owing to the electrical engineer, or those above him, being in too much of a hurry to make money at once, and entirely neglecting the future, in accordance with what seems to be the policy of the present day.

Chaos is surely exemplified by the various systems of charging now in use. It is not the desire of the writer to awake the wrath of the maximum demand, sliding scale, or flat-rate advocates, besides which any attempt at discussing the various merits of these systems is perfectly useless and beside the mark. But is there any excuse for the extraordinary combinations that a glance down the columns of a central-station list will reveal? One town favours the flat rate, another the maximum demand, and so on. That is all very right and simple, merely a difference of opinion, but how is it possible to combine the two, offering one as an alternative to the other? Maximum demand literature strives to convince the reader that the only possible system is the maximum demand, and in like manner flat-rate advocates strenuously uphold their opinions. What, then, are the ideas of the engineers or corporate bodies using both systems. On the face of it, it appears that they cannot thoroughly believe in either. The concurrent use of the maximum demand system does not hurt the flat rate, but the latter is surely both theoretically and practically fatal to the results sought after by the use of the former. This sort of thing is not reassuring to the consumer; he is apt to think that he is being done on the system he uses, and in the average case, where the results of the two systems are fairly equal, there is a very general tendency to chop and change about, on the strength of the old adage, "there is always better grass on the other side of the fence." This feeling of indecision is liable to have bad results where the gas company's tariff is simple and straightforward, and, it must be borne in mind, places a very powerful tool in the adversary's sometimes not too crupulous hands.

The cost and inconvenience of wiring is perhaps one of the greatest deterrents to the popularity of electric light. Free wiring very successfully combats the former point where a good system is in vogue, and seems about the only answer to the problem. There can be no doubt that in most cases wiring prices are cut to the very smallest limit of profit, which is unfortunately only too frequently a source of bad work and consequently moral harm to the light. On any of the present systems we cannot hope to compete with the gasfitter in price, but there is one thing that we can and should do, and that is try and conduct wiring operations with a little more regard to the comfort of the householder and the well-being of his property. There are, of course, many good firms and individual wiremen who make this point a special feature, but there are also very many who do not, with the result that one of the commonest objections to installing electric light is the havoc made by wiremen.

Who has not seen cases of molten solder dropped on carpets, furniture ruined by being used as scaffolding, and unsightly holes left in walls and ceilings, because, forsooth, "it is a plasterer's job to repair them"? Now, the wireman is by trade essentially a handy man; he is able to leave the house in as good order as when he entered it, and when he is a sensible man, and not overburdened with absurd socialistic and trades union doctrines, he recognises that the more satisfaction he gives to his employers, the better in the long run for himself and the trade in general. But there is a class, recruited usually from the sweepings of other trades—and, by the way, not at all loved by the genuine wireman—the presence of one of whose members on a job is harmful in the extreme to the prestige of electricity generally and wiring firms in particular.

Cheapness cannot be put forward as an excuse for employing this type of man. Generally he is the one that is most insistent upon being paid the full union rates for skilled work. Respectable wiremen who have an appreciation of *meum* and *teum* are to be had in hundreds; why, then, do those men find employment who are not only often bad workmen, but perfectly unscrupulous? It is obvious that the wiring contractor should be most particular about the men he employs. As a body he has a bad name; that is indisputable, and the chief cause for this lies in some of the men who work for him. If the contractor is more careful in his selection, the results will be better work at possibly less cost, greater satisfaction to his customers, and increased trade. In the present state of affairs a firm with a reputation for employing civil, clean, and careful men has a future in front of it far beyond the gloomy expectations that are usually entertained of the outlook of the wiring trade.

Returning to the central-station engineer's side of the

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question, there are one or two points in general management that have an important bearing on success. Canvassing obviously suggests itself first as a means for obtaining consumers, and the usual proceeding appears to be to obtain a *soi disant* canvasser, pitch him out into the streets of a town he knows nothing of for so many hours a day, and trust to the man himself and a good dose of luck for results. This is usual, but far too casual. In an article in the *Electrical Engineer*, vol. xxi., No. 16, the writer gave his opinion on this subject, based upon a fair amount of experience, and he would reiterate the point that bad canvassing, and a system which depends entirely upon the canvasser himself, instead of providing for the proper supervision of his work, invariably does more harm than good. As a calling it is looked down upon, and yet there is no getting away from the fact that the successful canvasser must be endowed with an unusual amount of tact and determination that is worthy of a larger scope, and such a man properly supervised will bring in good results if they are to be had. It is a most important, almost vital part of pioneer electricity supply, and as such should be conducted in a manner that tends to render everything easy for the prospective consumer, and in a way that does not jar upon him.

A petty annoyance that is often complained of is the too frequent calling of inspectors, sometimes at inconvenient hours. The men themselves are generally to blame for this; calling on consumers with the vague excuse of having to look at the meter, while scarcely profitable to the inspector's employers, is a very congenial way of spending an odd hour or two, affording him as it does the company of the female denizens of the lower regions and a possible glass of beer. This is only one of the many small points that have a bearing upon general results, but such details, insignificant as they may seem, all add up, and we have reached that stage in competition where even the smallest point must not be despised.

LIVERPOOL ENGINEERING SOCIETY.

President's Inaugural Address.

The above association held the first meeting of their thirtieth session on the evening of the 4th inst. The minutes of the last meeting of the previous session having been duly read and confirmed, the secretary, Mr. R. C. F. Annett, produced a list of new members, the length of which gave abundant testimony as to the vitality of the association. The retiring president, Mr. Ernest S. Wilcox, M.I.C.E., then introduced to the meeting Mr. T. L. Miller, M.I.C.E., M.I.Mech.E., M.I.E.E., the president-elect, who thereupon took the chair and delivered his inaugural address.

The main question discussed in the president's address is the cost of the production of power, and probably no more interesting subject could have been chosen at a time when the cheap supply of power is a matter of vital importance to the industrial welfare of the country. The address is of considerable length, but in this article we propose to briefly outline the chief points touched on by the author. He first considers the sources of energy on which we may draw for mechanical power. They are tidal and wave energy, wind, water, and fuel. As regards water power, the author says that under favourable conditions it is unrivalled as a cheap source of energy, and he supplies figures which show this to be the case. For instance, in Columbus, Georgia; Columbia, South Carolina; and Anderson, South Carolina, electrical energy for power purposes from water power stations is sold to consumers requiring 1,000 h.p. and over at £3. 2s. 6d. per horse-power year delivered on the secondaries of the transformers, the transformers being furnished by the power company. This energy can be used under contract for 66 hours per week, or 3,432 hours per year. Assuming that full advantage could be taken of the supply of energy available, or, in other words, that the load factor is 100 per cent., the cost of energy works out at ·218d. per unit, which is an extremely low figure. He also shows that the capital cost of a water-power plant is low, instancing the case of the chlorate works at Vallarbe, where the capital expenditure upon the development of 3,000 h.p. amounted to but £3·89 per horse-power. The highest capital expenditure appears to have been at Lyons, where it amounted to £84 per horse-power developed, but the conditions in this case were exceptional. In dealing with fuel, the author reviews the progress that has been made in the direction of the economical production of power from fuel, and largely quotes from other papers in order to show the economical results that have been obtained at different times from coal and other fuel. He then turns his attention to turbines. Dealing with the De Laval turbine, he states that this engine has a very high rotative speed, which in the smaller sizes is as high as 30,000 revolutions per minute, and in the larger sizes about 10,000 revolutions per minute, the peripheral speed usually adopted varying from 600ft. to 1,200ft. per second. He describes the Parsons turbine, which is the one most extensively used at the present time in this country, and also the Curtis turbine. Although at first sight it would appear that little gain in economy would result from the use of superheated steam, the results of careful tests show a decided gain. Thus, Prof Thurston, experimenting with a De Laval turbine, obtained an increased economy of 1 per cent. for every 30deg. F. of superheat, which he attributed almost entirely to the reduction in skin friction. From a table of figures which is given of steam consumptions with different makes of turbines, it seems that a 600-kw. Curtis turbine when using steam superheated 150deg. F. has a steam consumption of 16·75lb. per kilowatt-hour. The table further shows that a 1,442-kw. Parsons turbine consumes 18·0lb. per kilowatt-hour with steam superheated 27deg. F.

The next section of the address deals with internal-combustion engines, special reference being made to the Diesel engine. The fuel used in this engine is crude petroleum, having a specific gravity of 0·922 and a calorific value of about 19,150 British thermal units per pound. There is, however, no reason why gas or coal dust should not be used. From the average of a number of tests the consumption of oil appears to vary from ·45lb. to ·5lb. per brake horse-power hour. The thermal efficiency of this engine is high, being 36·3 per cent. for the 35 b.h.p. size, 39·9 per cent. for the 80 b.h.p. size, and 40 per cent. for the 160 b.h.p. size; the efficiency in all cases being calculated on the net indicated horse-power. The cost of production of power from fuel is next considered, and the author quotes a considerable amount of data on this point. In a number of cases cited, Mr. H. A. Foster has found the average working cost per horse-power hour, taking an average of 3,080 working hours per annum, to be about ·412d. Mr. C. D. Gray, another authority, has found the cost of steam power to vary as follows: standing charges from ·045d. to ·37d. per horse-power hour, running charges from ·115d. to 1·22d.—total costs from ·155d. to 1·45; average costs, ·475d. per horse-power hour. In another case, that of an engineering works with a mean indicated horse-power of 773, the costs for a week's test of 139½ hours and an output of 60,403 Board of Trade units worked out at a total of ·399d. per unit. At Messrs. Cadbury's works at Birmingham the cost with a 500-h.p. five-ton Mond producer (without recovery plant) and two 150 kw. gas-driven generators for one week, worked out at ·344d. per unit. In yet another instance quoted—to wit, Mr. H. A. Humphrey's estimate of the costs to be obtained from a 20,000-e.h.p. gas plant, with sulphate of ammonia recovery and with a load factor of 33⅓ per cent.—the figure is ·217d.

In concluding the address, the author says that at the present time both the steam-turbine and the gas-engine are coming prominently into favour, and great developments in their application may be expected during the next few years. As regards the future, he believes much will be done in the way of utilising the heat now going to waste in many of our manufacturing processes, and as a striking illustration of the possibilities in this direction he instances the utilisation of the waste gases from blast furnaces, where, taking the figures given by the late Mr. Bryan Donkin for the world's output of iron from blast furnaces in 1899 as 40,000,000 tons, and assuming a yearly consumption of one ton of coke per ton of pig iron, with a

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production of 170,000 cubic feet of gas, the total indicated horse-power available from this source alone would be 6,400,000.

A hearty vote of thanks was accorded the president for his able address.

In his reply, Mr. Miller referred to the forthcoming joint meeting which has been arranged with the Manchester Section of the Institution of Electrical Engineers, as marking a notable development in the history of their society. The next meeting will be held on Nov. 18, when Mr. J. B. C. Kershaw, F.I.C., will read a paper, entitled "Fuel Economy from the Chemical Point of View."

INSTITUTION OF ELECTRICAL ENGINEERS.

Inaugural Address.

BY ROBERT KAYE GRAY, PRESIDENT.

Gentlemen,—Another session has opened, and another president addresses you, the twenty-eighth person who has had this privilege. On this occasion one of our usual forms of procedure must be dispensed with, or I should have to fill the *rôle* of vacating the chair in my own favour. You will remember that Mr. Swinburne, who gave us an extremely interesting and valuable address a year ago, resigned the presidentship two months before his term was completed. This he did in order to permit a telegraph man to be at the head of the Institution during the recent International Conference in London, to which telegraph delegates from foreign Governments were invited. For obvious reasons I cannot criticise Mr. Swinburne's action in this matter, but I feel at full liberty to say that the manner in which he carried out what he thought to be the best interests of the Institution was accomplished with great consideration, and for this, so far as it affected me personally, I tender him my sincerest thanks.

You, gentlemen, have placed me in the honourable position which I now fill, but the honour which you have conferred is one that carries with it a responsibility which might better have been confided to other hands. The Institution is ever growing, and shows the life that dwells in every healthy hardy plant which from a seedling becomes a well-grown tree. Not one of the founders of the Institution in 1871 could have foreseen the developments of a third of a century later. The guidance of your former presidents and councils have been wise, and it is for us to follow in their footsteps with the same open minds which have led to the consolidation of many diverging interests into one complete whole. We are under a debt of gratitude to the Institution of Civil Engineers for many advantages they have conferred on us, and not the least is the cordial hospitality they give us in their magnificent building. Your successive councils have continually had brought to their notice the desirability of our Institution possessing a permanent habitation, and it is believed this feeling is general among the members. I take this opportunity of stating that in deference to this view a site has been acquired, which, in the opinion of the Council's technical advisers, will amply suffice for the erection of an Institution building in which a suitable lecture theatre and other necessary offices could find place. Your Council has no intention of proceeding with the construction of the Institution building until they believe the Institution to be strong enough financially to meet the necessary expenditure while remaining in possession of a handsome surplus. It is also thought that developments in the near future may permit of an alliance with kindred institutions for the erection of one large temple of engineering, where the various branches may find their homes. A portion of this building could be allotted to the joint occupation of the various sections of engineering, and each section could in addition possess the accommodation it might require for its own particular work; a senate or court of governors appointed by the sections being constituted the supreme body. I understand that the late Sir William Siemens had such a conception, and perhaps its realisation may now be within the range of practical politics. In the event of such a scheme maturing, the property in Tothill-street, which the Institution has acquired, can be sold, as it will always be a realisable asset so long as no special building is erected on it. A temple of engineering costing a quarter of a million would be a fit home for the engineering bodies of this country.

Many opinions have been advanced as to the scope and aim of an institution such as ours: as to what it should do and what it should not do, and as to its relations with kindred societies. This, of course, is contentious matter, and should not probably be touched in an address, but I take advantage of the immunity from criticism in this room which my position to-day grants me, and will make a few remarks on the subject. In early days the Institution was the only association or body which could voice the views of electrical men, and therefore everything touching their interests was fit matter for discussion. To-day the necessity is not so imperative, as, owing to the great development of the electrical industry, other bodies are springing up who can more properly deal with a variety of questions which affect, but only indirectly affect the Institution as an Institution of Electrical Engineers. As time goes on this necessity will become less and less, and the Institution will fall back into its proper function as an Institution of Electrical Engineers, and will not fill the part of an Association of Electrical Engineers, which it has often been obliged to do in the past. The word "institution" in this connection bears in my mind the meaning of a body for dealing with technical interests, while "association" implies a corporation whose functions are related to everything affecting general interests. I hope that the Institution, for some time yet, will continue to take an interest in things general as well as technical, and conserving the open mind and progressive spirit, to which I referred in my preceding remarks, will assist in every reasonable way the aspirations of the different electrical associations which are being formed from day to day. These associations must not be looked upon as rival or interfering bodies, but rather as bodies formed to meet a real want, and from that point of view deserving every assistance and encouragement from the older body. There is one more point in this connection which from time to time provokes comment and criticism, and that is that many members of this Institution contribute papers to the Institution of Civil Engineers and other bodies which, in the opinion of the critics, should have been presented to this Institution. I do not think this is a fair or a wise criticism. People, readers of papers or others, will always carry their wares to the best market, and the only effective way of dealing with the situation is for the members and officers of this Institution to strive to make our market the best. Those who read papers on electrical subjects in other institutions are in reality doing a great good to the electrical industry and to this Institution, as they play the part of the missionary who goes out into the wilds, spreads the light, and eventually gathers converts into the fold. I, therefore, say that our members who read papers before other institutions or societies are well-doers, and should not be submitted to the unfair criticism which emanates from a spirit akin to some of the elements of trade unionism, and is much to be deprecated. While admitting the desirability of the existence of these electrical missionaries, I also urge that the members and officers of the Institution should leave no stone unturned in their search for what is good and useful to the Institution. Our predecessors have done this, and the task of the present Council and members should be much easier than the task which their forerunners have performed. What they accomplished is made clear by a reference to our membership. An institution, which in 1871 numbered 80 persons, and to-day numbers 4,800, has every reason to be proud of its development and growth. It is my belief that the Institution will continue to develop, and if it is governed in a tolerant and broad-minded spirit will never cease to be the referee in all cases affecting electrical science and industry.

I now propose to lay before you some matter I have had collected relating to the effect that existing legislation has had on electrical enterprise, and containing a few suggestions for the betterment of the present situation. As the generation and supply of electricity for lighting, power, or traction are strictly regulated by Act of Parliament, it is obvious that electrical progress must be seriously affected for good or for evil by the state of the law relating

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to electricity. It is impossible to attempt here to cover the whole field of electrical legislation, but attention may be directed to one or two special points. If we omit the Electric Lighting (Clauses) Act of 1899, which merely codifies the provisions usually incorporated in a provisional order granted by the Board of Trade, we find that there has been no public legislation upon the generation and distribution of electricity since 1888, when an Act was passed to amend certain defects in the original Act of 1882. This absence of legislation during a period in which the applications of electricity to the service of mankind have been enormously improved and extended, would not be remarkable if the original Acts had been adequate not only to the needs of the time at which they were passed, but to those of the present day; but, as everyone knows, this is far from being the case. Those statutes were framed to meet the case of distribution of electricity over a small area, and no provision was made for the time, which has long since arrived, when it would be possible and even economical to distribute from a given centre over a wide area, extending far beyond the boundaries of any particular parish or municipality. There might still have been a chance that the parochial idea embodied in these early statutes would in the course of time have been abandoned, had not Parliament fixed this idea as a permanent feature of British electrical distribution by giving to the local authorities the right of purchase of the undertakings supplying their areas after a period which was first stated at 21 years, but afterwards extended by the Act of 1888 to 42 years. In addition to this, the Act of 1888, although intended to promote the introduction of electric lighting, went far towards stifling private enterprise in this direction, by giving to the local authorities a veto on any petition to supply electricity within their areas. Thus it has come to pass that in spite of the great progress made since 1888 in the science of distribution, no one but a local authority can to-day obtain free unimpeded access to the Board of Trade with a petition for a provisional order, and as local authorities are as jealous of one another as they are of private companies, the general result is that the municipal area is still the unit area for distribution.

There are, of course, many other prominent defects in the Electric Lighting Acts. They do not, for example, provide for the compulsory purchase and sale of sites for generating stations, nor yet for the erection of these stations outside the area of supply. If promoters of an undertaking desire either of these things they must proceed by special Act, not by provisional order; and the best proof of the inadequacy of the Electric Lighting Acts to modern needs is that these private Acts usually contain special clauses of which the object is to render inapplicable a larger or smaller number of the sections of the controlling public statutes. The whole subject was considered in 1898 by Lord Cross's Committee, which made many recommendations of the highest value—among them, the abolition of the veto and the removal of the defects just noticed—but until the present year the Government has shown no sign of being desirous or willing to give these recommendations the force of law. The Institution of Electrical Engineers, which has always been alive to the serious consequences of this defective legislation, sought in June of last year to bring pressure upon the Government by sending a deputation to the President of the Board of Trade. It is impossible to express more forcibly or more clearly the objections to the present law than was done by the members of our deputation on that occasion; but although we were then promised a measure to remove these objections, nothing was attempted until May of this year, when a Bill, embodying most of the recommendations of the Lord Cross's Committee, was introduced in the House of Lords by Lord Wolverton at the instance of the Board of Trade. But the Bill did not get beyond the introductory stage, and at the close of the session no progress had been made. The measure, however, must not be allowed to drop; and as the President of the Board of Trade has told us that his department desired to "press forward" this measure when opportunity offered, we may express the hope that next session it may not only be introduced, but may be placed upon the statute-book.

With regard to the distribution of electricity for power purposes, the Electric Lighting Acts make no special provision. Any consumer may use his supply either for lighting or power, or both. But in recent years the idea of promoting large power schemes to supply very wide areas has come prominently to the front, and since 1900 several such schemes have been authorised by special Acts of Parliament. The powers of supply conferred upon companies under these Acts are twofold: they may supply energy for power purposes to any person, and they may supply energy in bulk to authorised distributors. In this connection it may be noted that if the Bill introduced by Lord Wolverton becomes law, it will be possible to obtain powers for supply in bulk to authorised distributors by provisional order, instead of proceeding, as at present, by special Act. The most important point, however, about these modern power schemes is that in many cases the promoters come into sharp conflict with local authorities and other authorised distributors supplying urban or rural districts within the large area which they desire to cover by their scheme. The local authorities are especially antagonistic to any proposal which would allow another body to come into their area to supply electricity, and in some cases Parliament has cut out from the area which a particular scheme desires to cover various towns and districts possessing their own electricity supply undertakings. Now, it seems desirable that the local authorities should consider carefully the advantages of taking their supply in bulk from a power scheme, instead of generating for themselves on a small scale. In very many cases it would be much more economical to do so, and they would still be left the sole distributors in their own areas. But if local authorities will not do this, Parliament must consider what is best for the country at large; and as the rural districts must obviously gain by the supply of electrical energy at cheap rates, the towns should not be allowed to prevent this gain by obstructing or rendering ineffective the scheme for the larger area. The point is that if all the towns, which constitute the "fat" districts, are cut out of these schemes, leaving only the "lean" rural districts for the large-area companies, there can be little or no hope of financial success. In order to obtain, therefore, the greatest good for the greatest number, the larger authority ought to be allowed, wherever possible, to prevail over the smaller municipalities opposing it, especially when we consider that this does not entail an injustice to these municipalities, but only a slight narrowing of the field of municipal enterprise.

(To be continued.)

LONDON TRAFFIC ENQUIRY.

The Royal Commission on London Locomotion on Friday last resumed the taking of evidence at the Westminster Palace Hotel, under the chairmanship of Sir David Barbour. This was the first sitting of the Commission after the visit paid to America.

Mr. William Edward Riley, architect of the London County Council and superintendent architect of metropolitan buildings, pointed out various defects of the existing systems of transport. The adoption, he said, of any ideal system in London was hampered by the existence of the Metropolitan and Metropolitan District Railways. He suggested that an ideal scheme would be one giving circumferential lines at various distances apart, and crossing these diametrically by other lines running across the county and joining the circumferential lines with the centre point. The existing and authorised electrical systems, of which only the North-West London and City and Brixton Railway were not now in course of construction, were made up of a series of irregular lines, which, as at present arranged, did not constitute a unified system. In order to further improve the system, broad avenues converging towards the central areas of the county were suggested, which would materially increase locomotion facilities. These avenues would provide for underground as well as for surface locomotion. The underground systems of all the diametrical lines, both tube and shallow underground, might be looped at the outer ends as in the Paris systems, in order not to obstruct possible future extension. The great railway systems brought in masses of persons from the other zones, and poured them into the streets surrounding their terminal stations, by which from necessarily crowded thoroughfares they had to find their way to the various centres. As these points could not, except in a few cases, be contiguous to the railway termini, it followed that these should be so connected with one another that passengers might rapidly reach any centre of these areas. In some cases shallow subways or tramways might be adopted. Witness proceeded to give at some length various suggestions for linking up the various railways, and, amongst other

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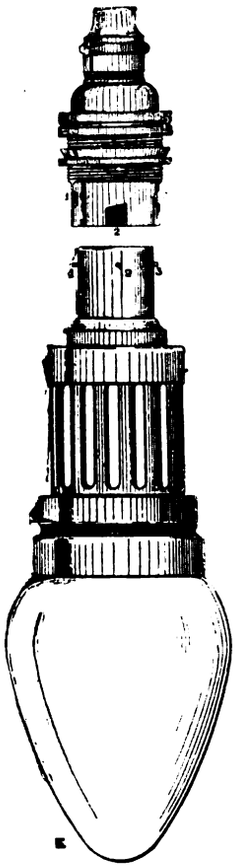
things, pointed out the convenience it would be to extend the Great Northern and Strand tube from the Strand under the river to Waterloo Station, thus forming an approximately north and south line. Another line which was needed in order to provide rapid communication between centre points was one from Piccadilly-circus to Charing Cross, the Law Courts, Ludgate-circus, and the City. Continuing, witness expressed the opinion that tramways should, where practicable, approach nearer to the centres of traffic north of the river than at present, and pointed out that the dangerous termini at Westminster Bridge and Blackfriars Bridge would be abolished by continuing the tramways over these bridges and along the Embankment. The witness also gave particulars of new tube railways which, in his opinion, were required to meet the growing requirements of London.

The Commission adjourned.

TRADE NOTICES AND NOVELTIES.

The Nernst Lamp.

The reason why a few electrical contractors do not get on well with the Nernst lamp while others obtain good results is often due to incorrect treatment of the lamps or their parts. The Electrical Company, Limited, of 121-125, Charing Cross-road, London, W.C., who are the patentees of Nernst lamps for



the United Kingdom, have carefully investigated a large number of such cases, and have found that the following two mistakes are very common: (1) The voltage of the lamp is not matched properly; the burner voltage, plus the resistance voltage, should be approximately equal to the *maximum* (not nominal) voltage of the circuit. (2) With direct-current lamps, especially the B type, the polarity is not observed when the lamp is fitted into the holder; and, what is even worse, the lamp is very often taken out of its holder and put back the wrong way, thus causing the polarity to be reversed and the filament to break very soon. To prevent this the Electrical Company supplies B-type Nernst lamps which have a third bayonet pin in the socket. If the holder is altered, by simply punching a third slot (as shown in the illustration) it will be impossible to put the lamp back into the holder in the wrong way. The polarity when once tested cannot therefore be reversed. With screw holders the reversing of the polarity is impossible *per se*, and it would be a great advantage, therefore, if on large installations screw holders were used. B-type lamps with screw caps can always be supplied by the Electrical Company.

The Locke Steel Chain.

On Wednesday last we had an opportunity of witnessing, at the works of this company at South Tottenham, their steel chain-making machinery. These machines automatically turn out steel chains by stamping the individual links out of steel sheet. The sheet is first cut up into strips, the width of which varies according to the size of the sprocket chain required. These strips are then fed into the chain-making machine, which in five operations completes each link. The metal which is punched out of the centre of the link is bent round to form the cylindrical bearing surfaces at either end. The chain when completed is passed into a gas furnace which heats it up for the hardening process, and after being plunged into water, it is tempered in an oil bath. The process is quite automatic and the chain produced is remarkably strong. Some tests carried out at the works on Wednesday last showed that these tempered steel sprocket chains were considerably stronger than the ordinary malleable cast-iron chains now generally used. We understand that practical trials with agricultural machinery under severe conditions have proved these chains to be superior to the malleable cast-iron type, and that they are especially serviceable where sudden shocks are likely to be transmitted. As regards the speed of manufacture, the machines we saw were able to turn out 200ft. of 1¼in. chain per hour. The company, which has its offices at 18, Bishopsgate-street, E.C., has standardised a number of different machines for the manufacture of special types of chains.

Lightning Arresters.

The British Westinghouse Electric and Manufacturing Company, Limited, have just issued a new circular, No. 1,045, on the protection of electrical circuits from the shocks due to lightning or other static discharges. The subject is treated in a simple but technical manner, and is illustrated by excellent photographs and diagrams. The various types of arresters, choke coils, etc., made by the British Westinghouse Company for high and low tension, alternating or direct current circuits, are described, and a large amount of valuable information, besides practical instructions for installation, is included. The great importance of adequate protection for electrical transmission lines is becoming widely recognised, and Westinghouse engineers were so early in the field that they have had valuable experience in this work. The standard accessories to these grips over which the lightning jumps, are many and interesting. They include choking coils, and their equivalent static interrupters for very high-voltage circuits. The static interrupter consists of a choking coil in series with the line, and a condenser connected between the coil and earth on the side furthest from the line. The arresters themselves listed are of the Wurts type.

Pamphlets, Catalogues, Etc.

ELECTRICITY AT HOME. J. Sunderland and Co., electrical engineers and contractors, 183, Gibbet-street, Halifax. — A well-illustrated booklet illustrative of a few of the very many private residences the firm have equipped with electric light and heating appliances.

B.T.-H. TYPE D-A CONTINUOUS-CURRENT GENERATORS (Pamphlet No. 159). The British Thomson-Houston Company, Limited.—Fully describes the apparatus.

WINN'S ENGINE AND BOILER FITTINGS (Section D, third edition). Charles Winn and Co., St. Thomas Works, Granville-street, Birmingham.—A new list, well printed and well illustrated. The firm's specialities are the reliable automatic water-gauges and glass protectors, boiler mountings and engine fittings, screwing machines for tubes or bolts, metallic packings.

RADIATORS, NERNST ELECTRIC LAMPS, AND OMEGA GUARANTEE FLEXIBLE CORDS (Nos. 1,046, S 1,045, and W 1,043). General Electric Company, Limited, 71, Queen Victoria-street, E.C.—Appendices to general catalogue.

ELECTRICAL FITTINGS (ILLUSTRATED), The Electrical Fittings Company, 38, Conduit-street, W.—Shows a number of charming brackets and electroliers of artistic design. The firm has lately laid down special plant for the manufacture of them at a price which will bring them within the reach of all classes.

PURE WATER for all steam-raising industrial and manufacturing purposes, waterworks for cities, towns, and villages, electric lighting and power plants, bleachers, dyers, laundries, paper mills, chemical works, sugar refineries, etc., obtained by the "Paterson" gravity and pressure filters, water-softening apparatus, effluent purifiers, greasy condensation water purifiers, combined feed-water heater and purifier, etc., as constructed by the Paterson Engineering Company, Limited, 77, Queen-street, Glasgow. When describing the metropolitan borough of Poplar electric works we referred to the good work being done by this grease filter, and we are informed that the firm have recently supplied boiler-feed purifiers to the following electric lighting and power generating stations: Blackpool, Ealing, Barrow-in-Furness, Maidstone, Ipswich, Portsmouth, Poplar (repeat order), Watford, St. Pancras Borough Council, Derbyshire and Notts Electric Power Syndicate. Messrs. Davey, Paxman, and Co., Limited, Western Electric Company, Sir Hiram Maxim Electrical and Engineering Company, Messrs. Babcock and Wilcox, Limited, Messrs. Dick, Kerr, and Co., have, amongst others, favoured the firm with their orders. They are about to open an office in London to better attend to matters in the South of England.

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YORK ELECTRICITY UNDERTAKING.

Mr. C. A. Midgley, the city electrical engineer of York, has sent us a copy of the financial statement of the above undertaking for the year ended March 31 last. He reminds us that in the revenue account there is an amount of £661 abnormal expenditure on extensions to buildings, which has, of course, made a considerable difference in the returns. In the following statement the first set of figures is for the year under review, while those in brackets represent the figures for the 1902 year: Units generated, 774,401 (517,055); total units sold, 652,000 (243,000); units sold to consumers, 545,285 (339,354); units sold for public lighting, 106,715 (83.645); units used on works, 28,360 (27,876); units sold per mean 8-c.p. lamp capacity, 17·3 (19·9); actual maximum supply demanded, 550 kw. (410 kw.); load factor, 14·15 per cent. (11·88 per cent.); number of public lamps, 66 (66); number of consumers, 386 (270); connections to mains in 8-c.p. lamps at end of year, 43,167 (32,766); capacity of plant at end of year, 720 kw. (720 kw.).

Capital.—Total authorised, £101,850 (£40,000); total received, £69,428 (£55,832); total authorised not received, £32,422 (nil); total expended, £69,428 (£55,832); lands and buildings, £9,205 (£8,053); plant, etc., £24,493 (£19,654); mains, etc., £32,467 (£25,272); miscellaneous, including meters, £3,263 (£2,853).

Revenue.—Total, £7 372. 17s. 2d. (£6,047. 17s. 5d.); from supply, etc., £6,100. 7s. 7d. (£5,093. 4s. 6d.); from motors, etc.. £110. 16s. 9d. (£12. 0s. 9d.); from public lighting, £1,160. 7s. 1d. (£941. 1s. 9d.); from miscellaneous, £1. 5s. 9d. (£1. 10s. 5d.).

Expenditure out of Revenue.—Total costs, £5,152. 0s. 4d. (£3,456. 1s 7d.; total works cost, £3,135. 15s. 1d. (£2,095. 11s. 10d.). Generation of electricity—fuel, etc., £1,452. 11s. 4d. (£1,237. 18s. 5d.); oil, waste, engine-room stores, etc., £212. 1s. 5d. (£241. 0s. 6d.); wages at station, £611. 5s. 8d. (£481. 13s 5d.); repairs, etc., at station, £761. 8s. 4d. (£89. 11s. 2d.). Distribution of electricity—wages, etc., £26. 5s. 7d. (£17. 8s. 4d.); repairs, renewals of mains, etc., £72. 2s. 9d. (£28). Public lighting—attendance, £259. 9s. 2d. (£247. 19s. 8d.); renewals, £178. 6s. 10d. (£95. 16s.). Management and property charges—rent, rates, and taxes, £426. 8s. 10d. (£202. 12s. 2d.); salaries, £793. 18s. 8d. (£622. 9s. 8d.); stationery, etc., £51. 18s. 11d. (£84. 14s. 10d.); establishment charges, £277. 19s. (£68. 14s. 6d.); law charges, etc., nil (£2. 2s.); insurance, £47. 13s. 10d. (£36. 0s. 11d.).

Financial Results.—Working profit for year, £2,220. 16s. 10d. (£2,591. 15s. 10d.); sum carried to reserve fund. nil (£349. 15s. 8d.); net profit for year, nil (£349. 15s. 8d.); balance from last account, £448. 11s. 5d. (£98. 15s. 9d.); deficit, £799. 17s. 5d. (—); percentage of total costs to revenue, 69·8 per cent. (57·2 per cent.); price charged for lighting per unit, 7d. and 1½d. demand, 4½d. to 3d. flat rate (7d. and 1½d. demand, 4½d. to 3d. flat); power, 1½d. to 1d. (1½d. to 1d.); receipts per unit for private supply, 2·69d. (3·62d.); public lighting, 2·61d. (2·70d.).

FARNWORTH ELECTRIC LIGHTING AND TRAMWAYS UNDERTAKING.

Mr. J. D. Pember, the engineer and manager of the electricity and tramways department of the Farnworth Urban District Council, has sent us particulars of the electricity and tramways accounts for the quarter ending Sept. 30 last. Following are the principal items in the electricity revenue account: Units supplied: private lighting, 8,166; power, 49,829; street lamps, 7,475; tramways, car propulsion, 78,137; tramways, shed lights, 1,417—total, 145,024. Units generated: private consumers, 57,995; street lamps, 7,475; tramways, 79,554; works lights, motors, testing meters, etc., 5,959; loss in accumulators, excitation of dynamos, 381—total, 151,364. Receipts: private consumers—lighting, £168 16s. 11d.; motors, £292 18s. 9d.; street lamps, £180; motor hire, £53. 1s. 11d; tramways, £331. 9s. 6d.; sundry receipts, £3. 1s. 9d.—total, £1,029. 8s. 10d. Expenditure: coal £184. 14s. 9d. (·30d. per unit); oil, waste, etc., £32. 10s. 3d. (·06d.); generation account (wages and materials), £83. 0s. 9d. (·14d.); repairs account (ditto), £61. 0s. 4d. (·10d.); street lamps account (ditto), £32. 11s. 3d. (·06d.); distribution account (ditto), £22. 11s. 3d. (·04d.); rents, rates, taxes, £55. 16s. 8d. (·09d.); management, £69. 15s. 8d. (·11d.)—total, £542. 0s. 11d. (·90d.); interest and sinking fund, £350—grand total, £892. 0s. 11d. Total receipts, £1,029. 8s. 10d.; total expenditure, £892. 0s 11d.; profit, £137. 7s. 11d.

The following applications for current were made: motors h.p., 10; equivalent in 8-c.p. lamps, 266; lamps, 8-c.p., 34. The following were connected during quarter: motors h.p., 88; connected previously, 294½—total, 382½; equivalent in 8-c.p. lamps, 2,345; connected previously, 7,837—total 10,182; 8-c.p. lamps, 349; connected previously, 6,309—total, 6,658; radiators, 99. The total number of 8-c.p. lamps connected to date is 16,939.

Following are particulars of the tramway revenue account: car miles run, 60,296½; receipts, £1,953. 3s. 9d.; receipts per car mile, 7·7d.; total number of passengers carried, 401,240; average receipts per passenger, 1·14d.; units for propulsion of cars, 78,137 = 1·28 per car mile. Expenditure: repairs and maintenance, £170. 1s.; less receipts for scrap brass, etc., £15. 15s. 7d. = £154. 5s. 5d. or ·61d. per car mile. Traffic expenses: current, £331. 9s. 6d. = 1·32d. per car mile; wages and materials. £590. 16s. 8d.; less receipts advertising, £35. 16s. 8d = £550. or 2 21d. per car mile; cleaning and overhauling, £180. 3s. 1d. (·72d. per car mile); rents, rates, taxes, etc., £57. 1s. (·22d.); insurance and general establishment, £36. 14s. (·14d.); management, £58. 7s. 5d. (·24d.)—total working expenses, £1,373. 1s. 5d. (5·46d.): estimated interest and sinking fund, £700; rent Kearsley track, £325. Total expenditure, £2,398. 1s. 5d.; total receipts, £1,953. 3s. 9d.; loss, £444. 17s. 8d.

APPOINTMENTS VACANT.

Engine-Room Attendant. Salary 35s., rising to £2 per week. Particulars from the Secretary, South-Western Polytechnic, Manresa-road, Chelsea, S.W.

Advertisement Assistant, London County Council. Applications by 10 a m. on Nov. 16, to County Hall, Spring-gardens, S.W.

Shift Engineer, Tunbridge Wells, £100 per annum.

Mains Superintendent, Bexhill Borough Council. Salary, £2; 21st inst. See advertisement.

Switchboard Attendant, Carlisle Electric Light Station. Salary, 25s. per week. Application by 18th inst.

Borough Electrical Engineer and Manager, Poplar Council. Salary, £400 per annum. See advertisement.

Brassfinishers accustomed to switches, arc lamps, the Manufacturing Electric Company, Limited, 11, Red Lion-street, Clerkenwell. See advertisement.

Assistant Works Manager for lamp factory, Ampere, care of J. W. Vickers, 5, Nicholas-lane, London, E.C. See advertisement.

FORTHCOMING EVENTS

FRIDAY, NOV. 13.

Physical Society.—At 8 p.m., ordinary meeting, Royal College of Science. Papers: "Means for Electrifying the Atmosphere on a Large Scale" and "An Arrangement for Driving Mercury Pumps," by Sir Oliver Lodge.

Electro-Harmonic Society.—At 8 p.m., "Ladies' Night" concert in King's Hall, Holborn Restaurant.

North-East Coast Institution.—At 7.30 p.m., general meeting at Newcastle. Paper: "Technical Education in Germany," by Mr. Max Wurl.

SATURDAY, NOV. 14

Glasgow Scientific Society.—At 7.30 p.m., ordinary meeting. Paper: "Motorcars," by Mr. Alex. Govan.

West Hartlepool Scientific Society.—At 7.30 p.m., ordinary meeting. Paper: "The Absurdities of the Present System of Measures," by Mr. Wm. C. Barrowman.

TUESDAY, NOV. 17.

Royal Statistical Society.—At 5.30 p.m., ordinary meeting. Address by Major P. G. Craigie, C.B., president.

Institution of Civil Engineers.—At 8 p.m., ordinary meeting. Paper to be further discussed: "Tensile Tests of Mild Steel, and the Relation of Elongation to the Size of the Test-Bar," by Prof. W. C. Unwin, F.R.S.

Institution of Electrical Engineers (Manchester Section).—At 7.30 p.m., ordinary meeting. Address by Mr. E. W. Cowan, chairman. followed by demonstration of the properties of radium by Dr. Schuster.

WEDNESDAY, NOV. 18.

Liverpool Engineering Society.—At 8 p.m., ordinary meeting. Paper: "Fuel Economy from the Chemical Point of View," by Mr. J. B. C. Kershaw, F.I.C.

Society of Arts.—At 8 p.m., opening meeting. Address by the Vice-President, Sir Wm. Abney, K.C.B., F.R.S.

Institution of Electrical Engineers (Students' Section).—At 7.30 p m., ordinary meeting.

Royal Meteorological Society.—At 7.30 p.m., at the Institution of Civil Engineers. Papers on "The Great Dustfall of Feb. 21 and 22 1903, and its Origin," by Messrs. H. R. Mill, D.Sc., and R. G. K. Lempfert, M.A.

THURSDAY, NOV. 19.

Institution of Electrical Engineers (Leeds Section).—At 7 30 p.m., ordinary meeting Paper: Destructor and Electricity Stations in Small Towns," by Mr. S. D. Schofield.

FRIDAY, NOV. 20

Junior Institution of Engineers.—Ordinary meeting. Paper: "Fires on Shipboard; their Chief Causes and the Method for Prevention and Extinction," by Mr. George Canning.

Institution of Mechanical Engineers.—At 8 p.m., ordinary meeting. Papers: "Roofing Existing Shops while work is proceeding," by Mr. R. H. Fowler; "Experiments on the Efficiency of Centrifugal Pumps," by Mr. Thomas E. Stanton, D.Sc.

SATURDAY, NOV. 21.

Junior Institution of Engineers.—At 2.30 p.m., visit to Orchard Dock, Blackwall, to witness a demonstration of fire extinguishing, etc., by invitation of the Clayton Company.

Symphony Concerts.—Those of our readers who happen to be of a musical turn of mind will be interested to know that the first of the Queen's Hall symphony concerts, under the direction of Mr. Henry J. Wood, takes place to-morrow (Saturday) afternoon at 3 o'clock. Herr Fritz Kreisler is the solo-violinist.

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THE

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TO CORRESPONDENTS.

All Rights Reserved. Secretaries and Managers of Companies are invited to furnish Notices of Meetings, Issues of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration

All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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TECHNICAL EDUCATION.

Mr. Max Wurl will to-day read a paper at Newcastle-on-Tyne before the North-Eastern Engineers upon the subject of "Technical Education in Germany." It is obviously impossible for us to comment upon a paper which is not yet read, but we welcome the opportunity of saying a few words upon the subject. In the first place, education as a whole has never obtained legislative consideration, and we incline to the opinion that no national system can be efficient which does not deal with the subject as a whole. Broadly speaking, the basis of national education depends upon the teaching in primary schools. The secondary schools take up the work where the primary schools leave off, and the teaching here must be of two kinds—one giving instruction suitable for those who enter the learned professions, the other dealing with those who enter into trade. The universities, again, must cater for these two great classes. Fundamentally, then, we must first have a kind of generalisation, then we must specialise. The capacity of a man for specialisation depends almost entirely upon his attainments in general knowledge. It would perhaps be a too sweeping condemnation to say that at present our whole system is a system of examination, not of education. The two things are entirely distinct, and many a one is well educated who is unable to pass certain examinations, while, on the other hand, a brilliant examinee may be emphatically uneducated. Education cannot give a man ability; that is inborn, not made. Every workshop proves this, for therein you will find the unlettered, because of his inborn ability, able to give points to the man of many examinations. Unfortunately, we cannot agree with those superficial observers who say that educationally, so far as business methods and manufacturing methods are concerned, we lag behind Germany and America We deny it; and again appeal to the workshops. The best equipped factories in this country are equal in all respects to those of any other nation. Those who make remarks only to the disparagement of their native land, are generally guided in such remarks by recollections of olden-day factories. They forget that a manufacturing nation has both old and new—the old will not compare favourably with the more recently equipped works at home or abroad—but that is a condition which must by the nature of things exist. Now we come back to the educational problem. Too much is attempted in ordinary schools. They seem to have no definite aim. They neither give the general education for the right training of workman, foreman, designer, or master. Their curriculum is a hotch-potch, leading nowhere definitely. In our primary schools there is too much smattering—a little parrot knowledge without a due comprehension or understanding of any one thing. Boys that do not know the meaning of half the words they read are taught science. Is it reasonable to expect any value from such teaching? Perhaps the greatest difficulty is to train a student to think. We now try to get him to remember. Change the *rôle* of the teacher, and let his aim be to arouse the dormant faculty of thought, and not so much to train the memory. In the first place, then, in our opinion, the teaching in primary schools should be greatly restricted, and the attempt made to so teach that at the close of primary school life the student should know something for himself—at any rate should know the meaning of words, and be well equipped for the future so far as reading, writing, arithmetic, geography, and history are concerned. Technical people and business men, however, look to secondary schools to obtain the training necessary for their future life. Here, we think, the system should be to deal almost entirely with principles You illustrate principles by practical examples, but the

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application of principles to new combinations has nothing to do with school life. If, again, the thinking faculty is further developed, the student will see that the illustrative examples are examples only, and do not embrace the whole application. The great question arises here as to the further extension of schools or colleges wherein the whole training is one of specialisation. Except in one or two cases, specialisation is better left till the student has had some practical experience. We do not think the latter can be given in the ordinary school course, and strongly object to the idea that any student—not a born genius—can be properly trained to undertake responsible duties without having really practical experience.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

REVIEW OF "PRACTICAL NOTES ON ELECTRIC MAINS."

SIR,—I am obliged for Mr. Lee's opinions upon the above review, and have waited for "others" to say where it is "absolutely wrong," without avail.

Mr. Lee mentions, in his letter, that in writing the book he had the "honest intention of helping those starting," but he admits that his "statements are apt to be misleading, because most readers will not have the same attendant convoy of thoughts" as he had; and he also states that "there are sure to be errors" in the book. These deficiencies are (as suggested in the review) easily explained by the fact that the book was written under difficulties; nevertheless, such misleading statements and errors require to be pointed out, if only for the benefit of the starters in question.

I trust Mr. Lee will excuse my anonymity and also the use of the title which the editor of this paper, perhaps too flatteringly, put at the head of the review. Mr. Lee's claim to the title, in view of his lengthy experience and the great responsibility of his work, is freely admitted.—Yours, etc., THE REVIEWER.

Nov. 8, 1903.

INDEPENDENT TELEPHONY.

SIR,—With regard to the "reply" of Messrs Gardner and Holme in your last issue to my letter which appeared in your columns of the 23rd ult., I shall be much obliged if you will kindly allow me to make a few further remarks.

My object obviously was to show that the increase in the multiple jacks was not the very inconsiderable thing that Messrs. Gardner and Holme tried to make it appear in their article under reference, and unless they do not anticipate that municipal exchanges will ever exceed 800 subscribers, I quite fail to understand what they mean in this connection by stating that their articles "are written from a practical point of view." I feel that it is I who have taken the practical view, and it is ridiculous to say I might as well have taken an exchange of eight million subscribers as 6,000. The latter figure was taken because there are already in this country several exchanges with about that number of lines, and the Glasgow Corporation claim to have considerably over 7,000 subscribers. Tunbridge Wells municipal exchange was reported to have had over 1,000 lines, and Brighton talk of getting 3,000. I think, therefore, your readers will see that there is far less reason, apart from any ulterior motive, for Messrs. Gardner and Holme stopping at 800 than for my going on to 6,000. Their remarks as to an exchange not increasing rapidly to 6,000 lines is entirely uncalled for, and beside the question. Whether the growth is rapid or not is quite immaterial to the argument, and, moreover, the point was not referred to by me. However, it may be well to remind them that the Glasgow Corporation glory in the fact, and advertise it widely, that they have in two years increased far more rapidly than Messrs. Gardner and Holme seem to think possible or probable, and did not "gallant little Tunbridge Wells" boast of its even more phenomenal growth, taking the size and character of the town into consideration.

As to the cost of the jacks, I gave this as 2s. merely because Messrs. Gardner and Holme put it at that figure. I do not know, of course, what they pay for them. If it includes the wiring, well and good; but they did not say so. It does not affect my argument in the least, which is that the number of jacks required *per line* will continue to increase more and more as the exchange grows.

When a critic is in the right it is quite the usual thing for his remarks to be characterised as "effusions," precious or otherwise, and for a strong point to be made of his anonymity. But facts are facts by whomsoever stated, and although I have no objection to my name being published in full, as no object would be served thereby, I prefer still to remain anonymous, but am prepared to satisfy you, Sir, that I am not employed by the National Telephone Company, nor in any way connected with that concern, as doubtless Messrs. Gardner and Holme think and wish to infer.—Yours, etc., R. M.

P.S.—I regret to see that a mistake has been made in the number of jacks required for exchanges of 2,000 and 2,400 subscribers. They should, of course, be—as I think I wrote them—14,000 and 19,200, not 1,400 and 1,920 as printed.

STEAM TURBO GENERATING PLANT.

SIR,—My attention has been called to a letter in your last issue from the well-known engine builders, Messrs. Belliss and Morcom, Limited, in which figures given in my paper recently read before the Leeds Section of the Institution of Electrical Engineers are adversely criticised. In the case of the Electric Construction-Belliss set in the Leeds electricity works, I gave the steam consumption per kilowatt-hour at 19 9lb. (the figure given to me as approximately accurate by the city electrical engineer), whereas Messrs. Belliss put it at 19·49lb., including boiler and steam-pipe losses, which correction I accept.

Although no definite statement is actually made, yet the whole letter is cleverly drawn out to convey the impression that reciprocating engine plants are as economical as turbine plants, and complaint is made that I compare the efficiency of reciprocating engines and turbines of about equal sizes, but working under different conditions, especially with regard to superheat and vacuum.

My reply is that it is quite fair to make comparisons between the plants mentioned in my paper, because the steam consumptions given are those obtained *under actual daily working conditions.* To the plea that a particular reciprocating plant would give a better efficiency with greater superheat and better vacuum, my reply is, Why do you not then provide the greater superheat and better vacuum, and thus obtain the alleged greater economy? Are we to assume that the engineers who have these plants under their charge, or that the engineers who built them and put them down, disregard their own fame and the interests of their employers so much that they are content to waste coal and boiler power rather than improve their vacuums and raise the temperature of superheat?

Engineers who have had an extended experience with both reciprocating steam-engines and steam-turbines know full well that to raise the superheat over, say, 60deg F., at the stop valve, means with the reciprocating engine: (1) increase in the difficulties and risks of running; (2) increased wear and tear and heavy bills for upkeep and repair; (3) an expensive oil, and much of it, for cylinder lubrication.

In the steam-turbine none of these difficulties and expenses present themselves, hence we see in actual every-day work reciprocating engines working with little or no superheat and turbines working on high superheats.

Messrs. Belliss state that with 237deg. F. superheat they can reduce the steam consumption in their Leeds plant from 19·49lb. to under 16lb. per kilowatt. Then why is not this desirable and valuable economy effected? I trow it is because both Messrs. Belliss know and the city engineers know that with such high superheat all the difficulties named above would then be at once encountered, and the

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extra expenses and risks thus brought about would more than counterbalance the temporary economy to be gained.

Thus, my contention that my comparisons are fair because they are on practical lines is a sound contention, and it applies with equal force to the comparisons drawn between the steam-turbine and the Sulzer-Kolben plants named in my paper.

Again, as regards vacuums, engineers with both classes of plant know that by reason of gland and packing leakage it is more difficult to maintain high vacuums with reciprocating engines than with turbines.

Doubtless Messrs. Belliss would like to prove that reciprocating plants are more economical than steam-turbines, but the weight of evidence is against them; it is not to be expected, however, that engine builders will allow the present rapid development of the steam-turbine to proceed without making some efforts to stem the tide, futile though it may be.

I repudiate Messrs. Belliss's insinuations that I am interested in booming the turbine, or that my paper contains "misleading statements"; the figures given are to the best of my knowledge correct, and, moreover, they are not theoretical values, as is the figure of improved economy given for the Leeds plant, but the outcome of everyday practice, which alone is the true standard upon which to found our conclusions.

With reference to the postcript, I would correct it and put it thuswise: It should always be borne in mind that the cost of obtaining the high vacuum necessary for efficiency with *either reciprocating engines or* steam-turbines may become a very formidable item in the majority of inland stations.—Yours, etc., GEO. WILKINSON.

THE GROUPING OF CELLS.

SIR,—Some months ago you allowed me to point out the inaccuracy of the usual rule for grouping cells for maximum current, and to put forward a better rule. I should now like to give a simplified statement of my rule, with a slight improvement upon it.

According to the usual rule, the cells must be arranged in a *simple* group—that is to say, a group consisting of a number of equal *ranks*, each rank consisting of a number of cells connected in parallel, and the ranks being connected together in series. Fig. 1 shows a group consisting of four equal ranks, each rank consisting of three cells, and Fig. 2 shows the same number of cells arranged in three ranks of four instead of in four ranks of three. They might also be arranged in six ranks of two, in 12 ranks of one, or in one rank of 12, and the rule says that the grouping which will give the maximum current is the one whose resistance approximates most closely to the resistance of the external circuit. But I find that a considerably greater current than is obtainable with this rule can frequently be obtained from a *compound* group—that is to say, a group consisting of two

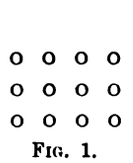

FIG. 1.

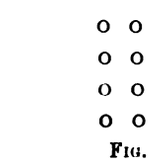

FIG. 2.

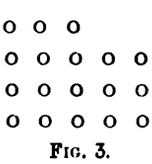

FIG. 3.

simple groups connected together in series, the ranks in one of these groups each containing one cell more than those in the other, as in Fig. 3, which consists of three ranks of four connected in series with two ranks of three. The number of ranks into which the available cells are to be divided is generally the nearest whole number to K in the following formula:

$$K = \sqrt{\frac{C \times X}{R}},$$

where C is the number of cells, X the external resistance, and R the resistance of each cell. This formula may lead to a simple grouping, in which case that is the best possible one that can be adopted. But if it leads to a compound grouping in which the larger ranks are more numerous than the smaller, they should, as far as possible, be made still more numerous at the expense of the smaller ranks. The grouping in Fig. 4, for example, should be changed to that in Fig. 5.

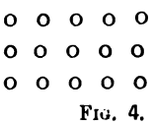

FIG. 4.

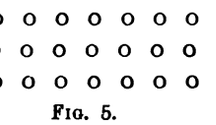

FIG. 5.

And if the formula leads to a grouping in which the smaller ranks are more numerous than the larger, they should be, as far as possible, made still more numerous at the expense of the larger ranks. The grouping in Fig. 6, for example, should be changed to that in Fig. 7.

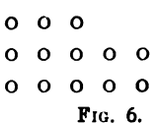

FIG. 6.

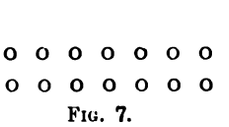

FIG. 7.

Two examples—one with a very small number of cells and one with a large number—will suffice to show how the above rule is applied, and to demonstrate the serious inaccuracy of the usual rule.

Suppose we have three one-volt and one-ohm cells and an external resistance of 1½ ohms. The formula

$$K = \sqrt{\frac{3 \times 1\frac{1}{2}}{1}}$$

gives 2 as the nearest whole number, and shows that the cells should be arranged in a compound group consisting of one rank of one and one rank of two, the resistance of which would evidently be 1½ ohms. The total resistance, external and internal, would, therefore, be three ohms, and dividing this into the number of volts, which is evidently two, we find that the current obtained would be 0·667 ampere. But the usual rule would say that the cells should be arranged all in parallel (in one rank of three), and the current obtained by this arrangement would be only 0 545 ampere.

Now suppose we have 101 such cells and an external resistance of 2½ ohms. Our formula gives

$$K = \sqrt{\frac{101 \times 2{\cdot}5}{1}},$$

the nearest whole number to which is 16, and we therefore arrange our cells in a compound group, consisting of 11 ranks of six and five ranks of seven (we leave the grouping like this, as it is impossible to increase the ranks of six at the expense of the less numerous ranks of seven). The current obtained from this arrangement would be 3·17 amperes. But according to the usual rule the cells should be arranged all in parallel, giving a current of only 0·4 ampere, about one-eighth of that obtained with the rule explained above.—Yours, etc., W. F. DUNTON.

CALCUTTA TRAMWAYS.

SIR,—With reference to your note *re* Calcutta tramways on p. 494 of your issue for Oct. 2, 1903, I should like to say that the comments of the local paper you quote are absolutely unreliable and steeped in prejudice, owing to causes well known in this city. In point of fact, I believe that the tramway company has not been to blame for a single fatal accident since the conversion, and for very few of the minor accidents, such as collisions, which inevitably occur on a new system. It must be remembered that not one driver had ever previously seen a car other than a steam or horse car, that they have capacity to pick up very little technical knowledge, and that they have to drive through narrow streets seething with coolies used to nothing but bullock carts. This being so, I consider, as a constant traveller on the system, that the running is most praiseworthy.

I may add that your contemporary bases its opposition often on no evidence, or on cases in which the company have been specifically absolved from blame; especially on one where a young man tried to jump off a moving car and fell underneath it. In the latter case another enlightened paper suggested that the company should pension his relatives.—Yours, etc., J. W. M.

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QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any questions should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

635. Describe some method of extracting air from water to be used for condensing purposes, the water having been raised from a bore-hole by compressed air.—BUBBLE.

636. Give sketches of how you would arrange to control a pump and motor of 2 h.p., 550 volts, two miles away to indicate when the water was at maximum and minimum height.—G. H.

ANSWERS.

Question No. 627.—What are the advantages and disadvantages of the underfed type of mechanical stoker, as compared with the moving grate and shifting firebar types?

Best Answer to No. 627 (*awarded* 10*s.*).—There are two types of underfed stokers in general use, the one feeding the coal intermittently by means of a ram or plunger, and the other having a continuous screw feed. They are, however, alike in principle, and most advantages of the one will apply equally to the other, so we will discuss them in turn.

The former, largely used in America and to a more limited extent in this country, consists essentially of a U-shaped tapering trough, extending the length of the grate, into the forward end of which the coal is fed through the usual hopper. The feed motion is given by a ram, which is worked at intervals by a piston in a steam cylinder fixed to the body of the stoker. The coal is thus pushed along the trough, the tapering form of which, in combination with a rod attachment in the trough which is worked with the ram, causes coal to rise to the surface, where it is first coked and then burnt entirely, the fire always being on the upper surface of the coal. The distilled gases have all to pass directly through the incandescent mass of the fire, and the combustible portion is thus consumed. The necessary air is supplied from a blower through tuyere blocks at the edge of the trough, and has also to perform the work of spreading the coal over the area of grate not occupied by the trough. The arrangement for working the steam distribution valve at required intervals is very simple and effective, consisting of a hollow rocking tube with a hollow vessel at either end, partly filled with water, which flows from the upper vessel to the lower, and when lower is full, tips a counterweight which opens steam-valve to cylinder. The resulting motion of the piston and ram restores the vessels to their original position. The speed of flow of the water is regulated by a valve in the tube.

The advantages claimed for this stoker are as follows: (1) Great simplicity, very few moving parts, and none of these in contact with the fires. (2) Consequent durability and absence of repairs. It is said that many of these stokers have been in constant use for five years without costing anything for repairs. (3) Economical working at all loads. (4) Smoke prevention even when forcing fires. (5) Cheap fuels smokelessly burnt, thus reducing coal bills. (6) Complete burning of all combustible, there being no bars for small coal to drop through. (7) Positive control of air supply. (8) Less air used than with any other method of firing, as the air is introduced only where it is needed, below the fire, and the amount is regulated by the blower supplying it. It is claimed that hardly any more air is used than is theoretically necessary for complete combustion, whereas other methods use from 50 to 100 per cent. more. This ensures better utilisation of the heat, for the gases are less diluted with surplus air, and so leave furnace in less volume and at higher temperatures; therefore the velocity is less, and the slower rate of travel results in a better transference of heat to the boiler. The gases are said to leave the boiler at lower temperatures than is usually the case with other stokers. (9) Forced draught being used, no high stack is needed. (10) Simplicity of erection, the work of which can be done by any ordinary mechanic. (11) No shafting or engine required, each stoker being self-contained. (12) No firebars, but simple dead plates. (13) No steam jets. (14) Hopper being below fire level, the labour of lifting the coal is much less than when it is high up. (15) Increase of boiler capacity.

Against these advantages must be balanced the following disadvantages: (1) The stoker not being self-clinkering, periodical cleaning out is necessary, with its attendant inconveniences of turning down fires, thus stopping the steaming of the boiler, and opening of firedoors, admitting cold air. Moreover, as it has been found in practice that a very heavy fire gives best results, as much as 18in. being used for most bituminous coals, the time of turning down is much prolonged. In an electricity supply station, where the maintenance of the steam pressure at critical times is everything, and the loss for half an hour of a single boiler might be the cause of the stoppage of supply to certain districts or even the whole town, this might well prove a serious objection. It must however, in fairness, be stated that it has been found possible to delay the time of cleaning out longer than would be possible with hand-fired boilers. (2) The air blast being relied on to spread the coal to make up the portion of the fire outside the trough, has to be of greater pressure than that in general use for this class of work, and thus will require more power. (3) It has been found that by far the greater portion of the heat is concentrated at the trough, and this has been found a great source of trouble, many burnt-out tubes in water-tube boilers having been attributed to this. To obviate this the stoker has been set as much as 6ft. below bottom row of tubes. (4) The necessity of cleaning out the fires involves extra labour over other types of stokers.

Reviewing the above advantages, Nos. (4) (5) (8) (15) are shared in a greater or less degree by other stokers, and the others only need be considered. Nos. (1) and (2) should make the cost compare favourably with other types. No. (9) is only an advantage in a new installation, as in the case of an extension the high stack will probably be already existing. Of the disadvantages, Nos. (1) and (3) are of great importance, (3) practically meaning a reduction of grate area, and, therefore, an increased fuel consumption per unit area, with the attendant dangers of burnt-out tubes, etc. It may be mentioned that an automatic device has recently been introduced in America for regulating the supply of coal and the draught to suit the varying loads.

The other type of underfeed stoker has very similar characteristics, but the feed is by a continually revolving helix in the trough, and the grate is of an inverted V-shape with the sides composed of a series of tuyere blocks, between which air is admitted. The coal as it rises from the trough slides down these sides, and a much better distribution of fire is obtained than in the other type. The other disadvantages still remain, and the cleaning out is said to be even more awkward. Also the continuous feed has been found undesirable owing to its breaking up the fire. As each is self-contained and the movement is continuous, it practically means having a separate engine for each stoker, which must be wasteful of steam.

In conclusion, it would seem that the latter type is preferable, on account of the better distributed fire; that either is admirably adapted for smokelessly and economically burning low-grade fuels, and that the cost of repairs to stokers would be low, but that the necessity for frequent clearing out and the heavier repairs bill to boilers in the first type would tell strongly against it in the minds of many. It certainly has not so far found much favour with central-station engineers in this country.—R. S. B.

Answer to No. 627 (*awarded* 7*s.* 6*d.*).—Mechanical methods of stoking have not made nearly the progress in this country as in America, and probably the principal reason for this is that while in the States the greater proportion of boilers are of the externally-fired type, the internally-fired

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boiler is generally preferred here. Externally-fired boilers lend themselves very readily, indeed, to the adaptation of almost any system of mechanical stoking, there being plenty of room to fix the gear, whilst the available space on an internally-fired class is necessarily limited. As a natural result, therefore, of the ease of application, the mechanical stoker has been considerably more developed in America than in this country, and more especially has this been so in the case of the underfeed class of mechanical stoker. Although in recent years there has been considerable progress made in the application of mechanical stoking apparatus with us, the advancement has been almost exclusively in the direction of the overfeed system, the use of underfeed stokers being extremely limited.

Before discussing in detail the various advantages claimed for the two systems, it is, perhaps, necessary to briefly consider their essential points. The overfeed system is, in its simplest form, merely an adaptation of the ordinary hand-fired furnace, fuel being admitted through the front of the furnace on to the top of the fire. The stokers operating upon this system may be divided into two classes—(*a*) the sprinkler or shutter type, and (*b*) the coking class, which are again sub-divided into (1) the ram or plunger, with moving bars; and (2) the chain-grate type. These various types having already been somewhat exhaustively discussed in these columns, it will therefore only be necessary to briefly refer to their operation.

Sprinkler Type.—This stoker consists of a shutter or flapper operated by means of suitably arranged springs; the shutter being sharply released, knocks the coal from a shaped plate in front of the furnace. The coal falls upon the plate from a hopper above, the supply being regulated to suit requirements. By a simple adjustment of the springs, the power of the shutter is so varied that the coal falls upon any part of the fire as required.

Coking Stoker—Ram Type.—As its name implies, this class of stoker consists essentially of a ram or rams which push the coal in at the front of the furnace on to a coking plate, from where it is gradually worked to the back by means of suitably arranged moving firebars.

Chain-Grate Type.—Although considerably different in their construction, practically the same end is obtained with the chain grate as with the ram type. With the chain grate the rams and moving firebars are dispensed with, and a series of endless chains are provided. These chains are arranged side by side, and revolve over two drums, one at each end, the coal entering at the front and being gradually carried to the back, where the unconsumed portion drops into the ashpit.

Underfeed System.—The principle of underfeed stoking consists essentially of feeding the fuel slowly, and for full economy continuously, through the underneath of the fire-grate, the coal, as it gradually reaches the top and hottest part of the fire, being slowly roasted and coked, the coal being released and immediately ignited by the air, which is supplied through specially constructed ducts in the stoker grate, and the coal, therefore, reaches the top of the fire practically as coke. Underfeed stokers may be divided into two classes: (A) the continuous-feed type, and (B) those equipped with plungers or pistons. The continuous-feed stoker, Class A, consists in the "American stoker" of a screw conveyor, which commences at the hopper and extends the full length of the furnace in what is termed the conveyor pipe. The conveyor is so arranged that the coal is distributed equally over the entire surface. Air is supplied through a pipe just under the hopper, the pipe communicating with what is termed the wind box. This wind box opens into the magazine, the upper edge of which is arranged with tuyeres or air ducts, through which the air is discharged to the fire. The driving arrangements are very simple, consisting of a small steam motor with a simple reciprocating piston, which actuates a pawl and ratchet wheel, the wheel being attached direct to the conveyor shaft. In the intermittent-feed stoker, Class B, the grate and system of admitting air is on the same principle as Class A, but the coal is forced up through the fire by means of plunger or piston instead of the spiral conveyor. This latter type has not been nearly so widely adopted as the continuous-feed type. It is apparent that a constant feed must be superior to an intermittent supply, as the latter has two rather serious objections: (1) there is a tendency during the intervals between feeding for coke to form in places, and through which the air cannot readily be forced, so that it takes a course through the fire where thinnest, thus causing blowholes; (2) when the piston enters these masses of coke are broken up suddenly, with the result that a considerable amount of smoke may be formed. In the following comparison therefore between the over and under feed systems of stoking, it will be understood that the continuous feed class is being considered.

In order to make the comparison as clear and concise as possible, we will consider the relative advantages and disadvantages under several headings, including economy, smoke prevention, cost, etc.

Economy.—It is generally conceded that the coking type of stoker is more economical than the sprinkler, but the actual economy resulting from mechanical stoking depends upon so many things differing considerably in almost every individual case, that although most elaborate tests have from time to time been made, it is almost impossible to make a really reliable comparison. The underfeed type of stoker may be taken as at least as good in this respect as the coker stoker, and possibly slightly better results may be expected.

Smoke Prevention.—The underfeed stoker is probably the best practical smoke preventer in everyday use. The continuous feeding of green coal on the underside of the grate, from where it gradually works to top of the fire, by which time it is practically coke, ensures almost complete combustion, and the only way in which smoke can be produced is when, as sometimes happens, the green coal forces its way through the fire without going through the coking process. The greatest offender as regards smoke is the sprinkler, which produces an almost continuous stream of smoke, which, however, is of a very light colour and scarcely noticeable.

Cost.—The first cost of either of the other types of stokers is considerably more than the sprinkler, this type also costing least for maintenance. The underfeed stoker is very expensive in first cost, and also, owing to its specially-constructed furnace plates, rather expensive to maintain, but this item depends to a great extent upon the arrangements and conditions of working rather than upon the type of stoker itself.

Forcing.—One of the great objections to all systems of mechanical stoking is the inability to force the boiler evaporation in case of emergency. It is impossible to force the underfeed stoker, and the coking stokers also cannot be forced to any appreciable extent. The rate of evaporation may be increased with a sprinkler stoker, but, of course, at the expense of economy and the production of smoke.

Accessibility for Repairs.—The chain-grate stoker is most readily examined, as it can be bodily removed from the boiler. The underfeed stoker is more difficult of access than either moving types.

Draught.—The underfeed stoker cannot be worked without some system of forced draught, and in certain cases this may be rather a serious objection.

In conclusion, it may be stated that the sprinkler stoker, in this country at least, is rapidly gaining favour for applying to Lancashire and similar boilers, while the chain-grate type is most extensively applied to water-tube boilers. The underfeed stoker is still somewhat a novelty here, and, notwithstanding several distinctive merits, will not apparently come into extended use.—F. A.

Answer to No. 627 (*awarded* 5*s.*).—The chief advantage of the type of mechanical stoker in which the fuel is fed into the fire from a trough beneath, is that more complete combustion is possible without an excessive supply of air than with the other types of stokers. The accompanying sketch, which shows a section through the furnace, will give an idea of its action. The unburnt fuel is introduced into the trough, A, it is slowly raised by the action of the ram till it is moved into the space B, where it meets with the draught of air which is forced by a fan up the passages, P P, through the tuyere blocks, T T, into the furnaces. Here the fuel is ignited, and the hydro-carbons contained in it burnt away; it is then raised into the space C, where

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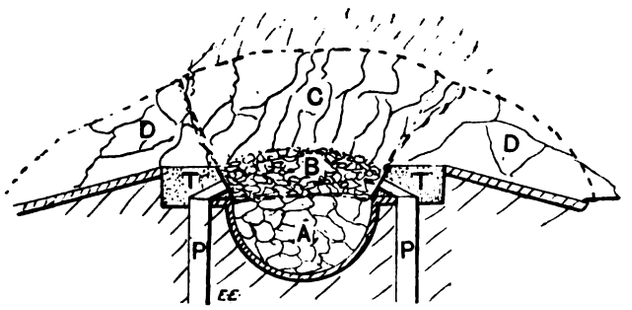
the process of combustion continues until all the fixed carbon is consumed; the residue in the form of clinker and ashes is pushed by the slow upward motion of the mass on to one side in the space D, where it remains until removed. The gases generated in the space B have to pass through the white-hot fuel in C before leaving, and so become completely burnt, thus ensuring smokeless combustion even of bituminous slack.



The advantage of this method of feeding is especially evident when used in connection with those types of water-tube boilers in which the gases rise vertically from the grate and strike on to cold water tubes; in other stokers the gases have not space to mix properly, and thus form dense volumes of smoke, but in this type the gases mix before reaching the surface of the fuel. Another advantage of the underfeed stokers is that they do not need the use of moving parts in the fire, all the mechanism being quite outside the furnace—this reduces the maintenance costs.

The chief disadvantage is that the draught cannot be produced by a chimney owing to the large pressure needed (from two to four inches of water), this necessitating the use of a fan, but the cost of this is usually made up by the cheapness of the stoker itself and the possibility of burning the cheapest coals.—E. J.

Answer to No. 627 (*awarded* 5*s.*).—The advantages of using the underfeed type of stoker are as follows: In this stoker the air to the furnace is supplied by a volume blower, and is delivered in the approximate proportion of 150 cubic feet of air per pound of coal fed, and at a pressure ranging from ½oz. to 1oz. at the tuyeres. This pressure is only such as to admit of the thorough mixing of the air with the coal, and is in no sense of the word a blast. The advantage of this arrangement is that, being independent of natural draught and the supply of air and coal under complete control, the fire can be forced at a moment's notice, and can be as quickly reduced. Further, the fuel is thoroughly coked before reaching the zone of combustion, and the air being admitted above the green fuel, but below the fire, is thus well mixed with the gases liberated from the coking coal below the tuyeres. This combustible mixture of air and gases passing upwards to the burning fuel is nearly completely consumed, and very little smoke is made. This prevention of smoke is a great advantage in large cities.

As a result of the above arrangements, it is found that the amount of air required per pound of coal when burned with this stoker is from 20 to 55 per cent. less than that required with the common mechanical stoker. This effects a two-fold economy in decreasing the volume of heated gases escaping up the chimney, and likewise decreasing the velocity of the gases as they pass over the heating surfaces, thus allowing more time for the absorption of heat by the said surfaces. The economic use of air in this stoker compared with other mechanically-operated stokers is due to the unusual depth of coal carried, the air being supplied from beneath and the continuous action of feeding overcoming the tendency of holes burning through the fire. The disadvantages of this stoker are the expenses entailed in the installing and upkeep of the blower and the difficulty of cleaning the fires when compared with the ease with which the fires are kept clean when using the chain-grate type of stoker.—J. WALKER.

Question No. 628.—What is the best method of improving the draught in a central station which at present has a very poor natural draught?

Best Answer to No. 628 (*awarded* 10*s.*).—A poor draught depends on so many details, that I think in answering this question it will probably be best to consider the whole matter of draught more or less in detail.

Definition of Draught.—More or less confusion exists in the use of the term "draught" owing to its double meaning. As usually employed, it refers to the difference in pressure between the external air and the gases from the boiler, and is measured by the height of the column of water such pressure is able to sustain. Methods for making such measurements will, however, be dealt with further on. This difference of pressure is called the "intensity" of the draught, although sometimes referred to simply as the draught, and is directly proportioned to the height of the chimney and the difference in temperature of the flue gases and the exterior air. Again, "draught" is sometimes used in referring to the velocity which the intensity of "draught" (or difference of pressure, as above) has the power to create and the corresponding volume of air moved. Draught, as thus understood, is directly proportional to the sectional area of the chimney at the top and the square root of the height.

Intensity of Draught.—The object of draught is to pass a sufficient supply of air through the boiler grates for the efficient combustion of fuel, and to carry away the gases resulting from such combustion. To do this the draught requires to be of such intensity as to overcome the resistance offered to the passage of air by the fire, boiler tubes, main flue, chimney resistance, etc. The proportion of such necessary for overcoming these various resistances is approximately as follows—viz.:

For entrance velocity	0·003in.	of water.
Resistance of fire-grate	0·182in.	,,
,, of combustion chamber and boiler tubes	0·246in.	,,
,, of main flue	0·012in.	,,
For discharge velocity.....	0·017in.	,,
Total effective draught pressure	0·460in.	
Resistance of stack	0·040in.	
Total pressure of chimney	0·500in.	,,

Any pressure over and above this quantity will be available for giving such velocity to the gases as will draw the necessary amount of air through the grate for the effective combustion of the fuel. The quantity of air will, of course, vary considerably with the class of fuel, thickness of fire, etc.

Chimney Design.—There are several formulæ for the correct design of chimneys, the best, I think, being the following—viz.: where H = height of chimney; F = pounds of coal burned per hour; A = effective area of chimney; T_a = temperature of external air, 460; T_c = temperature of gases, 460; D = draught; then

$$d = h\left(\frac{7{\cdot}6}{T_a} - \frac{7{\cdot}9}{T_c}\right), \qquad h = \left(\frac{0{\cdot}0825\ F}{A}\right)^2.$$

A well-designed chimney of about 150ft. should give a draught of 1in. water pressure with flue gases at 500deg. F. and an air temperature of 50deg. F. It has been found by experiment that the following minimum chimney heights are required for various classes and quantities of coal burned:

Class of coal.	Chimney height.	Coal consumed per hour.	Chimney height.
Free-burning coal (bituminous)	85ft.	1,000lb.	120ft.
Slow-burning bituminous	125ft.	2,000lb.	140ft.
Fine anthracite	130ft.-150ft.	3,000lb.	160ft.
Fine coal or slack	175ft.	4,000lb.	180ft.

Measurement of Draught.—Draught is usually measured by the difference in level of a liquid in the arms of a tube of U form, having one end open to atmosphere and the other connected with the flue or chimney, or wherever the draught is required to be measured. The preponderance of pressure in one arm forces the liquid downwards and causes a corresponding rise in the other. The difference in level represents the height of a column of the liquid which will be sustained by the pressure, and is measured on a scale graduated in one-tenth parts of an inch, as shown in sketch. This U-tube arrangement can be replaced

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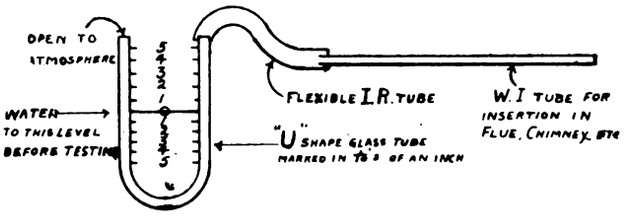
with excellent results by a direct-reading draught gauge, such as the "Ever-trusty," made by Wallach Bros.



Cause of Bad Draught.—Although the draught at the chimney root may be good, it can be absolutely spoiled by any of the following causes—viz, leakage of air through brickwork. At frequent intervals the whole of the brickwork forming the side and main flues, should be carefully tested for air leaks by means of an open flame lamp. On carrying out such tests, one will often be greatly surprised at the amount of air getting into a flue through cement joints, flue doors, and sometimes even through the solid brick. I have found such leaks causing a reduction in draught intensity of a full tenth of an inch. All these, of course, should be carefully stopped, and the whole flue brickwork occasionally repointed. Accumulation of soot is another item which has an extremely bad effect on the draught, especially when allowed to accumulate in the boiler flue tubes at back of fire arch. These flue tubes should be cleaned at least every three months and the main flue every six months. The draught will be increased thereby and coal saved. As to the construction of flues, they should be so constructed as to offer as little resistance as possible to the flow of the gases, and all sharp bends, abrupt change of cross-section, and sudden enlargements should be carefully avoided. A capacious flue means a low velocity of gases, and I have known of a small flue opening into one of almost twice the area causing a reduction in draught of 0·15in. water pressure. The main flue should not be less in area than the cross-section of the chimney at the top, and nothing is gained in making it much larger than this. The correct area is about one-seventh of the total fire-grate area. If the length of the main flue is great, the area of the chimney top will need to be increased. Counting this area as 1 for a 100ft. flue, then for any extra length of flue the dividing constant is: 100ft. = 1, 200ft. = 0·853, 400ft. = 0·708, 600ft. = 0·625; so that for a 200ft. flue the area would need to be increased in the ratio of $\frac{1}{\cdot 853}$. It is also desirable to have a damper in the main flue for cutting off every pair of boilers from the chimney, as otherwise considerable air may leak into the flue through badly-fitting dampers or boilers standing idle. Intensity of draught, as was above pointed out, depends on the height of the chimney, and cannot be altered except by increasing the height. A chimney for a works of any size should have a draught of at least from 0·8in. to 1in. of water pressure at the root under normal conditions of temperature and barometric height.

Remedies for Poor Draught.—If on testing the pressure at the root of the root of the chimney it is found to be good, the trouble must be looked for in the flues, and these should be tested and examined for the points of weakness detailed above, the remedy being applied in accordance with the finding of such examination, and as the construction of the flues under inspection will allow. On the other hand, if the intensity of the draught at the chimney root is found to be bad, the only remedy is to increase the height of the chimney, build another one, put a fan in the existing chimney, or use forced draught created by means of steam jets or supplying air under pressure to the underside of the grate. The possibility of increasing the height of the existing chimney will depend on the foundations, diameter at base, and the thickness of the brickwork at the top. As regards the foundations, these will usually be found sufficient, while to ensure the stability of the chimney the height should not be more than 12 times the diameter at the base. If the brickwork is less than 14in. at the top, it will be impossible to increase the height sufficiently to gain any increased efficiency thereby, as on no account should more than 25ft. of 9in. brickwork be erected, and if the chimney top is more than 6ft. diameter inside, no 9in. work should be allowed at all. Care must also be taken that in increasing the height the area of the chimney top is not contracted too much, as otherwise, if the chimney is working at full pressure, the benefit gained by the increased height will be lost. Whether the chimney top will stand diminishing or not can be arrived at with the aid of the formulæ given above and a knowledge of working conditions. The cost of heightening a chimney from, say, 100ft. to 150ft. is approximately from 35s. to 40s. per rising foot. If, then, the chimney is not 150ft. high, and the draught is poor, I would certainly advocate building to this height, providing the construction will allow. Beyond this height the expense of further increase is rarely justified by any additional efficiency obtained. If, however, the chimney is already 150ft. high, I would in preference to putting up another one (after proper consideration of existing conditions, of course) recommend the adoption of induced draught by means of a fan in the chimney, several excellent fans for the purpose being on the market at present. With such a fan any required draught can be obtained and regulated according to the class of fuel burned and the demand for steam, as boilers can be pressed easily and economically to 30 per cent. above their normal rate. Such being the case, if a fan is used, less boiler plant need be installed than would be necessary with natural draught. Economisers can be used with greater economy, as the reduction in the temperature of the gases will not affect the draught, and with this method you are independent of atmospheric conditions. One of the chief advantages is that a much cheaper class of fuel can be burned. The power taken by such fans is about 1·5 to 2 per cent. of the total output of boilers. There are also many excellent methods of forced draught, but in my opinion the induced-draught method is by far the best. Naturally, the cost and existing conditions would need to be considered in deciding whether to erect another chimney, or adopt any of these methods of improving a poor draught.—A. D.

Answer to No. 628 (*awarded* 7*s.* 6*d.*).—Unless a central station has originally been designed with very broad views as regards probable increased demand for power, the engineer has usually very soon to face the problem of what is the best means of increasing the output of the station. In this is frequently involved the question of providing a suitable draught of ample power to ensure efficient combustion. This may be accomplished in two ways: (1) by increasing the natural draught, (2) by adopting some form of forced draught. In the following remarks it must be understood that they are not intended as a comparison between natural and forced draught, but are merely made with a view to a solution of the present problem, which is to improve an existing inferior natural draught.

Taking, first, the case of natural draught. A defective draught may be improved by increasing the height of the chimney; or, if this is not practical, and ground space permits a second, and, if necessary, a larger chimney may be erected. Of course, the chimney itself may be of ample capacity and height, and yet only a poor draught obtained, owing to defective or badly constructed flues. Very frequently considerable improvement can be effected by giving proper attention to the flues. Turning now to forced draught, we will briefly discuss the various available systems. These may be divided into two classes—the steam jet and fan draught.

Steam Jet.—This consists of blowing air and steam by means of a steam jet into the furnace ashpit. This is accomplished with specially constructed blowers or nozzles, and the system possesses the great advantage of being low in first cost. It is, however, a very wasteful arrangement, consuming anywhere between 5 and 20 per cent. of the total steam produced. It may be generally accepted that steam jets should only be adopted when the station is of small capacity, comprising one or two boilers only. It is claimed for this system that when cheap fuel is used, there is a tendency to prevent the formation of clinker, owing to the decomposition of the steam into its constituent gases, hydrogen and oxygen. It is also very convenient, inasmuch as it can be easily regulated and shut off when the furnace door is opened for firing.

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Fan Draught.—This is divided into two systems—forced and induced draught.

Forced Draught.—This system consists of the application of fans which supply air at a suitable pressure through specially constructed conduits to the boiler furnaces, which are arranged with closed ashpits. Among the advantages ascribed to this system are: (1) it can be very readily adopted to existing boiler plant; (2) convenient and efficient regulation of air supply; (3) no great inrush of air when the furnace door is opened, as the stoker can shut off the pressure; (4) less wear and tear on the fan than with induced draught. The principal objection is that there is a liability of holes being blown in the fire. This, however, can be obviated by suitably arranged dampers in the ashpit for distributing the air supply. The supply should always be completely cut off before the furnace doors are opened, or flames and dust will be blown about the stokehold.

Induced Draught.—In this system the fan or fans are placed in the boiler uptake, thus producing a draught similar to that effected by natural means. With this arrangement the draught may very readily be increased or decreased, as the demand for steam varies, without the danger of blowing holes in the fire. There is also no possibility of fire or dust being blown into the boiler-room, as in the case of forced draught. It is somewhat expensive in upkeep, owing to wear and tear consequent upon the fan being exposed to the hot gases. When firing there is a considerable rush of cold air into the furnace, as in the case of natural draught. The above is a concise summary of the various points in favour of or against the different methods of securing an efficient draught, and we will now briefly refer to the consideration governing a selection to meet present requirements.

Ground Space.—If the proposed extensions are of any magnitude, and the available space for new chimney, boilers, etc., is limited, it may be quite out of the question to so increase the natural draught and boiler plant to a sufficient extent. One outstanding advantage of forced draught is that the capacity of existing plant may be increased as much as 30 per cent. by its adoption, and where room is of first importance forced draught is probably the best way out of the difficulty.

Cost.—The first cost of installing a fan-draught system is low as compared with building of a large chimney when power approximates 1,000 h.p., and gets more favourable as the size of the station increases; but, of course, when the chimney is once erected its maintenance is not so great as the running expenses and upkeep of a forced draught system.

Fuel.—The class of fuel to be burned has a considerable bearing upon the question, inferior fuels requiring considerably more draught than do the better grades of bituminous coal, and sometimes an installation of forced draught becomes necessary solely on this account.

Size of Plant.—The case in point does not contain any idea of the size of plant. This is a very important matter in coming to a satisfactory solution, but it may be stated that, generally speaking, the advantage of fan draught becomes more apparent as the size of plant increases.

The above points are the principal considerations governing a selection of the best system under various conditions, but there are many others to which some consideration has to be given, such, for instance, as the existing arrangement of flues, economisers, conditions of existing chimney, and efficiency of present draught. In making a selection it must always be kept in view that mechanical draught is unaffected by climatic conditions.—F. A.

Answer to No. 628 (*awarded* 5*s.*).—The methods of improving a poor natural draught are either to induce a draught by a fan placed in the flue, which by removing the gases causes the pressure in the flue to be less than that of the atmosphere, or to produce a draught by forcing air into the furnaces. Both induced and forced draught may be obtained by using either fans or a steam blast. The usual way, however, where induced draught is used is to employ fans, as although in one or two instances in non-condensing plants the exhaust steam from the engines has been turned into the chimney shaft to assist the natural draught, it will be obvious that with a free exhaust no great assistance can be looked for in this direction, and a throttled exhaust is, of course, out of the question.

The methods in general use are: (1) forced draught obtained by using either fans or a steam blast; (2) induced draught produced by fans placed in the flues. The cheapest method to instal is forced draught produced by means of steam blasts. In one well-known system two steam blasts are generally fitted to each furnace of a Lancashire boiler. The ashpit is closed by an air-tight cover, and the blast admitted underneath the furnace by two nozzles. The steam blowing through these nozzles at a fairly high speed takes in with it a certain quantity of air, and thus creates a draught; this draught is delivered about half way up the underside of the furnace by a bell-mouthed tube, which assists in distributing the draught. On the outside of the airtight cover are placed two valves for regulating the supply of steam and air respectively. Low first cost, however, is about the only point this method has to recommend it.

The efficiency of the steam blasts being considerably less than that of fans, the amount of steam necessary being greatly in excess of that claimed by the makers, the boiler is also liable to suffer damage unless the steam used in the blasts is perfectly dry. The draught, in spite of numerous precautions, is also very liable to be concentrated in one or two places, resulting in burnt firebars and other delights due to the excessive heat produced. Forced draught as obtained at sea by means of a closed stokehold has proved itself to be highly successful, but on shore it is practically impossible to obtain a closed stokehold, so that this method need not be considered.

In the Howden system of forced draught, adapted for land purposes, the air is forced by fans through rows of vertical tubes, placed in a box through which the waste gases are led; the air is thus heated before being admitted to the furnaces. An arrangement is also made so that the firedoor cannot be opened before the draught is shut off, and thus one of the objections to forced draught—viz., the risk to the fireman of being burnt by opening the furnace door when the draught is on—is done away with. This system does not necessitate a closed ashpit, and the contention of the makers that the wear and tear on the boilers is diminished, has been found to be substantiated in practice. Messrs. Ellis and Eaves have a system of induced draught, in which the air before being drawn through the furnace is heated in a similar manner to that in the Howden system, except that the tubes are placed horizontally. The heated air is also, as in the Howden system, admitted to the furnace by suitable dampers either above or below the fire. This system is in use in several central stations, and has given excellent results.

To sum up, in the case of induced draught the fans have to work in the hot gases from the furnaces (which are also very gritty), and this necessitates them being more powerful than if they simply had to deal with cold air, as in the case of forced draught. The increase in power required to move a given weight of air, and to maintain a given difference of pressure with air at a temperature of 300deg. F., is nearly 50 per cent., as compared with air at a temperature of 50deg. F. There is also the risk with induced draught that cold air will be drawn into the flues at undesirable places, owing to leaks in the brickwork setting. The great drawback to forced draught, the afore-mentioned risk to the fireman, being capable of being obviated, the balance is in favour of using the Howden system of forced draught.—W. T. W.

Answer to No. 628 (*awarded* 5*s.*).—Before giving a definite answer to this problem which confronts a great many central-station engineers after a few years' working, it will be as well if we enquire into the causes of natural draught, and whether it will be wise to extend it, or to use either of the other two methods in use in central stations—namely, induced draught or forced draught (*i.e.*, draught caused by steam blowers at the front of the boilers). Natural draught is produced by a chimney, and is due to the difference in the weight of a column of hot air inside the chimney, and an equal column of cold air outside. The weight of a cubic foot of air at 62deg. F. is ·0761lb., the weight of a cubic feet of air at 552deg. F. is

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·0393lb.—that is, practically one half its volume will be doubled. The air outside will, therefore, have a pressure to force it through the fires about twice the hot gases in the chimney possess. Note.—We are neglecting the slight differences in the specific gravities of air and the hot gases.

To determine what pressure—*i.e.*, the pressure as measured by a water-gauge at the bottom of the chimney—the above two temperatures will give with a chimney 140ft. high, we have

$$(\cdot0761 - \cdot0393)\ 140 = 5\cdot2\text{lb.}$$

Now, 5·2lb. is equal to the weight of a square foot of water 1in. high, so that the draught will be equal to the pressure of 1in. of water. From this formula, by assuming different heights and temperatures of gases in the chimney, it will be noticed that it requires a great increase in height to produce a much better draught, but this would be out of the question in certain localities, local authorities, as a rule, being prejudiced against high chimneys, and not only that, the foundations of the present chimney would probably require alterations as regards increasing the temperatures of the gases in the chimney—this would be very uneconomical, as possibly economisers would have to be done away with.

The best method of increasing the draught would be to put down an induced-draught plant, which consists of a fan with simple radial blades revolving in a steel casing fixed in the flues, usually at the bottom of the chimney; in revolving it drains the gases away from the boilers. The advantages of this method are numerous. Firstly, the maximum load in a central station lasts only for a short period of the day, during which you are enabled to work your boilers beyond their rated capacity without seriously reducing their economy; a less number are, therefore, required as stand-by. It is not necessary to have a large quantity of heat in the flue gases in order to keep up the draught, so that economisers and superheaters may be used with greater economy, and it might even be advisable to extend the former. The heat loss with natural draught is usually between 15 to 20 per cent.; with induced draught this may be reduced to two-thirds of this. It gives complete control in governing the fires—firstly, with different qualities of coal, the smallest (which usually works out the cheapest) can easily be burnt; secondly, in case of rapidly changing loads, due to fogs, etc. It is independent of atmospheric conditions. It is also independent of air leakages through brickwork of the flues. It is easily adapted to existing natural draught.

An induced-draught system must be properly designed. The fan must be large enough to give its maximum draught without being run at too high a peripheral speed. It may be driven either by an electric motor or steam-engine, which should be in duplicate, the power consumed being under 1 per cent. of total. The steam-engine may be made to govern automatically, so that if boiler steam pressure rises the fan runs slower, thus lessening the intensity of the draught and *vice versâ*. The initial cost will be considerably less than a new shaft, with its expensive foundations, flues, etc., in a 2,000-h.p. station, the chimney, etc., costing approximately £2,200, the fan complete £1,000, and the working costs will be about one-tenth of power represented by the waste heat in a good natural draught. The steam blast may be dismissed with a few remarks: it may be cheaply installed, but is very costly to work, not easily duplicated, and has the disadvantage that if the steam pressure falls, due to a sudden demand for steam, its efficiency falls too.—F. H. R.

PERSONAL.

We understand that Mr. Frank B. Cramer has left the International Electrical Engineering Company, where he held the position of technical manager, and has rejoined Messrs. Johnson and Phillips, with whom he was formerly associated for some years.

The Aston Tramways and Electric Light Committee have appointed Mr. Thomas J. Ballard, of Sheffield, resident electrical engineer, at a salary of £400 per annum.

On Wednesday Mr. W. W. Booker was presented at the electricity works, White Hart-road, Plumstead, with a handsome set of books from his late colleagues. He left these works, where he held the appointment of correspondence clerk, to take up a similar appointment in the electricity works of the borough of Hampstead, where we trust he will meet with every success.

The Frome Urban District Council have approved of the engagement of Mr. G. T. Pardoe as clerk of the electrical works at a salary of £180 per annum, the engagement to begin when Mr. Pardoe has completed his duties with the Fulham Corporation.

The Cardiff Town Council have increased the salaries of a number of officials in the electrical department.

Mr. H. E. Brown, an engineer at present in the employ of the Poplar Union, has been appointed second distributing assistant at the electricity department, at a salary of £120 per annum.

Mr. Thomas Holme, of the Portsmouth municipal telephone exchange, has been appointed manager of the Hull Corporation telephone undertaking, at a salary of £200, to be increased to £250 in the event of the expenditure not exceeding the amount of the loan.

Mr. Jack Hawes (late assistant engineer to the metropolitan borough of Bermondsey electricity and dust destructor works), having been appointed chief assistant electrical engineer to the firm of Messrs. Tyler and Duncan, has been presented with a dressing-case by Mr. A. E. Young, on behalf of the officials and staff of the above works, as an appreciation of his good services.

LEGAL INTELLIGENCE.

ISLE OF THANET TRAMWAYS.

In the case of Cole *v.* Isle of Thanet Electric Trams Company, Limited, before Mr. Justice Bigham and a special jury, in the High Courts, the plaintiff, a widow, recovered £200 for the loss of her husband, who was killed by one of the defendant company's cars in July, 1902.

His Lordship entered judgment in accordance with the finding of the majority of the jury (consented to by the parties), with costs, but granted a stay of execution, remarking that he did not think the verdict a right one.

SPEED OF TRAMCARS.

At the West London Police Court on Saturday, Mr. Rose again had before him the adjourned summonses against four drivers in the employment of the London United Tramways, Limited, for driving electric tramcars at more than 10 miles an hour, the limit laid down by the Board of Trade for the locality (Goldhawk-road, Shepherd's Bush) in which the offences were alleged to have been committed.

Prof. Silvanus Thompson now stated that since the last hearing he had made a careful examination of the company's mechanical and electrical plant, and of the four cars, and he had made four speed tests of each of the cars on the measured furlong used in Colonel Purcell's tests. The mean speeds attained by the cars were as follows: car No. 272, 14·465 miles per hour; No. 60, 12·487 miles; No. 75, 13·335 miles; No. 173, 14·157 miles. When he made these tests he had a voltmeter on the cars, and he was satisfied that the conditions under which the tests were made were fair, and that there had been no tampering of any sort or kind with the electrical plant or with the cars. In his judgment it was not possible for any of these cars to go at 17 miles per hour on the section of line referred to. In cross-examination, Prof. Thompson said it was not necessary to use a voltmeter for tests of speeds; the use of a voltmeter was only necessary when, as at the last hearing of this case, suggestions of fraud were made.

Mr. J. R. Salter, engineer-in-chief to the South Lancashire Electric Tramways, testified to the fact that the plant had not been tampered with. The conditions on the day Prof. Thompson made his tests were precisely the same as when Colonel Purcell's tests were made.

In giving his decision, **Mr. Rose** said it was clear that the methods by which Mr. Ford (the prosecutor) took the speeds were not so exact and accurate that he could have relied upon them if it had been alleged that the regulation speed per hour had been exceeded by, say, a quarter of a mile per hour. But after hearing the expert evidence he was not so satisfied of Mr. Ford's gross inaccuracy as to doubt his statement that the speed of the cars exceeded 10 miles an hour, although it appeared to be practically impossible that the cars could have attained the very high speeds which Mr. Ford alleged. If the speed exceeded 10 miles an hour there must be a fine, whatever the effect might be upon the public convenience. As to the amount of the fine, motorists would no doubt think that the same fine as they usually paid ought to be imposed on this great company; but it was not the company that was summoned, but the drivers, and he would impose fines of £2 each.

Mr. Muir said that Mr. Ford had in the course of the case made a deliberate suggestion of fraud against the company in connection with the tests, and he hoped the magistrate would express his opinion on that point.

Mr. Rose said he did not regard it as a suggestion of fraud.

Mr. Ford said he had not intended to make such a suggestion; if he had made it, he withdrew it.

DEFINITION OF A WORKMAN.

The case reported in our last issue, in which the Leeds Stipendary was called upon to define "a workman" in connection with the issue of workmen's fares on the electric tramways, was again before the magistrate on Wednesday. The Corporation summoned an estate agent's clerk for refusing to pay more than the workman's fare when travelling on a car intended for the carriage of workmen.

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The **Magistrate**, after a lengthy hearing, said that, inasmuch as it was admitted that this was a car run under the section in the Corporation Act relating to workmen's cars, the Corporation had no authority to demand from the defendant more than the penny which he offered to pay, because, whatever might be said about mechanics, artisans, or daily labourers, it provided that these cars should be run at tolls not exceeding ½d. per mile, and that the Corporation should not be required to take any toll or charge less than 1d. It was admitted that this was a car run under this section, and it was not open to the Corporation to demand the same toll as for an ordinary car. Inasmuch as the defendant was accepted as a passenger, and was not removed from the car or asked to leave, the only legal charge the Corporation could make was the penny tendered.

The case was dismissed, and the defendant was allowed 5s. cost.

A TELEPHONE AGREEMENT.

The National Telephone Company, at the Cardiff County Court, sued Mr. David Mullins for the recovery of 13s. 7d. in respect of telephone fees.

The **Company's Manager** said defendant signed a "party-line agreement." There were five subscribers on the line, and they agreed to pay 2d. per day. Under that agreement 13s. 7d. was due.

Mr. George David (for the defendant): You have had frequent complaints with regard to this instrument?—Yes, one or two.

Mr. David: You know they have been absolutely unable to use it?

The Judge: That's a matter for a counter-claim.

Mr. David: No, your Honour; there is an implied condition that they must supply us with an instrument that is fit for the purpose.

Plaintiff's Manager said the defendant's premises were connected on Dec. 24 last, and the instrument was paid for regularly up to May 16. There was then 3s. 7d. outstanding, and as this was not paid the line was disconnected on May 28.

Mr. David: Although they disconnected us their charges are running on.

Witness: The agreement provides for that. The instrument is still there.

The Judge: If you cut off a man's water, you cannot charge for it afterwards. I will certainly not enforce that part of your agreement unless I am compelled to. All you can recover is 2d. per day up to May 28. His Honour, having examined the agreement, gave judgment for the defendant.

GREENOCK TRAMWAYS.

We have received an official copy of the arbitration proceedings and award in the dispute between the Greenock and Port Glasgow Tramways Company and the Greenock Corporation as to what were the obligations of the former to take electrical energy from the Corporation for the working of the tramways. The agreement between the parties stipulated that the company were to take from May 1, 1901, all the energy required for the working of the tramways, the minimum amount guaranteed by the company being 500,000 units per annum. The price to be paid by the company for this energy was 1½d. per unit for the 500,000; the price of all energy in excess of this amount to be settled by mutual agreement. A further condition of the lease was that the company were to pay the Corporation a reasonable sum for the use of feeder ways. Owing to differences arising between the Corporation and the company an appeal was made as provided by the lease by the company to the Board of Trade, who appointed Mr. Sheldon, barrister, to act as arbiter between the two parties. The questions submitted to him were: first, to determine the date from which the company were bound to fulfil their obligation to take electric energy from the Corporation at the rate of 500,000 units per annum; second, the price to be paid by the company for all energy in excess of 500,000 units per annum; third, the sum to be paid as rental for the use of cableways, the capital value of which was admitted to be £2,000.

The sittings of the arbitration court took place in the Inns of Court Hotel, Mr. Sydney Morse representing the company (which is one of the British Electric Traction group), while Mr. John Kennedy represented the interests of the Corporation.

The most important of the three questions was, of course, that referring to the price to be paid for the energy in excess of the 500,000 units. The Corporation called Mr. J. A. Robertson, burgh electrical engineer, to give evidence as to the present condition of the undertaking, and the cost of producing energy for the company. He was cross-examined by Mr. Sydney Morse, who tried to show that the cost of producing traction energy in a combined station was much less than the cost of producing lighting energy, and that it was unfair to divide the costs of production equally over the whole output. The Corporation also called Mr. I. E. Winslow, of the New General Traction Company, who gave it as his opinion that no reduction should be made in the price charged for energy until the company's consumption reached a million units per annum.

The company called Mr. H. M. Sayers, Mr. A. J. Lawson, Mr. Arthur Wright, and Mr. Phillip Dawson. These witnesses were all of opinion that the excess power should be supplied at the rate of ½d. per unit. As the company are taking energy at the rate of nearly 800,000 units per annum, it will be seen that the difference between the company's figures and the price asked by the Corporation would amount to over £1,200 per annum.

The arbiter's award is as follows: first, the 1st of August, 1901, is the date from which the company were bound to take energy at the rate of 500,000 units per annum; second, that seven-tenths of a penny is the price to be paid for all energy in excess of the minimum guaranteed amount of 500,000 units per annum; third, that £125 per annum is the sum to be paid for the rent of the cableways used by the company for their traction feeders.

The costs of the arbitration are to be borne equally by each party.

COMPANIES' MEETINGS AND REPORTS.

EDISON AND SWAN UNITED ELECTRIC LIGHT.

The ordinary general meeting of the shareholders in this Company was held at Winchester House, E.C., on Thursday last week, Mr. Henry Wolfenden presiding.

The **Chairman**, in moving the adoption of the report (which appeared in our issue for the 30th ult.), said that the directors were sorry that they had not been able to hold the meeting at an earlier date. The great amount of detail involved would prevent the meeting being held before October, which he hoped would be the month in future. The shareholders would notice that the report was drawn up in a different manner to those of former years. A detailed profit and loss account was not shown, but only the balance of net revenue was stated. That course the directors thought was the right one in the interests of the Company. The sales for the year showed a decrease, but the deficiency in that direction was more than recouped by a reduction in expenses. The sales since last June showed an improvement over those for the corresponding period of last year. The balance had been arrived at after the present stock had been valued on conservative lines. He confidently believed that no further reduction of the prices of stocks would be likely, unless something extraordinary should arise, such as a heavy fall in the cost of production, etc., which, however, he did not look for. Some shareholders might think that the directors had put too freely to depreciation of plant, but the Board was in the best position to decide. The Board had added £1,000 to reserve for future stock depreciation. When that reserve reached a higher figure, the question would be reconsidered as to whether it should be added to annually. The investments, consequent upon the sales of National Telephone shares, were reduced. The indebtedness of the Altrincham Electric Supply Company was reduced by £151, and he expected that the process of reduction would continue during the current year. That undertaking was making steady progress. With regard to the possibility of reducing the capital of the Company, it did not appear to the directors that any good could be obtained at present by writing it down. He sympathised with the shareholders that the directors were not in a position to declare a dividend. The Company was making steady progress, and he looked forward to the future with confidence.

A **Shareholder** asked if the Company was holding its own in regard to competition, and whether the stocks were down to bedrock. He also said that the question of reconstruction nowadays was so easy that it ought to be dealt with at once.

The **Chairman** said that he was satisfied that the Company could compete in lamps, quality considered, with anyone. The stocks were valued down to bedrock. As to the writing down of capital, the directors would act upon any mandate given by the shareholders, but in a short period the directors would be better able to see what was required.

The report was adopted.

EASTERN EXTENSION, AUSTRALASIA, AND CHINA TELEGRAPH.

The report of the directors for the half-year ended June 30 states that the gross receipts amounted to £265,099, against £283,856 for the corresponding half-year of 1902. The working expenses, including £29,613 for maintenance of cables, absorb £138,516, against £121,237 for the corresponding period of 1902, leaving a balance of £126,582. From this is deducted £5,955 for income tax and £11,771 for interest on debenture stock, etc., leaving £108,856 as the net profit for the half-year. After adding £37,180 brought forward there is an available balance of £146,036. Two quarterly interim dividends of 1¼ per cent. each, amounting to £75,000, have been paid for the half-year, leaving a balance of £71,036 to be carried forward. The agreement concluded with the Australian Federal Government for extending to Melbourne and Brisbane the privilege enjoyed by the Company in other State capitals of Australia of dealing direct with the telegraphing public has been formally approved by the Federal House of Representatives, but the Senate has deferred coming to a definite decision upon it pending the result of a conference to be held between the interested Governments to consider what effect the agreement may have upon the British Pacific Cable, and other questions. Meanwhile the tentative arrangement come to with the Federal Government, by which the Company is allowed to work a special wire between Adelaide and Melbourne, and to deal direct with the public in the latter city, remains undisturbed.

NEW COMPANIES REGISTERED.

Electro Peat-Coal Syndicate, Limited (79,016)—Capital, £500. Object: to carry on the business of manufacturers of peat-fuel, peat-charcoal, and fibrous peat, etc.

Alert Electrical Company, Limited.—Capital, £2,000. Object: to carry on the business of electricians, electrical engineers, producers, generators, accumulators, etc.

Light Cure and Electro-Therapeutic Institute, Limited.—Capital, £12,000. Objects: to provide, furnish, and maintain an establishment for the cure and relief of diseases and ailments by electrical and other kindred treatment, etc.

Sunderland District Electric Tramways, Limited (79,054).—Capital, £270,000. Objects: to acquire the right to construct a tramway or tramways in the neighbourhood of Sunderland, etc.

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CONTRACTS FOR ELECTRICAL SUPPLIES.

Erith.—The Council invite tenders for the wiring and fitting of premises.

Newport (Mon.).—The Borough Council invite tenders for three 50-h.p. motors, etc., by 23rd inst.

Whitehaven.—The Guardians require tenders for the lighting of their infirmary. Tenders by Nov. 18.

Middlesbrough.—Tenders are required by the Corporation for dynamos, boilers, and condensers, by 28th inst.

Brussels.—The Belgian State Railways require tenders for four lots of telegraph poles (specification No. 217). Tenders by Dec. 23.

Canosa di Puglia (Italy).—The Municipality will receive tenders for installing and working electric lighting for 50 years. Tenders by 30th inst.

Witton (Birmingham).—Messrs Kynoch, Limited, invite tenders for electrical supplies for six or 12 months from Jan. 1, 1904. Tenders by 20th inst.

Hornsey.—The District Council invite tenders for one 300-kw. steam dynamo to be delivered in October, 1904, and another in March, 1905.

Dudley.—The Guardians invite tenders for the supply and fixing of the various appliances for the electric installation to the laundry and boiler house.

Windsor.—The Town Council invite tenders for the supply of electricity or gas for the purpose of public lighting throughout the district for a period of five years.

Wood Green.—The Urban District Council invite tenders for the erection of a power station and the buildings in connection with the Council's electric lighting scheme.

Leeds.—The Street-Lighting Department invite tenders for installing a heating plant at the new offices and workshops at Springwell-street. Tenders by noon on 16th inst.

Rangoon.—The Municipal Committee have decided to call for amended tenders for the electric lighting of the town on a continuous-current system. Five tenders were received for the first call.

Plymouth.—The Corporation invite tenders for painting, etc., tramcars. Specification, etc., can be obtained from the Tramways Manager, Ebrington-street, Plymouth. Tenders by 16th inst.

Greenwich.—The London County Council invite tenders for the supply delivery, and erection of four 3,000-kw. generators with exciters. Tenders by 10 a.m. on Dec. 8. See advertisement.

Wisby (Sweden).—Tenders are invited for a private and public electricity supply estimated to cost 180,000 kroner. Particulars may be obtained from the Director of the Draetselkammaren at the above place.

King's Norton and Northfield.—The Council invite tenders for the erection of car-sheds and waiting room. Tenders by 30th inst. to Mr. Edwin Docker, clerk to the Council, 10, Newhall-street, Birmingham.

London County Council Tramways.—The Council invite tenders for the wiring and fitting for electric lighting of five sub-stations and three car-sheds in connection with the tramways. Tenders by Dec. 5. See advertisement.

Sydney (N.S.W.).—Tenders are asked for the supply of continuous and alternating current meters. Specifications, conditions, and forms of tender are obtainable from Messrs. Preece and Cardew, 8, Queen Anne's-gate, S.W. See advertisement in last issue.

London, W.—The Great Western Railway Company invite tenders for the supply, delivery, and erection of water-tube boilers, engines, three-phase generators, and auxiliary plant at Park Royal, near Acton. Tenders by Dec. 7. See advertisement in last issue.

Kirkcaldy.—The Corporation invite tenders for one about 400-kw. combined steam-engine and dynamo for lighting or traction (vertical triple-expansion or three-crank compound and multipolar generator). Tenders by Nov. 23. See advertisement in last issue.

Christchurch (New Zealand).—Tenders are invited for the complete installation of electrical tramways, other than buildings. Specifications, etc., may be obtained from the Agent-General for New Zealand, Victoria-street, S.W. See advertisement in last issue.

Dartford.—The Metropolitan Asylums Board invite tenders for installing a complete system of telephones at the Darenth Asylum, Dartford, Kent. Specifications, etc., may be obtained at the office of the Board, Embankment, E.C. Tenders by 10 a.m. on Nov. 17.

Glasgow.—The Corporation invite tenders for the electric light installation, etc., for Anderston District Library. Specifications, etc., may be obtained from Messrs. Paterson and Stewart, architects, 14, Blythswood square, Glasgow. Tenders by 10 a.m. on 17th inst.

London, N.—The Hornsey Urban District Council invite tenders for the supply of meters, indicators, and consumers' fuse boxes. Specifications, etc., may be obtained from Mr. Norman Staniland, Electricity Works, Tottenham-lane, Hornsey. Tenders by 30th inst.

Todmorden.—The Corporation invite tenders for one Lancashire boiler, two steam dynamos and balancer booster, two feed pumps and one injector, economiser, surface or jet condenser, switchboard and instruments, storage battery, cable work, and overhead hand crane.

Blackadon (Devon).—The Corporation invite tenders for fitting up an electric light installation at the borough asylum. Specifications, etc., may be obtained from Mr. E. G. Okell, borough electrical engineer, Electricity Works, Prince Rock, Plymouth. Tenders by Nov. 14.

Dublin.—The United Tramways Company invite tenders for the supply of general stores, including car fittings, iron, steel, castings, oils, paints, glass, brushes, ironmongery, harness materials, electrical supplies, timber, etc., for year ending Dec. 31, 1904. Tenders by 30th inst.

Barrow-in-Furness.—The Corporation invite tenders for the completion of the electric lighting installation at Hawcoat and Walney police stations and the pig slaughtering hall and lairage at the public abattoirs. Further particulars may be obtained from the Borough Engineer.

Kilmarnock.—The Corporation invite tenders for three Lancashire boilers, engines and dynamos, overhead hand travelling crane, storage battery, switchboard. Specifications, etc., can be obtained from the Town Clerk. Tenders must be delivered at the Town Clerk's Office by Nov. 18.

Belfast.—The Committee invite tenders for the supply and erection of a complete heating and ventilating system, including steam boilers, heaters, etc., engines, blowers, and electric fans. Tenders by Dec. 4 to Messrs. Young and Mackenzie, architects, Scottish Amicable Buildings, Belfast.

Swindon (Wilts).—The Corporation invite tenders for complete traction switchboard cables, etc. Specifications, etc., may be obtained from Messrs. Lacey and Sillar, 78, King-street, Manchester, and 2, Queen Anne's-gate, Westminster. Tenders by Nov. 23. See advertisement in last issue.

Brighton.—The Council invite tenders for six water-tube boilers; a system of steam, exhaust, feed, blow-off, and suction pipes; and cast-iron storage tanks. Specifications, etc., may be obtained from Mr. Francis J. Tillstone, Town Hall, Brighton. Tenders by Dec. 7. See advertisement in last issue.

Warrington.—The Cheshire Lines Committee invite tenders for telegraph materials, steel fishplates, creosoted sleepers and crossing timbers, and oak keys. Specifications, etc., can be obtained from Mr. S. Saxon Barton, stores superintendent, Cheshire Lines, Warrington. Tenders by 10 a.m. on 27th inst.

Swindon.—The Corporation invite tenders for the supply, delivery, and erection of steel poles, overhead line section boxes, arc lamps, and accessories. Specifications, etc., may be obtained from Messrs. Lacey and Sillar, 78, King-street, Manchester, and 2, Queen Anne's-gate, Westminster. Tenders by Nov. 16.

Culiacan (Mexico).—Tenders are invited for lighting the town by electricity; 60 arc lamps of 1,200 c.p. and 110 incandescents of 50, 30, and 16 c.p. will be required. Propositions will be received by letter until Dec. 31 in the Secretaria del Ayuntamiento, Culiacan, where further information may be obtained.

Edinburgh.—The Lord Provost, Magistrates, and Council invite tenders for the wiring and fittings for the electric lighting installation at Gayfield-square police station. Specifications, etc., can be obtained at the office of the Resident Electrical Engineer, Dewar-place, Edinburgh. Tenders by 10 a.m. on 21st inst.

Radcliffe.—The Council invite tenders for the supply and completion of (Contract No. 12) lighting and traction switchboard and accessories; (14) rail bonds. Specifications may be obtained from Messrs. Lacey and Sillar, 2, Queen Anne's-gate, Westminster, and 78, King-street, Manchester. Tenders by Nov. 14.

Blackpool.—The Electricity and Tramways Committee invite tenders for one new 450-kw. traction set (vertical triple-expansion engine and multipolar generator). Specification may be obtained from Mr. Charles Furness, borough electrical and tramways engineer, Electricity Works, Blackpool. Tenders by Nov. 14.

Glasgow.—The Directors of the Caledonian Railway Company invite tenders for the supply of telegraph appliances, etc., and electric lighting material and fittings. Specifications, etc., may be obtained from Mr. Jas. Lorrimer, stores superintendent, Caledonian Railway, Charles-street, St. Rollox, Glasgow. Tenders by 23rd inst.

Handforth (near Manchester).—The Guardians of Chorlton-upon-Medlock Union invite tenders for an electric motor for the new laundry at Styal Cottage Homes, Handforth, near Manchester. Specifications, etc., can be obtained from the consulting electrical engineer, Mr. G. R. Peers, A.M.I.E.E., 16, John Dalton-street, Manchester.

Radcliffe (Lancs.).—The Urban District Council invite tenders for the supply of the pitch and oil required in the construction of the tramways in the district. Specifications, etc., may be obtained on application to Mr. W. L. Rothwell, engineer, at the Council Offices. Tenders to Mr. S. Mills, clerk, Council's Offices, Radcliffe, by Nov. 14.

Wednesbury.—The Corporation invite tenders for the electric wiring and fittings for the town hall, municipal offices, art gallery, public baths, public library, and electricity sub-station. Specification, etc., may be obtained at the offices of Mr. F. J. Warden-Stevens, A.M.I.M.E., A.M.I.E.E., 34, Victoria-street, Westminster, London, S.W. Tenders by noon on Nov. 20.

Manchester.—The Tramways Committee invite tenders for hard-drawn copper trolley wire for overhead equipment, galvanised steel span wire and span-wire brackets, and feeder straps for tramway poles. Specifications, etc., may be obtained on application to Mr. J. M'Elroy, Tramways Department, 55, Piccadilly, Manchester. Tenders to Chairman, Tramways Committee, by 17th inst.

Harrogate.—The Corporation Electricity Department invite tenders for the supply and part laying of two high-tension concentric, paper-insulated, lead-covered trunk mains from the electricity works to the town. Specification may be obtained from Mr. Geo. Wilkinson, M.I.M.E., M.I.E.E., engineer-in-chief, Corporation Electricity Department, 33, Swan-road, Harrogate. Tenders by Nov. 16.

Sydney (New South Wales).—Tenders will be received at the office of the Deputy Postmaster-General, Sydney, New South Wales, up to 2.30 p.m. on Dec. 30, for the supply and delivery at the departmental stores, Sydney, of telegraph, telephone, and electric light

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material. Specifications, etc., may be seen and tender forms obtained at the General Post Offices, Sydney, Melbourne, Brisbane, Adelaide, Hobart, and Perth.

Wednesbury.—The Corporation invite tenders for the electric wiring and fittings for the following public buildings: town hall, municipal offices, art gallery, public baths, public library, and electricity sub-station. Specification, etc., may be obtained between 2 and 5 p.m. at the offices of Mr. F. J. Warden-Stevens, A.M.I.M.E., A.M.I.E.E., consulting engineer, 34, Victoria-street, Westminster. Tenders by 12 noon on Nov. 20.

Colombo (Ceylon).—The Government of Ceylon invite proposals from persons willing to enter into a contract for the supply of electrical energy to the various offices, buildings, and premises of the Government, within the Municipality of Colombo, for a term of years commencing on or about Aug. 1, 1905 Proposals must be delivered at the office of the Colonial Secretary, Colombo, by Dec. 1. The *Ceylon Government Gazette* containing above notice may be seen on application at the Commercial Intelligence Branch of the Board of Trade, 50, Parliament-street, S.W.

RESULTS OF TENDERS.

St. Helens.—The Corporation have placed an order with Dick, Kerr, and Co., Limited, for a 400-kw. direct-current generator.

Hong Kong.—Messrs. Johnson and Phillips of Victoria Works, Old Charlton, Kent, have secured the contract for the 250-kw. steam alternator for the Hong Kong electric light station.

Chesham.—The Council have accepted the tender of the electric light company to light the market-house clock, the fire station, and the lamp outside, for a sum of £13. 13s. per annum.

Aberdeen.—The Parish Council have accepted the tender of Messrs. Pratt and Keith for the electric installation at the new poorhouse, amounting to £2,001, subject to the architects being satisfied with the schedule.

British Aluminium Company.—This company has placed an order with Dick, Kerr, and Co. for two 520-kw. direct-current generators. The machines are for the Aluminium Company's works at Foyers, N.B., and are to be driven by turbines.

Sub-Contracts.—Messrs. Belliss and Morcom, Limited, report the following contracts: Reigate: By the General Electric Company, Witton, one engine for coupling direct to General Electric single-phase alternator. Dewsbury: By Messrs. Siemens Bros. and Co., Limited, one 500-h.p. engine for coupling direct to Siemens generator. North Riding Asylum, York: By Messrs. Crompton and Co., Limited, one engine for direct coupling to Crompton multipolar dynamo. Gravesend: By the British Westinghouse Company, one engine for direct coupling to Westinghouse generator.

Condensing Plant.—The Mirrlees-Watson Company, Glasgow, report the following orders for condensing plant: Yorkshire Power Scheme, per Babcock and Wilcox, 3 sets; Lancashire Power Scheme, per Babcock and Wilcox, 4 sets; Tokio Tramways, per Dick, Kerr, and Co., 2 sets; Watson's Paper Mills, per Willans and Robinson; Wouldham Cement Company, 2 sets; Govan Corporation, 3 sets; Metropolitan Tramways, per Brush Company, 5 sets; Clyde Valley Power Company, per Westinghouse Company, 2 sets; Hong Kong, per Brush Company, 2 sets; Bromley, per Edmundson's Corporation; Bradford Corporation, per J. Musgrave and Sons; Isle of Man, per Babcock and Wilcox; British Thomson-Houston Company, Rugby, etc. The condensing plant orders booked during the current year are to deal with over 1,000,000lb. of steam, or, say, 65,000 h.p., and the average horse-power dealt with per set is rather over 1,600 h.p.

Canterbury.—The Urban Sanitary Authority have received the following tenders for the supply of 2,200 yards of ·4 square inch t c/c cable:

Siemens Bros. and Co., York Mansion, York-street, Westminster, S.W. (accepted)	£1,290	0	0
Land and Sea Cable Works, 27, Mincing-lane, E.C.	1,283	7	0
British Insulated and Helsby Cables, Limited, Prescot, Lancs.	1,308	0	0
W. F. Dennis and Co., 49, Queen Victoria-street, E.C.	1,320	0	0
Callender's Cable and Construction Company, Limited, Hamilton House, Victoria-embankment, E.C.	1,331	0	0
W. T. Glover and Co., Limited, Trafford Park, Manchester	1,334	7	6
Western Electric Company, Limited, North Woolwich	1,372	0	0
Burley and Strange, Folkestone	1,383	13	3
W. T. Henley's Telegraph Works Company, Limited, Blomfield-street, London-wall, E.C.	1,395	0	0
Johnson and Phillips, Old Charlton	1,453	0	0
St. Helens Cable Company, Limited, Warrington	1,495	0	0
Union Cable Company, Limited, 23, College-hill, Cannon-street, E.C.	1,699	0	0
R. F. Heath, 47, Dawes-road, Fulham, S.W.	2,000	0	0

BUSINESS NOTES.

TRACTION.

Newcastle.—The Town Council have finally decided not to construct the line to Heaton.

Ashton.—The Wigan Corporation tramways to Ashton are now being proceeded with rapidly.

Belfast.—A meeting of the Council in committee has approved the draft of the proposed Tramways Bill.

Ipswich.—A successful trial has been made over one of the completed sections of the electric tramways.

Liverpool.—At the last meeting of the City Council it was decided to increase the membership of the Tramways Committee to 19.

London-Brighton Electric Railway.—It is stated that the London-to-Brighton electric railway project is postponed for the present.

St. Marylebone.—The Borough Council are recommended to adhere to their previous decision against the construction of surface tramways in Edgware-road.

Manchester.—The Corporation intend to promote a Bill in the next session of Parliament to authorise the construction of further lines of tramways in the city.

Dudley.—The tramway company are negotiating with the Corporation for the acquisition of more space in the Market-place for the development of the tramway system.

Sutton Coldfield.—A sub committee has been appointed to confer with the City of Birmingham Tramways Company on the question of the construction of tramways within the borough.

Richmond.—The proposed tramway extension to enable the electric cars to pass over Kew Bridge has again been discussed by the Richmond Town Council, the proposal being finally negatived after a spirited debate.

Wednesbury.—A special meeting of the Town Council has decided to give notice to the South Staffordshire Tramways Company requiring the company to sell to them so much of the tramway undertaking as is within the borough.

Llanelly.—The Borough Council have confirmed their decision to promote a Bill in Parliament to compel the British Insulated Wire Company to carry out their contract in reference to establishing a system of electric traction in the town.

Newport (Mon.).—It is stated that the Tramways Committee have yielded to the many protestations against the construction of a tramway on Stow Hill, and are prepared, when the necessary powers have been obtained, to run a motorcar service instead.

Colne.—The Colne and Trawden Light Railway Company intend to make an application to the Board of Trade for an extension of the time in which to complete the light railway No. 2, from the top of Heifer-lane to the terminus, and No. 3 from the borough boundary to the Rock Inn, Trawden.

Bettws-y-Coed.—At the monthly meeting of the Urban District Council it was reported that Messrs. Mansfield and Co., of London, proposed, on behalf of a syndicate, to proceed for powers to construct an electric railway from Corwen to Bangor. The Council decided to apply for full details of the scheme.

Cardiganshire.—The County Council, who had promised £18,000 towards the Aberystwyth-to-Aberayron light railway, have now given the promoters six months' extension of time for raising the capital. It was decided at the last meeting to contribute towards the cost of preparing a scheme for a line from Lampeter to Aberayron.

Raworth Motor and Control.—The new electric motor and control designed by Mr. A. Raworth, jun., on his regenerating system was tried on the Devonport and District Tramway Company's lines last week. No figures are as yet available on the subject, but the inventor claims considerable savings from the use of his system.

Rochester.—Mr. C. H. Merz has submitted a report to the City Council as to the construction of tramways along the New-road and Star-hill at once, instead of waiting for the main drainage scheme to be completed. Inasmuch as the scheme of drainage will not interfere with the construction of the tramways, the work is to be proceeded with at once.

North Lincolnshire.—The scheme for constructing a light railway from Frodingham to Winteringham Haven on the Humber, which has been in abeyance for some considerable time, has lately been resuscitated, and it is stated that the contracts will shortly be let and the work commenced. The estimated cost is £80,000, and the line will be about eight miles long.

Electro-Pneumatic Signalling.—The Great Central Railway Company, in addition to equipping their Woodhead tunnel with the Miller electric signals have, it is stated, now also placed a contract for the equipment of their main line at Manchester with low-pressure pneumatic signalling plant. The work will be carried out by the British Pneumatic Signalling Company.

Rochdale.—A meeting of the representatives of the various authorities concerned in the acquisition of the Bury, Rochdale, and Oldham Tramway Company's undertaking was held at Rochdale on Friday. The meeting unanimously resolved to request the Board of Trade to urge upon Sir Frederick Bramwell, the referee appointed by them, to proceed with the arbitration at the earliest date.

Wolverhampton.—The Board of Trade have conditionally approved of the Lorain system for the routes to be converted, subject to requirements which may be considered necessary on the inspection of the completed work. Speaking on the Tramway Committee's report at the last meeting of the Town Council, Alderman Mander explained that they had accepted tenders for six new cars at £570 less than they had cost before.

Liversedge.—Complaint was made at the last meeting of the Urban District Council that the electric traction company were not carrying out their obligations, so far as regarded the widening of the road at Millbridge and the continuation of the existing line to the top of Hightown. In regard to the first matter it was suggested that the Board of Trade should be written to, and be asked to compel the company to carry out their promise.

Kirkcaldy.—The Corporation provisional order to be lodged for the ensuing session of Parliament relates to the doubling of certain portions of the existing tramway line, alternative routes to High-street,

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and a new tramway line from the cottage hospital to Dysart, partly in the burgh of Kirkcaldy and partly in the parish of Dysart. Power is also asked to provide or run omnibuses to and beyond any of the termini of the tramways or in connection therewith.

Aston.—The District Council have made arrangements with the Council of the city of Birmingham to supply them with electrical energy until 1906 for the purpose of running their cars between the Old Square and the Council's boundary, at the rate of 1½d. per unit, the city of Birmingham contributing £200 towards the cost of laying the necessary cables. The engineer has been instructed to give the contractor notice to commence the reconstruction of the tramways.

Llandudno.—A special meeting of the Urban Council has been held to consider whether the Council should give notice of an application for a provisional order for powers to lay down electric tramways in the district. Several members expressed the opinion that the Colwyn Bay Light Railway Company had made a very substantial commencement of their undertaking, and it was decided to defer until March next the question of whether the Council should seek tramway powers.

Lancashire and Yorkshire Railway.—In connection with the electrification of the Southport-Liverpool line on the Lancashire and Yorkshire Railway it has been decided to carry out the electrification as far as Crossens, and the work has been commenced. The triangular line which touches Chapel-street Station, Southport, is to be electrified, so that a train may pass from the northern end of the line at Crossens through St. Luke's Station and Birkdale direct to Liverpool. On the line from Southport to Liverpool the work is well advanced.

South Hams Light Railway.—The Light Railway Commissioners resumed in London on Friday the enquiry respecting the proposed light railway in the South Hams district, particulars of which were given in our last issue. Counsel announced that an agreement had been arrived at between the promoters and the Great Western Company, and the former had consented to so alter the scheme as to meet with the approval of the railway company. On the suggestion of Colonel Boughey the promoters will take time to consider the question of gauge.

Swansea.—At a meeting of the Corporation Electric Lighting and Tramways Committee the scheme for the construction of tramway extensions to the outlying districts of Morriston, Sketty, and Port Tenant was described in detail, and the tenders received for the construction of the lines were opened and considered. They numbered 30, and it was agreed to refer them to the sub-committee for classification, and the selection of three tenders for further consideration. The firms selected will be asked to specify the extra charges for laying the electric lighting cables in trenches opened from the tramway cables if desired.

Brighton.—A singular position has arisen in connection with the projected tramway extension along the Preston-road at Brighton. Under the Act of Parliament 38 members of the Council must vote on the question, but though a majority in favour of the scheme has twice been obtained, its opponents have now triumphed for the time by refusing to vote at all. The effect of their action has been to reduce the voting strength of the Council to less than 38, so that if the opponents persist in a course of action which the tramway advocates contend was never for a moment contemplated by the Act the majority will be in the curious position of being defeated by the minority. The estimated cost of the scheme is £18,000.

Torquay.—It will be remembered that after lengthy negotiations with the Dolter Traction Company the Town Council decided to adopt the system of traction which that company are exploiting. The company, needless to say, were anxious to obtain the concession, but, curious as it may seem, they have now informed the Corporation that they have decided "to abandon the business," on the plea that the terms proposed by the Corporation are not such as it was possible for business men to accept. In a letter to the secretary of the company, the town clerk of Torquay refuses to accept this explanation "as the real cause for abandoning the business." The Corporation would now be well advised to proceed with the scheme themselves.

Additional Traffic Returns.—Anglo-Argentine, £2,113 increase; Barcelona Ensanche y Gracia, £117 increase; Barcelona, £209 decrease; Brisbane, £77 increase (month of August, £11,736, increase £294), British Columbia Electric (month of March), gross earnings £10,352, net income £2,659; Buenos Ayres and Belgrano Electric, £89 decrease (month of October, £14,055, increase £1,002); Calcutta, £366 increase; Cape Town (month of September), receipts £15,174, expenditure £8,503; Isle of Thanet Electric, £4 increase; Lisbon Electric (month of September), receipts 89,636 milreis, expenses 51,231 milreis; Mexico Electric (month of August), receipts £48,600, expenses £27,900; Perth Electric, £267 increase; Port Elizabeth (month of September), receipts £3,730, expenditure £2,767.

Paisley.—Operations in the burgh in connection with the construction of the electric tramways have been resumed. Last week we stated that Sheriff Lyell had issued an interim interdict against the work being proceeded with, pending the settlement of the dispute as to the quality of granite setts to be used. On behalf of the tramways company an appeal was lodged against this decision, and the sheriff has now recalled the interim interdict, but continues the injunction as regards the relaying of whin setts on the roadways. The general effect of the decision is that foreign granite may be used instead of the quality of Scotch granite, as desired by the Paisley Town Council. In order, however, to have the points at issue settled, the Paisley Corporation have applied to the Board of Trade to appoint an arbiter.

Pontypridd.—At the ordinary monthly meeting of the District Council this week Mr. J. B. Hamilton was appointed to value the position of the tramway undertaking owned by the British Electric Traction Company between the town and Hafod, and the rolling-stock, loose plant, machinery, and furniture at Porth. Mr. Hamilton is the manager of the Leeds Corporation tramways. The committee recommended that double-decked cars should be used on the system, which, however, the engineer (Mr. R. P. Wilson) considered was impracticable owing to the bridges *en route* being too low to admit of their use. The clerk was, notwithstanding, instructed to reply to the engineer that the committee thought it desirable that such cars should be adopted, and to ask him to report further upon the matter.

Peak District.—A scheme is being prepared for the Light Railway Commissioners which affects this district. It is felt that Bradwell and Castleton should have better accommodation, hence the scheme for a light railway to both places. The plans, which have been prepared, show the new railway to commence at a point near the station at Hope, crossing the village of Brough, and proceeding to Grey Ditch. It then turns to the right, and crosses the Bradwell Brook and the road between the New Bath Hotel and the Bradwell Town End, where there is to be a station. From this point the line continues through the meadows to Castleton, where another station is intended, the entire distance being a little over three miles. The various landowners interested are giving the scheme their support. Electricity will be the motive power.

Tube Proposal for Woolwich.—The provision of adequate facilities for communication between North and South Woolwich has become acute. The free ferry boats cannot work in foggy weather, and great inconvenience and loss result. A local committee has been advocating a subway, but the proposal has thus far been shelved by the London County Council owing to financial considerations. The local committee has been informed that Sir John Szlumper has evolved a scheme which will get over the difficulty as far as pedestrian traffic is concerned. The proposal is to make a tube railway from the main Arsenal gates, running down Beresford-street, under the river, to North Woolwich. The details of the scheme are to be submitted by Sir J. Szlumper to the Bridges Committee of the London County Council at an interview they have granted him.

Bradford.—A dispute, which will probably be settled in the law courts, has arisen between the Bradford Corporation and the local authorities of Pudsey, Farsley, and Calverley, and relates to the rating of the Bradford tramways, which passes through those districts. The assessment has been made and has previously been paid by Bradford on the basis of a tramway. Bradford now contends, however, that the lines should be rated on the basis of a light railway. Light railways are classed as railways, and may under certain circumstances be entitled to an exemption of three-quarters of the district rate. The Councils, however, contend that the circumstances do not in this case justify an application of the law to this light railway, and that it is to all intents and purposes a tramway, and has been constructed by Bradford under the powers which they obtained in their local Act of 1899.

Portsmouth.—The financial results from the working of the tramways is furnishing a burning topic of local discussion. According to the auditors' report, a sum of £6,918, which appears as a balance at the end of two years' working, would not be there if a somewhat similar amount, which should have been debited to revenue, had not been charged to capital. The capital expenditure in the town stood at the end of March last at £620,000, of which £208,000 was the purchase price of the old company, leaving £412,000 as having been spent on depreciable property. Now, 5 per cent. on that amount means £20,600 per annum. The result of the two years' working, it is pointed out, is, therefore, a loss of upwards of £40,000 in the shape of depreciation not provided for, plus the normal maintenance, which will necessarily be an increasing item year by year. One of the local papers declares that to satisfactorily meet the position it appears necessary to earn nearly £30,000 per annum more than at present, without increasing the expenses—viz., £20,000 for renewals and £10,000 for current repairs and maintenance.

Leith.—A conference was held on Monday between the directors o the Edinburgh and District Tramways Company and a sub-committee of Leith Town Council, with regard to the proposals made by the Corporation for the working by the company of the Leith tramway system. Leith proposes on acquiring the tramways to introduce electric traction, doubling the lines where practicable, and to lease the whole to the company along with a portion of the depôt at Morton-place. They stipulate as a basis for negotiation that the lease should expire at the same time as that of the Edinburgh tramways, that the company pay them an annual percentage on the total cost of acquisition, conversion, and extension of the lines, and a rent for the other property, that they should take electric energy from the Corporation electric lighting station at 1½d. per unit, that fares and service be subject to arrangement, that the company take over the present horse plant at the cost to the Council, and that for the purpose of through traffic the lessees equip their electric cars so that these might be taken over the cable system to St. Andrew-square or other point agreed upon. The proposals were considered at the conference as a possible basis of agreement.

Metropolitan District Railway.—Messrs. Glyn, Mills, Currie, and Co., on behalf of the Metropolitan District Railway Company, invite subscriptions for £500,000 4 per cent. perpetual debenture stock. The prospectus states that the work of converting the District Railway from steam to electricity is steadily progressing, and that the engineers anticipate that the whole system will be equipped and ready for working by the end of next year. Provision is being made for a largely increased service of trains, and it is intended to provide eventually on the main line a service of 40 trains per hour, as against 18 trains now running, and on each of the five suburban western branch railways a 10 minutes' service. When the system is electrically equipped and in full working order, the company expects to carry at least 100,000,000 passengers per annum and to meet this it is providing a seating capacity for 143,548,000 persons per

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annum. Part of the net proceeds of this issue will be applied for the general purposes of the company, and the balance will from time to time be paid over to the Underground Electric Railways Company of London, Limited, for the work of electrification. The subscription list opened yesterday, and will close on or before Saturday next at noon.

Sunderland District Electric Tramways.—The Sunderland District Electric Tramways, Limited, has been formed with a share capital of £270,000. The prospectus states that the company has been formed for the purpose of acquiring, constructing, and working certain tramways by electric traction through the colliery district in the neighbourhood of Sunderland, lying between the southern terminus of the Sunderland Corporation tramway system and the parish of Easington. A portion of the tramway is in course of construction. The tramways authorised comprise a length of 19¼ route miles, and will be of the standard gauge of 4ft. 8½in., being uniform with the Sunderland Corporation lines. The estimated population of the district to be served is 105,262, and besides traversing busy colliery centres, a considerable summer traffic to the seaside at Roker and other coast places in the neighbourhood is expected. The construction of the tramway, which has already been commenced, has been contracted for at the sum of £227,500, and it is anticipated that the line will be open for traffic next year. The purchase price for the provisional order and the benefits of contracts is £36,500, payable in cash. The Electric Conversion Syndicate, Limited, has agreed to guarantee the minimum share subscription of 150,000 shares for the sum of £12,500, payable as to £8,000 in cash and £4,500 in cash or fully paid shares, at the directors' option, and also a subscription of 600 debentures for a commission of 5 per cent. and a brokerage of 1 per cent.

Huddersfield.—At the last meeting of the Town Council the following report was presented: "The work of the tramways department has been steadily kept on during the past year. At the Longroyd Bridge power station the generating plant has been maintained, and continues to work satisfactorily. The rolling stock at present consists of 70 cars, comprising 22 bogie and 48 four-wheeled or truck cars. A contract has been entered into for the conversion of 12 of our bogie cars into truck cars, and this work is now proceeding, and is to be completed by Nov. 12, 1903. The cars have been kept in a thoroughly efficient state and in a clean condition. During the past municipal year the whole of our cars, with the exception of the bogie cars, have been fitted up with the Westinghouse-Newell magnetic brake. The work of equipping the bogie cars is now being carried out with all possible speed. This brake is a most powerful one, and its value has been fully demonstrated on two or three occasions, and what might otherwise have been a serious accident has been averted with the magnetic brake. The bogie cars have been fitted throughout with a new type of lifeguard—viz., the Hudson improved guard—the old kind of guard which we had on the bogie cars, known as the tray type, having been condemned by the Board of Trade. All the cars are now fitted with this very efficient guard, and, as in the case of the magnetic brake, it has fully proved its worth. During the year another addition has been made to a number of the cars by putting a cover over the top saloon. The total number of covered cars is 27. The present service of cars is 50 on ordinary days and 58 on Saturdays, as against 40 and 52 respectively the previous year. The overhead equipment and cables have been thoroughly maintained, and continue to give good results. The overhead work carried out by Messrs. Macartney, McElroy, and Co., Limited, has now been taken over by the Corporation. The total traffic receipts from Nov. 1, 1902, to Sept. 30, 1903, amount to £55,863. 17s. 6½d., being an increase of £9,006. 18s. 7½d. over the corresponding period last year. The total is made up as follows: receipts from passengers, £55,324. 13s. 3½d.; parcels, £496; miscellaneous, £43. 4s. 5d.—total, £55,863. 17s. 8½d. The mileage run during the period amounts to 1,410,768 miles, an increase over the corresponding period of 369,542 miles. The number of passengers carried is 10,353,213, an increase of 2,927,666 over the corresponding period."

Melbourne (Australia).—Through the courtesy of Mr. E. E. Rogers, who has charge of the Essendon and Flemington electric tramways lighting and power scheme, we are able to give some interesting particulars of the scheme, which has for its primary object the construction of electric tramways outside the city of Melbourne, Victoria, Australia. The Municipalities of Essendon, Flemington, Kensington, and Ascot Vale are situated together, immediately north of North Melbourne. The Melbourne tramways run cable cars to the northern boundary of North Melbourne. From this point it is proposed to construct two routes—first, through Ascot Vale, Kensington, and Flemington (all thickly populated), past the cattle yards, abattoirs, many of the principal warehouses, past principal entrance to Flemington Racecourse, Ascot Vale Racecourse, Royal Agricultural grounds, down to the Salt Water River, and on to the Moribyinong Racecourse. The line from the Salt Water River to the latter course is offered free of all cost of construction by the proprietor. The second route starts from the same point (North Melbourne terminus), and runs directly north through Ascot Vale and Essendon on past Moonee Ponds, Moonee Valley Racecourse, Queen's Park Gardens, to a terminus at the northern end of Essenden on the Mount Alexandra-road. The total routes to be constructed aggregate 7½ miles. The gauge is to be 7ft. 8½in. The promoters also have electric lighting and power rights at 6½d. and 4½d. per unit respectively. The resident population is 30,000, sufficient in itself to justify a tram and lighting scheme; but the extraordinary advantages in addition are that the system will have to carry passengers to the various places of amusement and sport the most popular around Melbourne. As an example of the attendance, the Royal Agricultural Show was held at the grounds recently. The attendance for three days was 52,000, 48,000, and 45,000 respectively. The attendance at Flemington on "cup" days often exceeds 100,000. Generally speaking, outside of the resident population of 30,000 for tramways and the electric lighting and power rights (in themselves a splendid concession), this little system for tramways will be fed by 500,000 people on "occasion" days alone. Mr. Rogers has had large experience in electric tramways, and as the late managing director of the Perth trams (which he put down and managed from their initiation till last month) he says he has never seen so good a proposition of its size as this. The concession is for 30 years. The straight-out fare is 2d. a ride, with the right to charge double on race-days and holidays.

London County Council.—At Tuesday's meeting of the London County Council, the Highways Committee had several reports on the agenda relating to tramways matters. In regard to the report presented to the last meeting recommending the Council not to purchase the London Southern Tramways Company's undertaking, and which was referred back, the committee now brought up a recommendation advising the summoning of a special meeting to decide the point. In the meantime, negotiations will be opened with the local authorities concerned with a view to seeing whether they will contribute to the cost of the street widenings involved in the reconstruction of the lines for electrical working. In another report the committee asked for authority to spend £1,500 for the purchase of tools, etc., in connection with the operation of the electric lines. The construction of the authorised tramways in St. John-street and Rosebery-avenue was the subject of another report, in which the committee recommended the adoption of the underground conduit system for these lines. The local authorities concerned are to be given an opportunity of expressing their views on the question. In regard to the payment of rent by the North Metropolitan Company in respect of the proposed new tramways, the committee recommended that an agreement be entered into with the North Metropolitan Tramways Company, providing (1) that the tramways, authorised by the London County Tramways Act, 1900, in St. John-street and St. John-street-road, shall, when constructed for the underground conduit system of electrical traction, be worked by the company by horse traction pending the reconstruction, for electrical traction, of the tramways with which they will be connected; (2) that during the period that the new tramways are worked by horse traction, the company shall pay to the Council a rent in respect of them equal to 8 per cent. per annum on the estimated cost—namely, £12,375—of their construction for horse traction, with the addition of £800 in respect of parliamentary, etc., expenses, making £13,175 in all; and, further, that when the new tramways shall be worked by electrical traction, the amount by which the actual cost of constructing the tramways exceeds the sum of £12,375 above mentioned shall, for the purposes of calculating the rent provided for in the company's lease, be taken as the cost of reconstruction for electrical traction. A joint report of the Highways and Improvements Committee was brought up recommending that the requisite powers be sought in the session of 1904 for the construction of a double line of tramways in the part of Wellhall-road proposed to be diverted and altered in accordance with the foregoing recommendation, such tramways to be in substitution for the proposed tramways between a point immediately south of the South-Eastern Railway and the junction of Woolwich-road and Eltham High-street, the construction of which was authorised by the London County Council (Tramways and Improvements) Act, 1902. Next week the Highways Committee will bring up a report, in which they state that in view of the proposal to proceed at an early date with the reconstruction for the conduit system of electrical traction of the first 22½ miles of the Council's (northern) tramways, steps should be at once taken to arrange for the supply of the rails and fastenings which will be required for this work. The Council authorised them to proceed with the preparation of the plans, etc., for the construction for an overhead system of electrical traction of the tramway in Archway-road authorised by the London County Council (Tramways and Improvements) Act, 1901, and rails will eventually be required for this purpose also. To ensure that there shall be no unnecessary delay in the carrying out of the works, they suggest that tenders should be invited for 12,500 tons of rails, conductor tees, fastenings, etc. This quantity of materials will suffice for the lines above referred to, and also for certain other works which, in their opinion, it is desirable should be put in hand at an early date, including the reconstruction of the present cable tramways between Kennington and Streatham. The cost of these materials is estimated at £90,000, and they propose that these shall be delivered and paid for as they are required. The prices for steelwork at the present time are very low, and they are advised that it is probable that the adoption of the course we suggest will result in a considerable saving, while the risk of delay will be obviated. They have sent to the Finance Committee the necessary estimate of £90,000, and recommend "that the estimate of £90,000, submitted by the Finance Committee, be approved; and that expenditure on capital account not exceeding that amount be authorised for the purchase of the rails, and other track materials, required in connection with the reconstruction, for electrical traction, of certain sections of the London County Council tramways and of the Council's (northern) tramways, and for the construction, for the same method of traction, of certain authorised tramways." The same committee will bring up another report next week with regard to the construction of new termini at Tooting. They will recommend "that the estimate of £13,850, submitted by the Finance Committee, be approved, and that the expenditure on capital account of sums not exceeding that amount in all, be authorised, in connection with the extension, under the powers conferred by the London County Council (Tramways and Improvements) Act, 1901, of the existing tramways in Tooting High-street, along portions of that thoroughfare and Defoe-road, and the construction of new termini in those thoroughfares." Mr. H. H. Asquith, K.C., has been appointed arbitrator with regard to the amount of rent to be paid to the Council by the North Metropolitan Tramways Company in respect of the new line of tramway constructed by the former in Agincourt-road, Hampstead.

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LIGHTING AND GENERAL.

Derby.—The Electric Lighting Committee are purchasing property in Full-street.

Pontypridd.—The Council are raising a loan of £26,000 for electric lighting purposes.

Yeovil.—The Town Council have agreed to purchase a piece of land for electric lighting purposes.

Ramsgate.—Decision with regard to the electric light agreement has been deferred until Nov. 18.

Clitheroe.—The Corporation intend to apply to the Board of Trade for an electric lighting provisional order.

East Barnet.—Application is to be made for an extension of time for the carrying out of the electric lighting order.

London County Council.—Sanction was on Tuesday given to the borrowing by the Islington Borough Council of £3,753 for electricity meters.

Sowerby Bridge.—The Gas Committee have decided that now the gasworks are in good order to devote some attention to the electricity scheme.

Farnham.—In view of the applications before the Council as to electric lighting, the Board of Trade is to be asked to extend the order for another year.

Brynmawr.—The Urban District Council have decided to obtain the advice of an electrical engineer on the question of lighting the town by electricity.

East Ham.—The Urban District Council propose to apply for sanction to borrow £15,000 for extending the plant at the electric supply and tramways power station.

Stepney.—The Borough Council have decided to apply for sanction to borrow £2,845 for laying new distributing mains, and £1,670 for extension of public arc lighting.

Kirkcaldy.—In the Corporation's provisional order to be promoted next year powers are sought to enter into contracts for supplying electrical energy beyond the borough.

Agency.—The St. Helens Cable Company, Limited, have appointed Mr. James C. Boyd, of 33, Elm Park-avenue, Ranelagh, Dublin, as their representative for cables in Ireland.

Walton-le-Dale.—The Urban District Council intend to apply to the Board of Trade, on or before Dec. 21, for a provisional order under the Electric Lighting Acts, 1882 and 1888.

Chesham.—The Town Council have agreed to a proposal to pump the water at the waterworks by means of electric motors instead of the present gas-engines for one month as an experiment.

Newport (Mon.).—The Electricity Committee propose to supply power and light to a private firm at 1d. per unit, it being estimated that the firm indicated would need 250,000 units per annum.

Colne.—During the last quarter 12,665 units of electricity were sold against 6,136 last year. An increase of 100 per cent. is by no means discouraging for a new undertaking. The new plant is now all well in hand.

Eton.—At the last Urban District Council meeting the vice-chairman said he did not think the cost of electrical power at the pumping station exceeded the price of the coal bill for the previous six months.

Monmouth.—An extra cable is to be purchased, at a cost of £250, to be laid between the generating station and the North-parade, in case the existing cable should fail, and to meet the increasing demand for the light.

Northumberland.—At the quarterly meeting of the County Council it was reported that the work connected with the installation of the electric light at the county asylum, at a cost of £8,496. 6s. 3d., had been completed.

Calne.—The Town Council have resolved to apply for a provisional order to supply electricity for all public and private purposes within the borough and the parishes of Langley Burrell, Chippenham Without, and Hardenhuish.

Sherburn.—A deputation of the Parish Council will seek an interview with Mr. Hornsby to enquire whether and upon what terms the Lambton Colliery Company can supply the parish with public electric lighting, and report to the Council.

Newcastle.—The Finance Committee have arranged that a deputation wait on the Tramways Committee respecting the price levied for the electric lighting of public buildings. The committee were of opinion that the price ought to be reduced.

Dunfermline.—The National Electric Construction Company, London, intend to apply for a provisional order granting to them statutory powers in the burgh. The Fife Electric Supply Company propose to lay down a station at Cowdenbeath.

Cookham.—The Rural District Council have decided to consent to the application of the Maidenhead Town Council for a provisional order authoriting the supply of electricity for public and private purposes within the parishes of Cookham and Bray.

Clacton.—The Urban District Council have received sanction to the application to borrow £15,225 for the purposes of electric lighting. A deputation will wait on the Board of Trade with a view to obtaining a further extension of the time granted by the order.

Sale of Plant.—An auction sale of an extensive stock of electrical lighting plant, dynamos, machinery, and surplus stock of accessories will take place by Messrs. Terson and Son, London-road, Buckland, Dover, on Nov. 24 to 26. Particulars appear in another column.

Banbury.—We understand that the Town Council have accepted an offer of the Banbury and District Electric Supply Company, Limited, to place two arc lamps in positions to be approved of, and at the expense of the company, for the purpose of demonstrating the use of the light for public lighting.

Manchester.—The Corporation will promote a Bill containing clauses to authorise them to supply electrical energy beyond the city and to acquire land and execute works in connection therewith. This has become necessary because of the agreement made with the Southern Tramways Company, whereby the Corporation would work the tramways towards Altrincham.

South Africa.—We are informed that the directors of the Cape Town Industrial Exhibition (International) are open to receive offers for lighting the grounds, etc. This exhibition opens in November, 1904, and closes at the end of January, 1905. The Belgian Government have decided to take part officially, and will expend £40,000 for the purpose. The address of the managers is Palmerston House, Old Broad-street, London, E.C.

Hull.—Last week we referred to a local agitation for a reduction in the price of current. It appears that the Corporation Committee, who have already agreed to make a uniform charge for meters, are of opinion that no reduction in the price of current can be made until the end of the financial year, which closes on March 31. During the half-year ending Sept. 30 there has been an increase of 60,156 units used for motors, and the revenue from the sale of current has increased from £9,144 to £11,877.

Flax Spinning.—We understand that the Irish Flax Spinning Company, of Belfast, have placed a contract with the British Thomson-Houston Company for the electrical operation of the extensions to their mills now in course of erection. The contract comprises the provision of a 60-kw. three-phase generator, switchboard, and three motors for driving the various rooms in the mill, which contain the usual flax-preparing and spinning machines. It will be interesting to watch the development of this, which we believe to be the pioneer scheme of electrical operation of flax machinery in Ireland.

Stock Exchange.—The Stock Exchange Committee have appointed Nov. 11 a special settling day for Charing Cross and Strand Electricity Supply Corporation's 4,000 "City Undertaking" 4½ per cent. cumulative preference shares (1903) of £5 each fully paid, Nos. 40,001 to 80,000; and London United Tramways (1901), Limited, further issue of £206,000 4 per cent. first mortgage debenture stock, and have ordered the said securities to be quoted in the official list. Application has been made to the committee to appoint a special settling day in and to grant a quotation to Dick, Kerr, and Co.'s 52,000 ordinary shares of £5 each fully paid, Nos. 1 to 52,000, 61,000 6 per cent. cumulative preference shares of £5 each fully paid, Nos. 1 to 61,000, and £300,000 4½ per cent. debenture stock.

Ammonia Sulphates.—Mr. Walker Smith, the borough surveyor of Barrow, has been lecturing to the townspeople on the municipal undertakings. In the course of his lecture, Mr. Smith referred to the refuse destructor, and spoke of the possibility of extracting nitrogen from the refuse as ammonia, which could be sold at about £12 per ton as ammonia sulphates. He also alluded to the fact that the steam could be used for generating electricity for the tramways, and they expected to obtain 1¼lb. of steam from 1lb. of refuse. Thirty per cent. of the residual clinker would be used for roadmaking, and it could also be crushed for filtering material or ground for flags, etc. But the greatest real profit of all would, he said, be the sanitary reform which was effected. The amount of refuse burned daily would be 40 tons.

Swansea.—The electrical engineer, Mr. Prussman, is drawing up specifications for the high-tension plant for lighting Morriston. A number of Nernst lamps are also to be installed. The members of the Corporation Electric Lighting Committee, with a number of friends, paid a visit of inspection to the Corporation electric lighting station, Strand, on Friday evening, where a change-over was effected from one of the largest engines to the other in 1min. 40sec., and Mr. Prussman, engineer, explained that that was the longest time the town would be in darkness through failure of an engine at any time. Notwithstanding a hitch in the original arrangement for the construction of an electric organ in St. Mary's Parish Church, Swansea, the committee of the church have determined to realise their scheme, and they have just decided to arrange with Messrs. Norman and Beard, of Norwich, who are constructing a similar instrument for the new Roman Catholic cathedral at Westminster, for an instrument to cost £3,000, and be the finest of its kind in South Wales. The work will be proceeded with in two sections, and the first will be opened by Easter. The organ will be blown by electricity from the Corporation mains.

Frome.—A curious bargain has been struck by the Urban District Council with Messrs. Edmundson's Electricity Corporation, Limited, the holders of the electric lighting order. The Council have decided to allow the company the use of the waste water from the baths during seven months of the year, and charge them for water supplied during the remainder of the period from the mains at 1d per 1,000 gallons. An agreement is to be prepared embodying this arrangement, and containing a clause that if at any time during the continuance of the arrangement it should be found that owing to the increased cost in fuel, or wages, or other expenditure the water could not be lifted to the reservoir at less than 1d. per 1,000 gallons, the charge should be proportionately increased for the time being. In consideration of the Council having done so, the company have decided to treat the lighting of all premises owned by the Council as "public lighting" and supply current for lighting such premises at a flat rate of 2½d. per unit. They will also supply current for power purposes to the Council at a reduction of 10 per cent. on their standard rate or at a flat rate of 1½d. per unit, at the option of the Council. Complaint is made that the Council which charges other consumers 6d. per 1,000 gallons is giving the water away, but it was explained that it was not desired to overload Messrs. Edmundson's with expense, as the Council was providing the necessary capital, and hoped to purchase the company's interests within seven or ten years.

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Steyning.—The Brighton Corporation have asked the Council to consent to terms for the supplying of electricity to certain villages in the district, but as there is no evidence of any desire for electricity in the parishes named no action has been taken in the matter.

Arc Lighting in the Suburbs.—With reference to the article "Gilbert Arcs in North-West London," in our last issue, we are informed that the very graceful columns both for Willesden and Hampstead were supplied by Messrs. Rowland Carr and Co., Lime-street-square, E.C.

London School Board.—The Board propose to expend £398 for supplying installation and fittings required for the electric lighting of the Gravel-lane School, Houndsditch. The work is to be executed by workmen employed direct by the Board, under the instructions of the architect of the Board.

Burgess Hill.—The Brighton Town Council have informed the Council of their intention forthwith to proceed with the construction of their telephone system within the district, and they have received permission to erect black fir telephone poles as they proposed in the roads within the district.

Glastonbury.—The Telephone Sub-Committee have circularised the town for subscribers to the proposed telephone service, but only received 38 replies, comprising nine promises of intention to subscribe and 29 refusals. The result is to be sent to the Wells Town Council, who instituted the idea.

Margam.—The proposal for a joint electric lighting and traction scheme for Port Talbot and Aberavon has been defeated by five votes to four. The chief argument of the opposition was that an electric tramway between Taibach and Aberavon would draw people into Aberavon and be detrimental to the trade of Taibach.

Louth.—The Town Council have accepted the proposal of the Sir Hiram Maxim Company, who had expressed their readiness to purchase the rights of the Council under the provisional order, and to supply electricity at an average of not more than 6d. per unit for private lights, 4d. per unit for public lighting, and 3d. per unit for motive power.

Longton.—The Corporation have sanctioned the extension of the electric cables to the British Anchor Pottery and to Beaconsfield Works, both in Anchor-road. Both firms have given a guarantee of a consumption equal to 10 per cent. upon the expense, and the work will be proceeded with at once. Messrs. Callender and Co. are the contractors.

Sleaford.—Mr. R. S. Yates, the electrical engineer, in his last report, states that in 1901, for four weeks, 582 units were generated, there were 21 consumers, and 253 lamps connected, the cost per unit being 3⅞d. In the corresponding four weeks in 1903 2,860 units were generated, 97 consumers, 1,988 lamps connected. The cost per unit of production had been reduced from 3⅛d. to 2⅝d.

Whitby.—The Urban District Council have decided to apply for sanction to the raising of a further loan of £2,000 for the purpose of laying a feeder from the central station to the end of Argyle-road, and for the further extension of cables, with the idea of lighting the whole of the public lamps with electricity. Mr. L. H. King, resident engineer to the Council, has been appointed consulting electrical engineer.

Bury St. Edmunds.—The report of the electrical engineer (Mr. L. P. Greig) mentions that during October five new services, equal to 104 8-c.p. lamps, and a motor of 1½ b.h.p. had been applied for, showing the steady advance made by the department was being maintained. The comparative statistics show the results of the past year's work to be most satisfactory. The total income to April 1, 1903, amounted to £2,251, as compared with £1,194 to April 1, 1902.

Wolverhampton.—The Lighting Committee propose to provide at the electricity works, Commercial-road, further engineering plant at a cost of £1,200, and also to erect a coal-conveying plant at a cost of £850. The latter will dispense with a great deal of labour in unloading boats and the use of wheelbarrows to the furnaces. The consumption of fuel is over 10,000 tons per year, and the proposal will effect a saving in its removal from canal boats to the steam-boilers.

Whitchurch.—At Tuesday's meeting accounts amounting to £637 were passed, and Mr. Martin explained that this included £150 for the telephone extension to the waterworks. The clerk reported that he had not yet received the requisite number of signatures required by the Post Office authorities for the establishment of the telephone communication in Whitchurch, but as there were only 25 guarantors required he hoped this number would soon be forthcoming.

Cab Calls.—The National Telephone Company propose, if a sufficient number of subscribers can be obtained in a district, to make telephonic communication with the nearest cab shelter, so that cabs can be called to private residences, thus doing away with the baleful whistle which often disturbs a whole neighbourhood. The subscription will be very moderate, and should benefit both householders and cabdrivers. The first experiment is to be made at Portland-place.

Arnside.—In answer to a requisition signed by several ratepayers of Arnside, and presented to the Parish Council, a meeting of ratepayers was held on Monday to discuss and determine whether the provisions in the Lighting and Watching Act, 1833, relating to lighting should be adopted and carried into execution in this parish. In the end a committee was appointed to consider various schemes for lighting the village and ascertain the approximate cost, and to present their report at a further meeting.

Bognor.—A letter having been received last week from the National Provincial Electricity Corporation, Limited, enquiring whether the Council would support their application for a provisional order empowering them to supply electricity in the Council's district, the latter decided to reply that they were already entering into an agreement for the supply of electric light to the town under their provisional order, and that under the circumstances they were not prepared to enter into negotiations with them.

Gelligaer.—At the District Council meeting last week Mr. A. Hayter dealt with the lethargy of the District Council in not providing proper light for the district or adopting some measures to bring about a reform. He suggested that they should ask the South Wales Electrical Power Company to send down a man to lecture upon the efficacy of electric light over gas. If they could not get works in Bargoed, they might be able to arrange with the Powell Duffryn Company to run a cable over, as was done at Bedwellty Pits.

Carnarvon.—The National Electric Contruction Company have declined to consider the proposal whereby they should undertake the distribution work in the borough immediately, and put down a temporary generating plant for use until the North Wales Power Company were in a position to supply in bulk from Leydaw Lake. They are, however, agreeable to putting down temporary plant to supply current until their Leydaw station was ready. An expert has been engaged to advise on the respective merits of the schemes.

St. Marylebone.—The Council have received a report from a sub-committee on the question of the cost of lighting the underground public conveniences. It was found that in many cases 8-c.p. lamps would give an efficient illumination where at the present time 16-c.p. lamps were in use, and the substitution of 33 8-c.p. lamps in place of 33 16-c.p. lamps has been arranged for. At an expenditure of £3, the lights over the w.c.'s would be utilised to more advantage by having shade carriers with shades, so as to throw the maximum candle-power of the lights downwards instead of on to the ceiling. It was also arranged to fix such contrivances.

Electrical Exhibition.—The Corporation of Eastbourne propose to hold an electrical exhibition at the town hall from Tuesday, Dec. 2, to Saturday, Dec. 6, inclusive. We understand that the committee will welcome novelties in the way of electric lighting or decorative effects, heating, cooking, ventilating apparatus, and electric power-driven machinery, or any other apparatus, fittings, or accessories relating thereto which might be of interest. A supply of electrical energy can be obtained at 200 volts alternating current and a frequency of 50, the rate of charge being 2½d. per unit for all purposes. A minimum fee of £1 will be charged in order to partially cover the cost of the service.

Plymouth.—Subsequent to the withdrawal of their recent Bill from Parliament, the Corporation applied for sanction to borrow the sum of £248,252 for purposes of electric lighting, sewerage, street improvements, parks, workmen's dwellings, and other works. Of this sum about £170,000 was in respect of capital expenditure already incurred, and the balance of nearly £80,000 represented further capital expenditure to which they are committed during the current financial year. In addition, the Council also applied for sanction to borrow £3,200 for repaving Sutton-road, and £6,700 for electric lighting purposes. Mr. E. Pearse Burd and Mr. H. Percy Boulnois, C.E., will hold an enquiry next Tuesday.

King's Lynn.—The electrical engineer in his last report states that applications had been received for 511 additional lamps of 8 c.p. or equivalent, making a total of 16,953 from private consumers. The total number of consumers up to date was 434. One motor of 8 h.p. had been ordered during the past month. The units sold to private consumers for the first six months of the present financial year, as compared with the same period last year, showed an increase of 30 per cent. for light and 178 per cent. for power. The output for power was greater than the output during the whole of last year. The working expenses for the six months were practically the same as those of the same period last year.

Ayr.—The following figures appear in the last report of the borough electrical engineer, Mr. Roland Marshall: "Number of consumers as per last report, 721; number connected during month, 3—total, 724; number of lamps connected as per last report, 28,041; number connected during month, 260—total, 28,301; number of motors connected as per last report, 13; number connected during month, 2—total, 15; units generated as per last report, 340,302; generated during month, 115,076—total, 455,378; generated for corresponding period last year, 436,491—increase, 18,887. The Blackburn-road new sub-station has been erected during the month, and is now ready for the cables, which I hope to get laid next week. The work of heightening the chimney has been commenced."

Lowestoft.—The engineer has been instructed to lay a network for 50 yards on the east side of Corton-road to supply new houses. There are now 433 consumers connected to the mains, representing 29,975 8-c.p. lamps; there was an equivalent of 64 8-c.p. lamps connected to the mains during last month. The tramways are paying an average of £45 or £46 per week for current. The matter of free wiring was considered, but after considering the various offers, it was agreed that the matter be not entertained for the present. It is proposed that all consumers are to be given the option of taking the current either on the present maximum demand system of 7d. and 3d., or at a flat rate of 6d. per unit, on signing an agreement to take the current for twelve months on the system selected.

East Dereham.—The Urban District Council last week considered a communication from the Southern District Electricity Corporation, who some time ago wrote to the Council stating that they intended to apply to the Board of Trade for a provisional order for supplying the town with electricity, and they now submitted terms upon which they proposed to deal with the matter, and asked the consent of the Council to their application. They would find all the capital for constructing and running the works, but in order that the residents of the neighbourhood who might desire to become interested in the undertaking might have an opportunity of subscribing for shares, they would form a local company, and give preference in allotment to applications of residents. They also submitted the terms they would be prepared to charge for lighting and power, and stated that the Council would have the right to purchase the undertaking at any time during the period of the order by giving one year's notice.

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Hampton Wick.—At the last Council meeting a letter was read from the Twickenham and Teddington Electric Supply Company enclosing draft copy of their provisional order, and asking the Council for their formal consent. They were prepared to give the Council the right to purchase the undertaking at a valuation as a going concern at the end of seven, fourteen, or twenty-one years, and to supply electricity to private consumers at the following rates: 7d. per unit for the first hour per day at the maximum demand, or its equivalent, and 3d. per unit for any further quantity. As it could not be a clause in the order, they would be prepared to enter into an agreement to supply electricity for public lighting at a price not exceeding 2½d. per unit. The clerk was empowered to obtain an independent report on the proposal, and the subject was therefore adjourned for further consideration.

Bridgend.—The arrangement of the District Council with the Electrical Power Company states that in consideration of the permission of the Council being granted to the company to supply customers with energy for power and light, the company will not charge the ½d. for transforming, and the company undertake to pay to the Council 2½ per cent. on the gross estimated sum receivable from all future customers for energy for both light and power. This arrangement is for 12 months only, and is then to be determined or made permanent at the option of the Council, and not at the option of the company. The company further undertakes not to encourage the supply of power to private individuals or firms, and if any dispute arises out of this new arrangement as to whether any person or firm is one to whom power and not lighting is the chief consideration, the question shall be decided by an outsider nominated by the chairman of the Council and chairman of the company.

The New Pacific Cable.—Some interesting figures have been compiled, says the Central News, showing the expenses and receipts of the new Pacific Cable. The cable was opened early in December last, and consequently three months' revenue is all that can be set off against 2¼ years' expenditure—that is, from the initiation of the business. The expenditure during that period up to March, 1903, was £120,000, and the revenue for the three months ended March this year was £18,310, showing a deficiency of £101,690. This deficiency will have to be made good by the parties to the scheme as follows: United Kingdom and Canada, £28,055 each; Victoria, New South Wales, Queensland, and New Zealand, £11,222 each. The estimated expenditure for the next financial year is £165,500, and the receipts £75,400, which will leave an estimated deficiency of £92,100. This loss will be apportioned among the Governments concerned as follows: United Kingdom and Canada £25,409; Victoria, New South Wales, Queensland, and New Zealand, £10,072 each. Australia bears one-third of the annual charge.

London Gazette.—The partnership existing between William Townend Drabble, Samuel Carter, and Thomas Carter, in the trade or business of electrical engineers, carried on at West-street, Leeds, under the style of Drabble, Carter, and Co., was dissolved on Aug. 24, 1903. All debts due to and owing by the late firm will be received and paid by William Townend Drabble, by whom the business will in future be carried on. A dividend is to be declared in the estate of John Frederick Worthington, electrical engineer (trading with Gerald Nuttall under the style of Worthington and Co.), Foundry Works, Foundry-street, Hanley, Stafford. Last day for receiving proofs, Nov. 21, at the office of Messrs. Poppleton and Appleby, 26, Corporation-street, Birmingham. A petition for the winding-up of the Electrical Publishing Company by the High Court of Justice, presented by Thomas William Sheffield, of Trevellyan-buildings, Corporation-street, Manchester, is to be heard before the Court sitting at the Royal Courts of Justice, Strand, London, on Nov. 24, 1903. The Light Railway Commissioners have submitted to the Board of Trade for confirmation an order made by them amending the Robertsbridge and Pevensey Light Railway Order, 1900. Any objections to the confirmation of the order should be sent to the Assistant Secretary (Railway Department), Board of Trade, Whitehall-gardens, London, S.W., on or before Nov. 28, 1903. Copies of the order may be obtained from Messrs. Cheesman and Cope, 15, Victoria-street, Westminster, S.W., and 23, Havelock-road, Hastings.

Hove.—The Town Council have sanctioned the application of the National Telephone Company for permission to lay underground ducts within the borough, subject to the following conditions: The routes to be approved by the Council, and the Western-road to be excepted; the Council to be at liberty to grant a similar concession to any other authority; the Council to construct the ducts, the company finding the funds for that purpose and for keeping the ducts in repair; the ducts to be the property of the Council, the company to have license to use the same until May 1, 1926; the license to use the ducts shall not be transferred or sublet without the consent of the Council, excepting that if the Postmaster-General exercises his power to purchase the undertaking of the Telephone Company, they shall be at liberty to sell their interest in the license to him, subject to the obligations and liabilities affecting the same; an annual payment of 5s. to be made to the Corporation for each subscriber in Hove above the £5. 10s. charge, and 2s. 6d. each subscriber at or below that charge; in the case of party lines the annual payment to be 1s. 3d. each subscriber; in the event of the company increasing or abolishing the present scale of charges for telephone service in the borough, then the charge to telephone subscribers for unlimited service shall not at any time thereafter exceed £8 per annum; in the event of the company reducing the present charges for unlimited service to subscribers in any city or borough with a population according to the then preceding census of 150,000 and upwards (excluding the Metropolis) below those in operation in the borough of Hove, the company will reduce the charges to subscribers within the borough of Hove to similar amounts; the whole of the borough to be considered as within the "two-mile radius"; the company to pay to the Council half the cost of laying the existing ducts in Church-road, their right of user being limited to three channels; a formal agreement embodying these terms and such further details as the Council may be advised to be entered into, and until such agreement is completed, the Council not to be bound; that cost of the agreement to be paid by the company.

PROVISIONAL PATENTS, 1903.

Nov. 2.

23686. An improved fog or danger signal for steam or electric railways. Arthur Johnson, The Highlands, Broomy-hill, Hereford.

23712. Improvements in the manufacturing of dry batteries. Henry Nehmer, 36, Clifton-street, Finsbury-square, London.

23715. Improved apparatus for operating railway signals and points by electricity. Edmond Meyer Tudor Boddam, 71, Bishopsgate-street, London.

23716. Improved electric interlocking apparatus for operating electrically worked signals and points. Edmond Meyer Tudor Boddam, 71, Bishopsgate-street, London.

23717. Improved method of operating electrically worked signals by means of contacts made by moving trains. Edmond Meyer Tudor Boddam, 71, Bishopsgate-street, London.

23743. Improvements in electrical indicators. Leopold Percy Coppard Hodson, 55, Chancery-lane, London.

23750. Improvements in or relating to electric signalling apparatus for railways. Edouard Danneels, 72, Cannon-street, London. (Complete specification.)

23767. Improvements in galvanic batteries. The Halsey Electric Generator Company, Limited, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (The Halsey Electric Generator Company, United States.)

Nov. 3.

23830. Improvements in or relating to electric light and similar fittings. William Wickstead Barton, 111, Hatton-garden, London.

23833. Improvements in electrical resistances. Percy Macaulay Ashworth Matthews, 9, Teneriffe-street, Lower Broughton, Manchester.

23851. Improvements in electric cranes. Stothert and Pitt, Limited, and Walter Pitt, 24, Southampton-buildings, Chancery-lane, London.

23853. Mercury electrolytic apparatus specially applicable to electric meters and electric switches. Edward Du Bois and the Reason Manufacturing Company, Limited, Norfolk House, Norfolk-street, Strand, London.

23854. Method of effecting a phase-shift of 90deg. or more between the pressure and the field in the shunt circuit of alternating-current meters. Oliver Imray, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Siemens-Schuckert Werke G. m. b. H., Germany.) (Complete specification.)

23862. Improvements in electric log recording and like apparatus. Hjalmar von Kohler, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

23863. Improvements relating to electric distribution systems. Josef Henrik Hallberg, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

23876. Improvements in or relating to autographic telegraph systems. Arthur Korn, 18, Buckingham-street, Strand, London. (Complete specification.)

Nov. 4.

23915. Electric light adaptor for reading lamps. Walker Laird Miller, 222, Berkley-street, Glasgow.

23928. Improved means applicable for use in automatically cutting out resistance in alternating-current electro-motors. John Bush, 90, Lausanne-road, Peckham, London.

23933. Improvements in shades or reflectors for electric and other lamps. John Laird, 9, Warwick-court, Gray's Inn, London.

23948. Improvements in and connected with electric tram-cars. George John Conaty, 128, Colmore-row, Birmingham.

23956. Improvements in connection with vacuum brake apparatus for electrical and other railways. James Gresham and Henry Albert Hoy, 18, Southampton-buildings, Chancery-lane, London.

23961. Improvements in meters for use in connection with electric heating systems, and other systems or apparatus consuming energy, or for recording periods of time. Edward Cunliffe-Owen, Edward William Johnston Macdonald, and A. F. Harmer, 322, High Holborn, London.

23978. Improvements in and relating to overhead electric current conductors. Emile Giraud, 18, Buckingham-street, Strand, London. (Date applied for under Patents Act, 1901, Nov. 5, 1902, being date of application in France.) (Complete specification.)

Nov. 5.

23987. Improved electric ignition devices for gas-engines, oil-engines, and petroleum motors. Elias de la Roche Rendell and George Arthur Minshall, Longport, Stoke-on-Trent.

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23988. Improvements in the means for electrically operating switches and other apparatus. Henry James Fuller, 13, Park-view, Beeston-hill, Leeds.

24013. Improvements in or connected with electric light switches. James Walter Thompson, 71, Albion-street, Leeds.

24023. Improvements in or relating to electric arc lamps or mercury vapour lamps or the like. Charles Orme Bastian, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

24025. Improvements in printing telegraph receivers. James Dundas White, 50, Clanricarde-gardens, London.

24055. Improvements in apparatus applicable for use in connection with telephones and other purposes. John Alexander Gamble, 6, Lord-street, Liverpool.

24070. Improvements in storage batteries. Franklin Wise Howorth, 46, Lincoln's-inn-fields, London. (David P. Perry, United States.)

Nov. 6.

24083. Improvements in electrical apparatus used in propelling autocars and other vehicles, launches, and the like. Edmund Scott Gustave Rees, Prince's-chambers, Wolverhampton.

24098. An apparatus for limiting electric currents. José Azarola, 4, Corporation-street, Manchester. (Complete specification).

24102. Improvements relating to electric ignition apparatus for motor cars, motor cycles, and the like. William Walter Gerald Webb, John Hall, Charles Herbert Offord, and Archibald Carlyle Barfield, 18, Southampton-buildings, Chancery-lane, London.

24116. Improvements in electrical machines. Bernard Charles Molloy, 5, Paper-buildings, The Temple, London.

24127. Improvements in electric bath tubs and in electrodes therefor. Josef Zwiebel, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

24129. Improvements in the structure of alternators. Arnaldo Paulo Zani, 18, Southampton-buildings, Chancery-lane, London.

24142. Improvements in regulating means for electric lamps. Howard Coppuck Levis, 83, Cannon-street, London. (Albert Gould Davies, United States.)

24144. Improvements in electrically controlled valves. Oscar Junggren, 83, Cannon-street, London. (Date applied for under Patents Act, 1901, Nov. 15, 1902, being date of application in United States.) (Complete specification.)

Nov. 7.

24200. A portable electric fan. Max Margowski, 72, Cannon-street, London. (Rudolf Klemm, Germany.)

24212. New or improved means for controlling arc lamps. Herbert John Haddan, 18, Buckingham-street, Strand, London. (The firm trading as Samuel Zielenziger, Germany.) (Complete specification.)

24214. Improvements in and relating to attaching devices or connections, especially applicable to electric fuses. William Richard Macdonald and George Edward Heyl-Dia, 322, High Holborn, London.

24216. Improvements in cut-outs having two or more fuses. Thomas Herbert Marsh and Henry Herbert Stanley Marsh, 322, High Holborn, London.

24217. Improvements in and relating to automatic fuse cut-outs and cut-ins. Thomas Herbert Marsh and Henry Herbert Stanley Marsh, 322, High Holborn, London.

24220. Improvements in apparatus for lighting gas lamps by electricity. Otto Gergacsevics, 6, Lord-street, Liverpool.

24223. A device constituting a combination of an electric lamp with a lighter for cigars and the like. John Edward Waller, 47, Lincoln's-inn-fields, London.

24235. Improvements in electric arc lamps. William James Davy, 40, Chancery-lane, London.

COMPLETE SPECIFICATIONS ACCEPTED.

To be published Nov. 26, 1903.

1902.

24148. Electric fuses. Esson.

24149. Electric fuses. Esson.

24192. Trolley collectors employed in overhead systems of electrical traction. Rowlands.

24295. Switch lampholders for incandescent electric lamps and the like. Hewett.

24235. Heating by means of electricity. Bronn.

24328. Electric incandescent lamps. Bowen.

24517. Method of constructing electric resistances for heating or other purposes. Hankin.

24576. Telephone party-line system on telephone exchanges working on central battery system. Oppenheimer. (Actiengesellschaft Mix und Genest.)

24643. Detection of faults in the conductors of electric traction systems. De Ferranti.

26051. Trolley poles for electric railways. Carolan. (General Electric Company.)

24709. Electric cut-outs. Carolan. (General Electric Company.)

27619. Control of electromotors on electric railway cars. Siemens Bros. and Co., Limited, Lydall, and Duke.

27761. Electric cut-outs. Carolan. (General Electric Company.)

27772. Electric regulators. Carolan. (General Electric Company.)

27858. Electric light switches and the like. Eckstein and Krause.)

28384. Automatic minimum and reverse current circuit breakers. Thomas and Thomas.

28486. Electric switches. Leitner and Lucas.

28487. Means for controlling variable-speed dynamos. Leitner and Lucas.

28552. Conductors or oscillators for use in electrical wireless telegraphy. Lake. (Stone.)

1903.

3426. Chemical rectifiers for converting an alternating electric current into a direct current. Chaplin.

7831. Process for manufacturing electrodes for arc lamps. Hopfelt.

11427. Radiator systems for wireless telegraphy. Blondel. (Date applied for under International Convention, May 28, 1902.)

16487. Telegraph pole. Schütz.

21304. Driving electrical machines by means of steam-turbines. Siemens Bros. and Co., Limited. (Siemens und Halske Actiengesellschaft.)

22639. Covers and frames for electric junction boxes and the like. Robinson.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.	Last price
Commercial and Industrial.—	£	£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1 ..	½-¾
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1 ..	1/16-3/16
British Insulated and Helsby Cables, Ord., 1-100,000	5 ..	6¼-6¾
—— 6 per cent. Cum. Pref., 1-100,000	5 ..	5¼-5¾
—— 4½ per cent. Mortgage Debentures	100 ..	102-105
British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red.	100 ..	103-105
British Westinghouse Elec. and Manuf., 6 per cent. Pref., 275,001-375,000	5 ..	5⅝-5¾
—— 4 per cent. Mortgage Debenture Stock	100 ..	100-102
Brush Electrical Engineering, Ordinary, Nos. 1-105,731	2 ..	¾-1¼
—— Non. Cum., 6 per cent. Pref.	2 ..	1-1¼
—— 4½ per cent. 1st Debenture Stock	100 ..	97-100
—— 4½ per cent. 2nd Debenture Stock	100 ..	85-90
Callender's Cable, Debentures	100 ..	106-110
—— Ordinary	5 ..	11-12
—— 5 per cent. Pref.	5 ..	5¼-5¾
Crompton and Co.	5 ..	1¾-2¼
—— 5 per cent. Debentures	100 ..	100-104
Edison and Swan United, "A" Shares, 1-99,261	3 ..	¼
—— "A" Shares, 01-017,139	5 ..	1¼-2¼
—— 5 per cent. Debentures	100 ..	76-81
—— 4 per cent. Deb. Stock, Red.	100 ..	72-77
Electric Construction, Limited, Nos. 1 to 112,100	2 ..	1¼-1¾
—— 7 per cent. Cumulative Pref.	2 ..	2¼-3
—— 4 per cent. Perp. 1st Mort. Deb.	100 ..	97-100
Ferranti Limited, 5 per cent. 1st Mort. Deb. Stock, Red.	100 ..	90-95
General Electric Company (1900), 5 per cent. Cum. Pref.	10 ..	9¾-10¼
—— 4 per cent. 1st Mort. Deb. Stock	100 ..	96-99
W. T. Henley's Telegraph Works, Ordinary	5 ..	14-15
—— 4½ per cent. Preference	5 ..	5-5¼
—— 4½ per cent. Debentures	100 ..	108-112
India Rubber, Gutta Percha, and Telegraph Works	10 ..	18¼-19¼
—— 4 per cent. Debentures	100 ..	100-103
Parker, Thos., Limited, Ordinary	10 ..	14¼-15¼
Telegraph Construction and Maintenance	12 ..	34-37
—— 5 per cent. Bonds	100 ..	100-103
Electric Lighting and Supply.—		
Blackheath & Greenwich District Ordinary 1,201-101,200	1 ..	⅝-¾
—— 4½ per cent. Deb. Stk. Certs., Red. and Conv.	100 ..	116-119
Bournemouth and Poole, Ordinary	10 ..	12¼-13¼
—— 4½ per cent. Cum. Pref., 7,501-15,000	10 ..	10-11
—— 6 per cent. Cum. Second Pref., 15,001-22,500	10 ..	11-12
—— 4½ per cent. Debenture Stock, Red.	100 ..	103-106
Bromley (Kent) Electric Light and Power Co., 4½ per cent. 1st Debenture Stock, Red.	100 ..	100-103
Brompton and Kensington, Ordinary	5 ..	10¼-10¾
—— 7 per cent. Preference	5 ..	10-10¼
Calcutta Electric Supply Corp., Ordinary, Nos. 1-40,000	5 ..	6¼-7¼
—— Nos. 20,001-30,000	5 ..	7-8
Cambridge Electric Supply Company, Ltd., £10 Ord.	8 ..	14½
—— " £10 Ord.	6 ..	10¾
Central Electric Supply, Ltd., 4 per cent. Guar Deb. Stock	100 ..	107-110
Charing Cross and Strand, Nos. 1-70,000	5 ..	9-9½
—— 4½ per cent. Cum. Pref.	5 ..	5¼-5¾
—— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000	5 ..	4¾-5
—— 4 per cent. Debenture Stock, Red. (Prov. Certs.)	100 ..	104-106
Chelsea Electricity Supply	5 ..	5¼-6
—— 4½ per cent. Debentures	100 ..	108-111
City of London, Ordinary	10 ..	9¾-10¼
—— 6 per cent. Cumulative Pref.	10 ..	13-14
—— 5 per cent. Debenture Stock	100 ..	122-127
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100 ..	102-105
County of London and Brush Provincial, Ordinary	10 ..	7¼-8¼
—— 6 per cent. Cum. Pref.	10 ..	11¼-12¼
—— 4½ per cent. Debentures Prov. Certs. All pd. Red.	100 ..	107-110
Edmundsons' Electricity Corporation, Ordinary, 1-50,000	5 ..	6¼-6¾
—— 6 per cent. Cum. Pref.	5 ..	6-6¼
—— 4½ per cent. First Mort. Deb.	100 ..	104-107
Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-30,000	5 ..	3¼-4¼
—— 5 per cent. Debenture Stock, Red.	100 ..	96-98
Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000	5 ..	5¾-6
—— 4½ per cent. First Deb. Stock, Red.	100 ..	100-103
Hove Electric Lighting, Limited, Ord., 1-13,000	5 ..	7¼-8¼
Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000	5 ..	10¼-11¼
—— per cent. Debenture Stock Red.	100 ..	100-105

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Name.	Amount paid.	Last price.
	£	£
Kensington and Knightsbridge and Notting Hill	100 ..	101-104
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10 ..	9⅞-10⅛
London Electric, Ordinary	3 ..	1⅞-2⅛
—— 6 per cent. Pref.	5 ..	5-5⅛
—— 4 per cent. 1st Mortgage Debenture Stock, Red...	100 ..	98-101
Metropolitan, Ordinary	10 ..	17-18
—— 4½ per cent. First Mortgage Debenture Stock	100 ..	110-114
—— 3½ per cent. Mortgage Debenture, Red.	100 ..	96 99
Newcastle-upon-Tyne Electric Supply, Ordinary.....	5 ..	98-101
—— Preference.....	4 ..	100-103
Notting Hill Electric Lighting	10 ..	12½-13½
—— 4 per cent. First Mort. Debs., Nos. 1-500 (Reg.) ..	100 ..	98-101
Oxford Electric, Ordinary, 1-96 and 407-14,310	5	5½-5⅝
—— 4 per cent. Debenture Stock	100	98-101
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	10 ..	98-100
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000 ..	5 ..	3-3½
—— 4 per cent. Debenture Stock	100 ..	85-90
South London, Ordinary	5 ..	3½-4
St. James's and Pall Mall, Ordinary, 101-20,080	5 ..	14½-15½
—— 7 per cent. Pref.	5 ..	8-9
—— 3½ per cent. Deb.....	100 ..	97-100
Urban Electric Supply Co., Ordinary, 8-30,007	5 ..	4⅞-5⅛
—— 5 per cent. Cumulative Preference, 50,001-80,000	5 ..	4⅞-5
Westminster, Ordinary	5 —	12-13
—— 5 per cent. Cum. Pref., 110,101-138,251	5 ..	6-6½

Electric Railways.—

Central London, Ordinary.....	100 —	95-98
—— 4 per cent. Pref.	100 —	99-102
—— ,, ,, deferred	100 —	99-102
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)..	100 —	115-118
City and South London, Consolidated Ordinary	100 —	51-53
—— 4 per cent. Debenture Stock	100 —	110-115
—— 5 per cent. Pref. Stock '91	100 —	127-130
—— ,, ,, ,, '96	100 —	125-128
—— ,, ,, ,, '01	100 —	122-127
Liverpool Overhead, 5 per cent. Pref.	— —	13-13½
—— Ordinary, 1-50,000	— —	7⅞-8
—— 4 per cent. Mortgage Debentures, Red., 1-1,700 ..	— —	102-104
Waterloo and City, Ordinary	100 —	92-95

Electric Tramways.—

Anglo-Argentine, 1-260,007	5 ..	4⅜-4⅝
—— Permanent 6 per cent. Debenture Stock, 1888....	100 ..	125-130
Blackpool and Fleetwood Tramroad.....	10 ..	13½-14½
Brisbane Tramway Invest., Lim., Ord., 1-75,000	5 ..	2-3
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5 ..	3½-4½ xd
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100 ..	98-102
British Columbia Electric Railway Co., Ord., Nos. 1-20,000	100 ..	84-87
—— Non-Cum. 5 per cent. Pref., Nos. 25,001-38,600 ..	100 ..	93-96
—— 4½ per cent. 1st Mt. Debs., Nos. 1-5,250, of £40 each	40 ..	102-104 p.c

Name.	Amount paid.	Last price
	£	£
British Electric Traction, Ord. 1-300,000 & 60,001-90,000..	10 —	11½-12
—— 6 per cent. Cm. Pf., 30,001-60,000	10 —	11-11½
—— 5 per cent. Perpetual Debenture Stock	100 —	120-123
Buenos Ayres and Belgrano Tram., Ord., 1-100,000	5 —	2⅜-2⅝
—— "A" 6 per cent. Cm. Pf., 1-40,000	5 —	5-5½
—— "B" 6 per cent. Cm. Pf., 1-27,500	5 —	4⅜-5½
—— 5 per cent. Deb. Stock, Red.	100 —	107-110
—— Prov. Cert., all paid	100 —	99-102
Cape Electric Tramways, Nos. 1-480,000	1 —	1⅞-2⅛
City of Birmingham Tramways, 5 per cent. Cum. Pref.....	10 ..	5-5½
—— 4 per cent. 1st Mortgage Deb., 1-3,000 (1917)	100 —	98-101
Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red.	100 ..	100 103
Cork Electric Tramways and Lighting Co., Ordinary	10 —	13-14
—— 5 per cent. Cum. Pref.	10 —	11-12
—— Debentures	100 —	96-99
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10 ..	12-13
—— 6 per cent. Pref., Nos. within 1-60,000	10 ..	15-16
—— 3½ per cent. Mort. Debs., 1-3,000, Red.	100 —	94-97
Imperial Tramways Ordinary.....	all —	22-22½
—— 6 per cent. Cum. Pref.	all —	14½-15½
—— 4½ per cent. Deb Stock	100 —	112-114
Isle of Thanet Electric Tramways and Lighting, 5 per cent. Cum. Pref., Nos. 30,001-60,000	5 ..	3⅜-4½
—— 4 per cent. Debenture Stock	100 ..	92-95
Kidderminster and District Lighting and Traction, Pref...	5 —	3½-4
London United Trys. (1901), 5 per cent. Cum. Pref.	10 —	11½-12
—— 4 per cent. 1st Mt. Db. Stock, Red	100 ..	104-106
Metropolitan Electric Trams., Deferred, 1 000 001-1,314,016	1 ..	3/16-5/16
—— 5 per cent. Cum. Pref., 500,001-814,016..	1 ..	⅛-⅛
New General Traction, Ordinary	5 —	¼
—— 6 per cent. Cum. Pref.	5 —	1½-2½
—— 5 per cent. Mortgage Debentures, 1-1,713 (Regd.).	100 ..	88-93
Oldham, Aston, and Hyde Tramway, Ordinary.....	10 ..	10½-10⅝
—— 5 per cent. Cum. Pref.	10 ..	11½-12½
Perth Elec. Tramways (W.A.) 5 per cent. 1 Mort. Deb. Stk.	100 ..	99-102
Potteries Electric Traction, Ordinary, 20,001-40,000	10 —	8½-9½
—— 5 per cent. Cum. Pref., 1-20,000	10 —	8½-9½
—— 4½ per cent. Debenture Stock.....	100 —	104-107
South Lancashire Electric Traction and Power Company—		
—— £250,000 Ordinary	1 —	1
—— £101,132 6 per cent. Preference.....	1 —	1
—— £528,093 4½ per cent. Debenture Stock	100 p.c. —	100 p.c.

Telephones.—

National Telephone, Preferred	100 —	100-102
—— Deferred Stock	100 —	74-76
—— 6 per cent. Cum. First Pref.	10 —	13-14
—— 6 per cent. Cum. Second Pref.	10 —	13-14
—— 5 per cent. Non. Cum. Third Pref.	5 —	5-5½
—— 5½ per cent. Deb. Stock, Red.	100 —	93 96
—— 4 per cent. Deb. Stock, Red.	100 —	102-104
Oriental Telephone and Electric Company	1 —	13/16-15/16

TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line	Traffic Returns for week			Increase or decrease.		Miles of single track open.		Accounts for past year.						Cost per car mile.
	Ending	1903.	1902.	Week.	Current year.	1903.	1902.	Ending	Total receipts	Passengers carried.	Car miles run.	Receipts per Pas-s'nger	Receipts per Car mile.	Receipts per Mile of track.	
		£	£	£	£				£			d.	d.	£	d.
Aberdeen Corporation.....	Nov. 7	1,108	815	+ 293	+ 4,789	19½	17½	May 31	37,931	9,099,715	794,641	0·98	13·02	1,970	6·14
Ayr Corporation.....	Oct. 31	184	187	− 3	+ 36	8	6	Sept. 25	12,503	2,979,276	290,099	1·00	10·34	1,560	4·7
Birmingham Tramways	Nov. 7	5,067	5,052	+ 15	+ 9,119	6½	6½	—	—	—	—	—	—	—	—
Blackburn Corporation	,, 6	783	765	+ 18	+ 827	24	24	March 25*g*	40,964	7,234,106	826,558	1·36	11·87	1,705	7·44
Blackpool Corporation.....	,, 5	338	343	− 5	− 210	17½	16½	,, 31	211,168	6,169,121	784,443	1·52	10·8	—	—
Blackpool-Fleetwood Tramways	,, 7	216	205	+ 11	− 125	16½	16½	Dec. 31	30,923	2,049,677	584,989	3·62	12·68	1,932	6·99
Bolton Corporation	,, 8	1.687	1,574	+ 112	+ 7,457	38	25	March 31	85,704	17,761,605	1,896,247	1·15	10·75	3,430	5·87
Bournemouth Corporation.....	,, 4	834	—	—	—	10½	—	—	—	—	—	—	—	—	—
Bradford Corporation	,, 8	3,462	3,132	+ 330	+14,648	41	—	—	—	—	—	—	—	—	—
Brighton Corporation	,, 8	866	748	+ 118	+ 6,248	6½	—	,, 31	—	10,432,508	1,031,928	1·00	10·10	—	—
Bristol Tramways Company	,, 6	4,521	4,581	− 60	—	51½	51½	Dec. 31	223,480	41,192,899	5,724,114	1·30	9·38	4,348	—
Burnley Corporation	,, 7	777	687	+ 90	—	—	—	—	—	—	—	—	—	—	—
Burton Corporation	,, 8	283	—	—	—	—	—	—	—	—	—	—	—	—	—
Cardiff Corporation	,, 7	1,853	1,521	+ 342	+18,098	—	—	—	—	—	—	—	—	—	—
Carlisle Tramways Company....	,, 9	182	161	+ 21	+ 644	—	—	,, 31	—	2,216,583	320,129*h*	—	—	—	—
Central London Railway.....	,, 7	6,859	7,122	− 263	− 6,262*h*	6	—	,, 31	367,225	45,305,110	1,276,971*a*	1·87	66·6 *a*	59,076	35·6 *a*
City and South London Railway	,, 8	2,937	3,489	− 552	− 7,662	6⅜	—	,, 31	165,003*a*	19,069,319*a*	—	—	—	—	—
Cork E. T. and L. Company	,, 5	464	563	− 99	− 3,437	—	—	—	—	—	—	—	—	—	—
Darwen Corporation.....	,, 6	231	221	+ 10	− 195	7·23	—	March 31*g*	12,341	2,360,735	254,279	1·25	11·65	1,707	9·36
Dover Corporation	,, 7	177	189	− 12	+ 68	3	—	—	—	—	—	—	—	—	—
Dublin & Lucan Electric Railway	,, 8	140	92	+ 48	+ 155*h*	—	—	Dec. 31	5,796	364,796	102,087	3·81	13·62	359	7·68
Dublin U. T., electric cars.....	,, 6	3,800	3,752	+ 48	} —	46	46	March 31	126,121	24,553,133	3,429,356	1·23	8·82	2,741	5·06*h*
Dublin S. District, Electric	,, 6	800	758	+ 42											
Dundee City Tramways	,, 4	842	769	+ 73	—	22	22	May 15	35,874	9,084,522	752,814	0·93	11·276	1,630	—
East Ham Corporation	,, 7	657	458	+ 109	—	10·75	7·52	March 31	25,341	9,971,337	650,224	0·61	9·35	2,357	—
Farnworth U.D.C.....	Oct. 21	150	143	+ 7	—	—	—	—	—	—	—	—	—	—	—
Glasgow Corporation	Nov. 7	13,718	12,668	+1,050	+33,953	124	101	May 31*g*	656,572	177,179,549	14,008,750	0·88	11·25	5,489 *b*	7·40*d*
Halifax Corporation.....	,, 4	2,546	2,169	+ 377	+ 5,122	30½	27¾	—	—	—	—	—	—	—	—
Huddersfield Corporation	,, 7	1,137	1,016	+ 121	—	34	35	March 31	56,631*h*	9,738,213	1,218,539	1·4	11·14	1,618	6·38
Hull Corporation, E. S.....	,, 7	1,899	1,721	+ 177	+ 3,180	19	19	,, 31	87,707*h*	21,065,999	2,218,696	1·00	9·49	5,004	5·07
Ilkeston Corporation	,, 4	137	—	—	—	—	—	—	—	—	—	—	—	—	—
Kirkcaldy Corporation	,, 4	152	—	—	—	—	—	—	—	—	—	—	—	—	—
Leeds Corporation	,, 7	4,829	4,816	+ 13	+10,710	77	—	March 25	262,656	57,239,779	5,773,651	1·11	10·91	3,283	—
Liverpool Corporation.....	Oct. 31	10,226	9,831	+ 395	+14,527	101	95	Dec. 31	504,304	108,906,472	11,705,425	1·11	10·34	5,000	6·88
Liverpool Overhead Railway....	Nov. 8	1,605	1,465	+ 140	+ 2,125	15½	15½	June 30	79,252	10,466,726	986,185*a*	1·82	19·30*a*	5,110	— *a*
Lowestoft Corporation	,, 7	161	—	—	—	—	—	—	—	—	—	—	—	—	—
Nelson Corporation	,, 7	86	—	—	—	3	—	—	—	—	—	—	—	—	—
Newcastle-on-Tyne Corporation	,, 7	3,545	3,091	+ 454	—	38½	36	March 25*g*	150,334	33,474,122	3,379,119	1·08	10·93	4,175	6·17
Portsmouth Corporation.....	,, 7	1,531	1,282	+ 249	—	29	29	Sept. 30	47,651	9,168,137	868,157	1·24	13·17	1,643	—
Rochdale Corporation	,, 2	117	121	− 4	—	4½	—	March 31	5,416	925,281	127,456	1·38	10·27	—	7·66
Rotherham Corporation	,, 5	551	—	—	—	—	—	—	—	—	—	—	—	—	—
Salford Corporation	,, 9	3,768	2,775	+ 993	+37,169	—	—	—	—	—	—	—	—	—	—
Sheffield Corporation	,, 8	4,477	—	—	—	53½	46½	Mar. 25*g*	216,309	56,812,049	4,926,083	0·904	10·428	7,510	7·0
Southampton Corporation	,, 5	967	969	− 2	—	11	11	,, 31	35,874	9,084,522	752,814	0·946	11·436	3,760	—
Sunderland Corporation	,, 8	1,093	1,022	+ 71	+ 2,028	18·48	17·18	,, 31	59,930	13,987,121	1,270,957	1·03	11·3	3,243	6·43
Wallasey U.D.C.	,, 7	599	538	+ 61	+ 2,351	10·5	10·5	,, 31*g*	31,307	5,690,378	654,550	1·32	11·47	2,981	6·97

* Includes maintenance of permanent way and proportion of profits paid to the tramway companies for term of unexpired lease. *a* Train mile.
b Per mile of single track. *c* Include rail and tram. *d* including depreciation. *f* Including one section of horse traction. *g* 1903. *h* Half-year's figures.

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THE SPEED REGULATION OF THREE-PHASE MOTORS.*

There are three principal methods of regulating three-phase motors: (1) by changing the number of poles; (2)

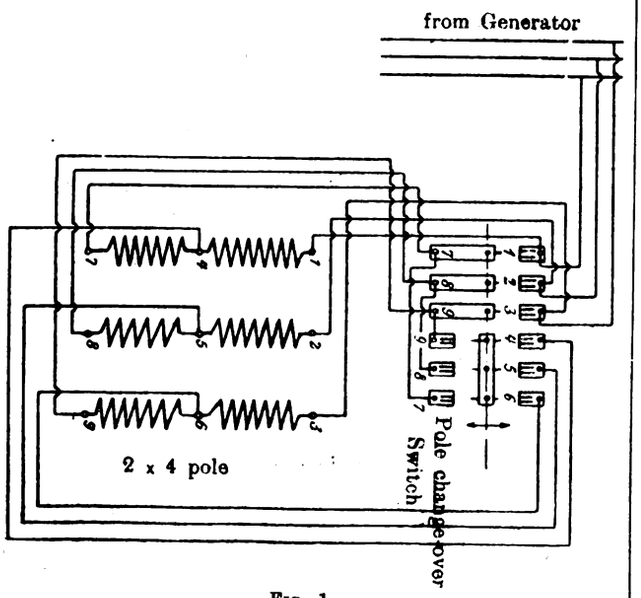

FIG. 1.

by inserting resistances in the rotor; (3) by employing a number of motors arranged coaxially and wound with different numbers of poles.

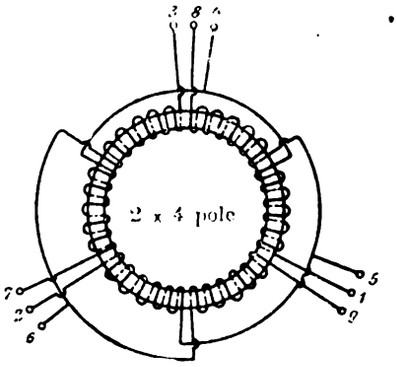

FIG. 2.

Each of these methods may be carried out in various ways. The earliest three-phase motors had Gramme-wound stators, and for these a simple switch is all that is necessary to change the poles in the ratio of 1 : 2. The connections for this purpose are shown in Figs. 1 and 2 for a two to four pole arrangement. The writer recently constructed a 3-h.p. motor of this type having a stator of 190mm. internal diameter and 355mm. external diameter, and a core length of 70mm. It was designed for 415 volts at 50 periods. The stator had 48 slots with 32 conductors in each, and the rotor had a four-pole short-circuited winding, with two bars in each of the 72 slots. The starting torque of such a motor is almost nil with the four-pole coupling. This

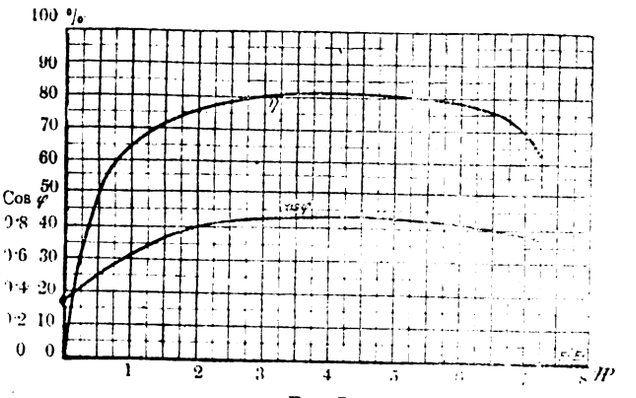

FIG. 3.

machine required 28 amperes at 410 volts in order to start light, and took eight seconds to attain full speed. With the two-pole coupling, on the other hand, the starting torque is very good, the maximum torque obtained being equivalent to 6 h.p., and the current taken being 28 amperes at 400 volts. It is characteristic of all motors arranged for pole changing that a lower starting torque, output,

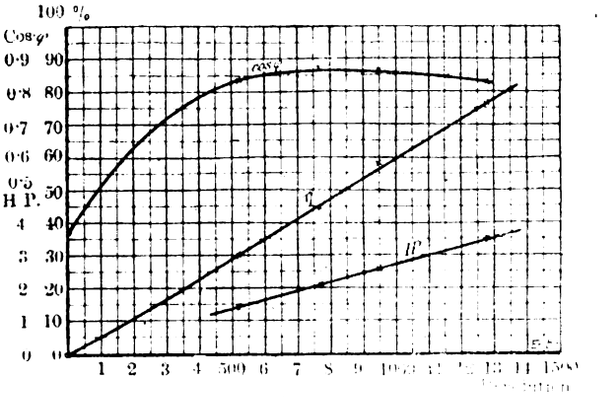

FIG. 4.

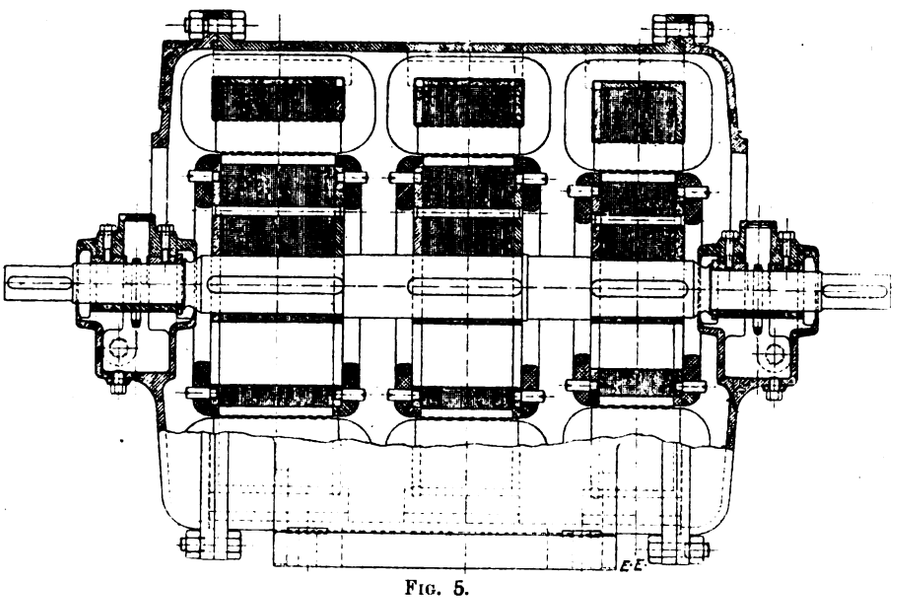

FIG. 5.

efficiency, and power factor are obtained with the low than with the high speed coupling. On this account such motors have to be started with the high-speed connections when

* Translation in abstract of an article by W. Burkard in *Elektrotechnische Zeitschrift* for Aug. 27, 1903.

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any considerable starting torque is required, as for cranes or machine tools, and this is unsatisfactory, on account of the sudden shock to the machinery leading to such excessive currents as to often melt out the solder of the rotor con-

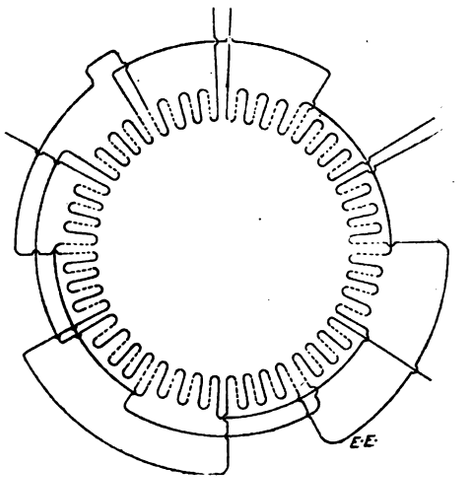
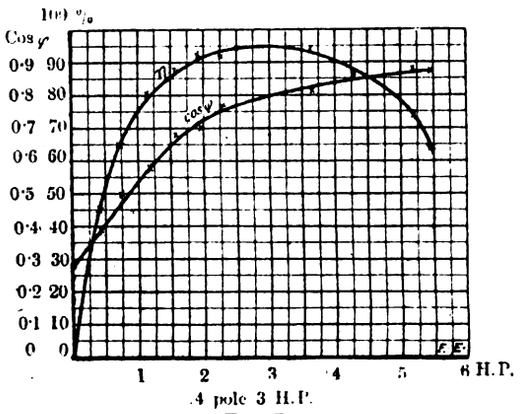


FIG. 6.

nections. When drum wound motors came into use, various modifications were patented to permit of coupling up to suit different numbers of poles, but all suffer more or less from the same disadvantages as the Gramme windings.

though the carbon brushes glowed in this case, due to the excessive currents passing.

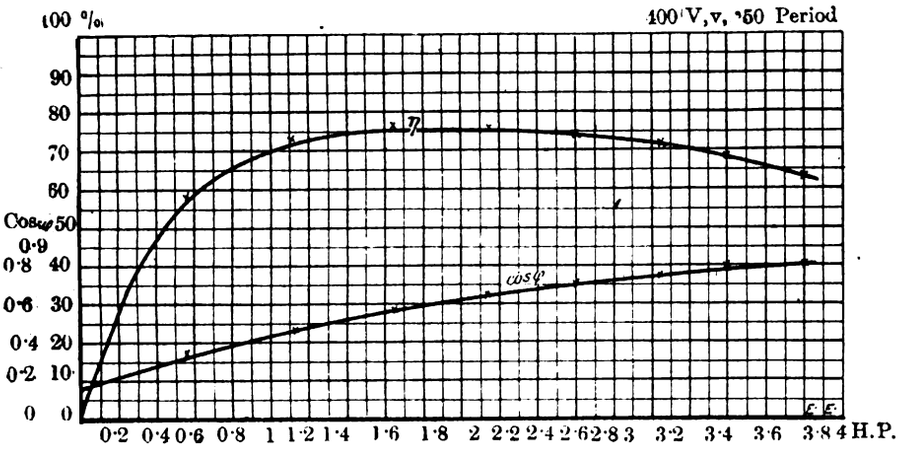
The third method of speed regulation, by means of several motors mounted on the same shaft, was first employed in 1901 by Messrs. Wüst and Co. All the different elements of such a motor may be wound for the same load, but each for a different number of poles; or, as



4 pole 3 H.P.

FIG. 7.

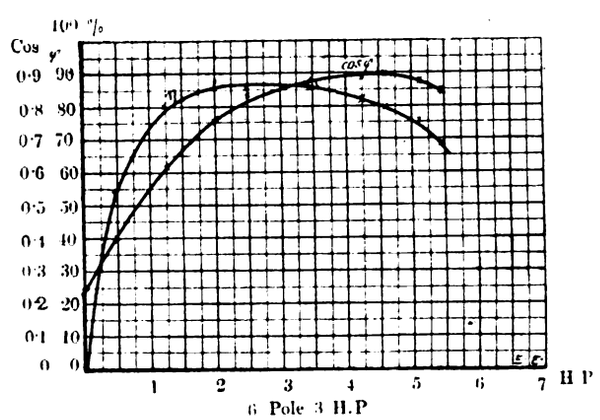
is sometimes preferable, the higher speed elements may be designed for more power than the lower speed ones. The lowest speed element can, if desired, be wound for a very large starting torque. Should it be necessary to obtain a considerable overload for a short time, as in the case of a steep gradient on a railway line or an excessive load on a crane, all the elements wound for different poles can be coupled in parallel, and in this way an output can be obtained which is at least as great as the sum of the powers of all the elements at a given speed (which is smaller than that corresponding to the largest number of poles). Fig. 5 shows a three-step motor of this type having three elements of 3 h.p. each, and wound for



8 pole 3 H.P.

FIG. 9.

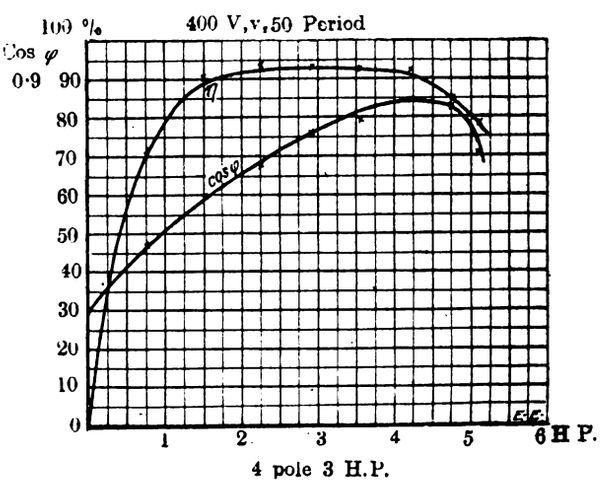
In order to avoid the excessive currents taken by motors with short-circuited rotors at starting, wound rotors with external resistances were introduced, and these permitted wide speed regulation, though at the same time the efficiency and output fell off at the lower speeds, whilst the power factor remained fairly constant. Figs. 3 and 4 show the connection between output, efficiency, and power



6 Pole 3 H.P

FIG. 8.

factor, and between speed and efficiency, for a 4-h.p. standard three-phase motor regulated in this way. As a further experiment the writer took readings of efficiency at various speeds, taking a constant power out of the machine, and obtained results similar to those shown in Fig. 4,



4 pole 3 H.P.

FIG. 10.

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four, six, and eight poles respectively. Fig. 6 shows the standard four-pole stator winding, and Figs. 7, 8, and 9 show the efficiency and power factor for each element. The four-pole element has a starting torque corresponding to 2·9 h.p., the six-pole to 3 h.p., and the eight-pole to 2 8 h.p. at 400 volts and 50 ~. The winding of such a motor is simple, and at the same time there is always a reserve of power in hand in case of accident to any one element, as the latter can be repaired whilst the motor continues to work with the remaining elements.

ments in parallel. Figs. 13 and 14 give the winding and connections respectively for the above two-step motor. Since the changing over of a single element from one number of poles to another is open to the same objections as described at the beginning of this paper, a special switch, which also acts as the starting switch, is arranged to make each element at each speed start with its normal load, and the test results embodied in Figs. 9, 10, 11, and 12 were taken with this arrangement.

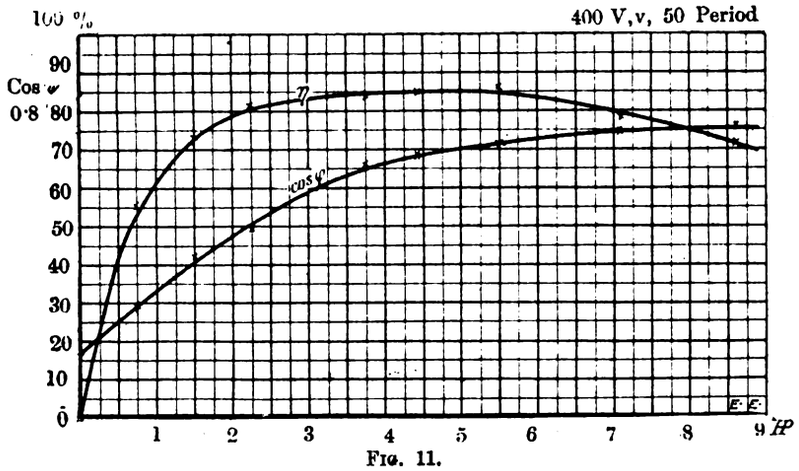

Fig. 11.

The above described motors have all been fitted with

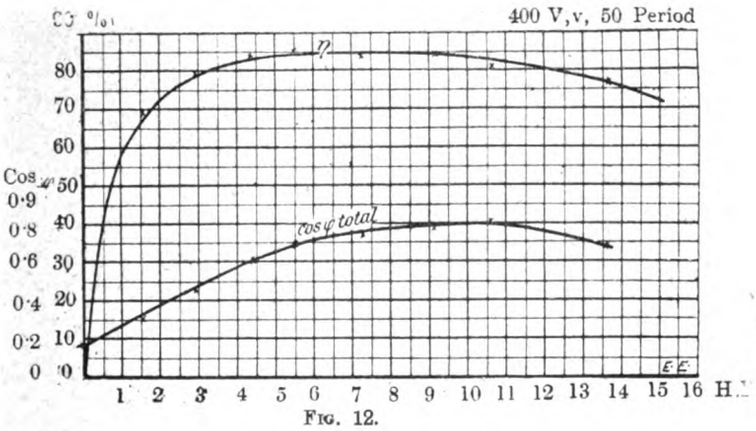

Fig. 12.

With a two-step motor three speeds and various powers can be obtained. A motor with, for instance, a four-pole element and an eight-pole one, each wound for 3 h.p., will run at 750 and 1,500 revolutions at 50 ~. By changing the eight-pole winding over into a four-pole one, 6 h.p. can be obtained at 1,500 revolutions, and by coupling this eight-pole winding changed over to four poles in parallel with the four-pole element, 9 h.p. can be obtained at 1,500 revolutions. By changing the four-pole winding into a two-pole one, 3,000 revolutions can be obtained. Fig. 10 shows the efficiency and power factor of the four-pole element of such a 3-h.p. motor. Fig. 11 shows the same for the eight-pole winding changed over into four poles, and Fig. 12 shows the combined effect of these two arrange-

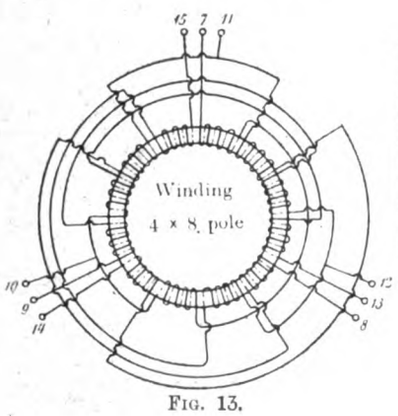

Fig. 13.

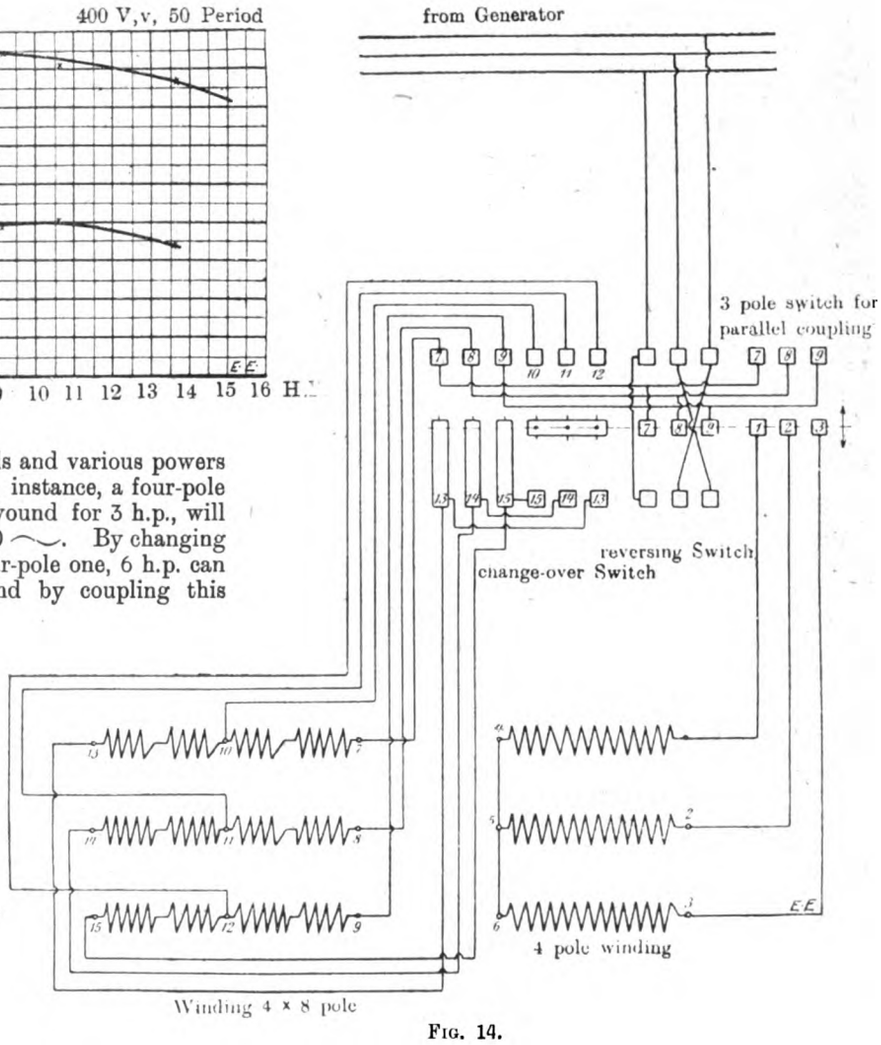

Fig. 14.

short-circuited rotors, but, of course, slip-ring rotors can also be employed. Fig. 15 shows a two-step 15-h.p. motor with four and eight pole elements, and Figs. 16 and 17 give its test results. Figs. 18 and 19 show a four-step motor intended for driving a large lathe for locomotive axles in which speed cones were to be avoided. The elements are wound with two, four, six, and ten poles at 500 volts 25 periods, and each element can develop 5 h p.

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Such motors are, of course, more expensive and occupy more room than ordinary motors, but in certain applications both price and floor space are secondary considerations, as may be seen from the large number of installations already employing these motors. In order that the additional weight which the extra rotors put upon the bearings may not be harmful, the latter are made specially large.

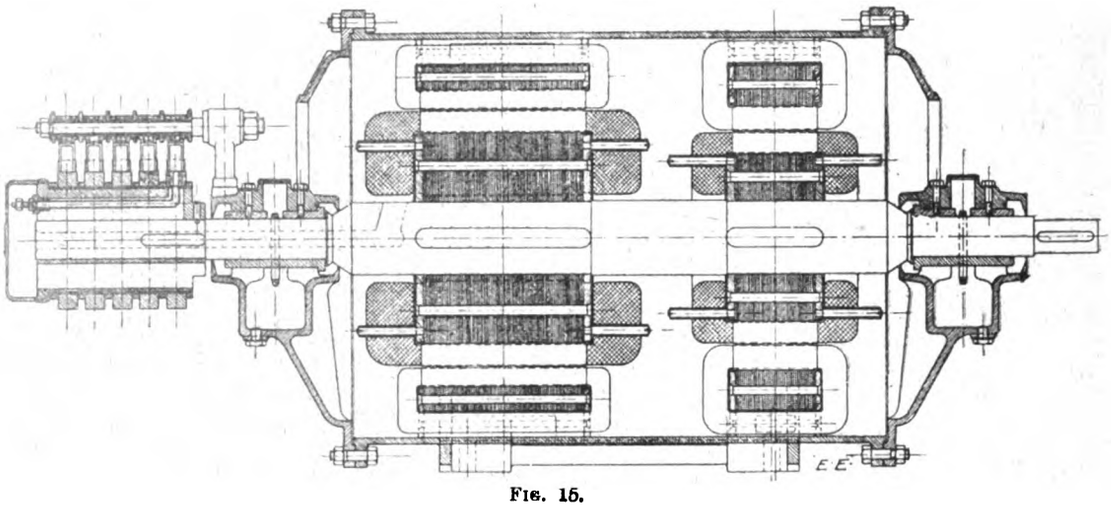

Fig. 15.

In conclusion, some experimental results obtained with a standard three-step 3-h.p. motor may be of interest. The elements were wound for four, six, and eight poles respectively at 410 volts 50 ⁓. The speeds obtained

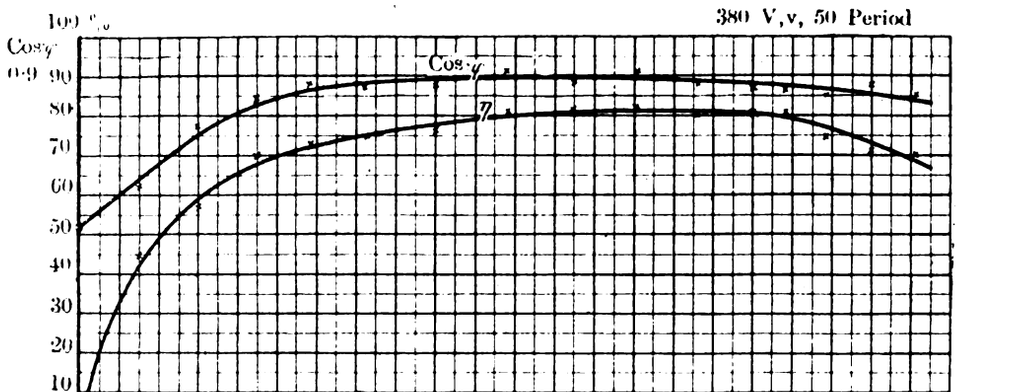

Fig. 16.

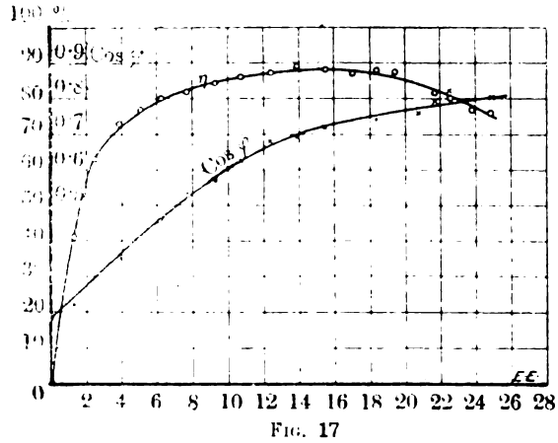

Fig. 17

with the three elements at light load were 1,500, 1,000, and 750.

With the 4 and 6 pole elements in parallel ...				1,060 revs.
„ „ 6 and 8 „	„	„	...	790 „
„ „ 4 and 8 „	„	„	...	770 „
„ „ 4, 6, and 8	„	„	...	820 „

When the six-pole element was opposed to the eight-pole one—*i.e.*, the coupling of one being arranged for one direction of rotation and that of the other for the opposite direction—the speed was 720 revolutions.

With the 4-pole against the 8-pole		730 revs.
„ „ „ „ „ 6-pole		950 „

With the 4 and 6 pole against the 8-pole the motor remained at rest.

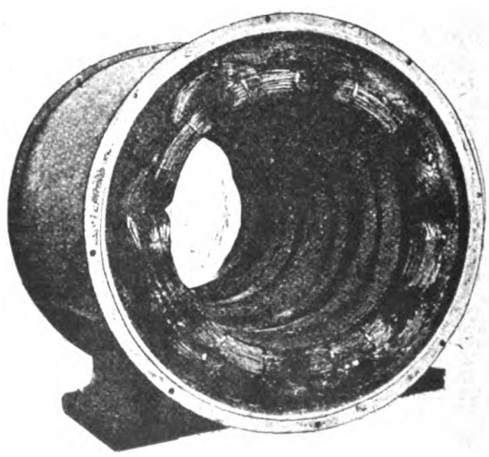

Fig. 18.

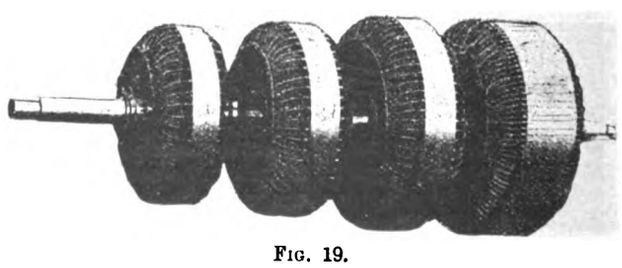

Fig. 19.

With the 6 and 8 pole against the 4-pole the speed was ..... 760 revs.

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With the 4 and 8 pole against the 6-pole the speed was ..... 740 revs.

By connecting the four and six pole elements together a maximum load of 7 h.p. at 930 revolutions was obtained; the six and eight pole combination gave 8·7 h.p. at 690 revolutions; the four and eight pole, 6·7 h.p. at 670 revolutions; whilst all three elements together gave 10·6 h.p. at 690 revolutions.

TOTAL AND FREE ENERGY OF THE LEAD ACCUMULATOR.*

BY R. A. LEHFELDT, MEMBER.

In choosing a subject on which to address the opening meeting of the Faraday Society, it seemed to me I could not do better than deal with some points in the theory of the accumulator. It is a subject in which technical and scientific interests are thoroughly combined, and it is, perhaps, not very generally known how completely electro-chemical theory has been found to harmonise with the experience of technicians, how satisfactorily it brings together many experimental facts, and how suggestive it is. I have little to say to-night that is new. What I aim at is to bring into as clear a light as possible one salient aspect of physics as applied to the lead accumulator of the technical electrician. The chemical reaction of the accumulator I take to be

$$\tfrac{1}{2}Pb + \tfrac{1}{2}PbO_2 + H_2SO_4 \rightleftarrows PbSO_4 + H_2O.$$

(Read from left to right on discharge, from right to left on charge †)

That this, on the whole, accords with the facts there can be no doubt. The evidence in favour of it—chemical, electrical, and thermodynamic—is a more than sufficient proof. It is quite possible that certain minor points are not explainable without taking other actions into account. Elb's observations on plumbic sulphate, $Pb(SO_4)_2$, seem to show that that substance plays an important part, at least in the formation of spongy lead. But it will not be necessary for my present purpose to pay attention to such possibilities. Taking the above equation to be correct, I wish to point out how the general laws of energy allow one to draw conclusions with regard to the E.M.F. of the cell in which the reaction takes place.

For the purpose of analysing the transformations of energy involved, the reaction on discharge may be regarded as consisting of three parts: (*a*) from the electrolyte of the accumulator remove 1 mol. of sulphuric acid (H_2SO_4); (*b*) cause this to react with the dry solids, Pb_1 and PbO_2; (*c*) mix the mol. of water thus formed with the electrolyte. Action (*b*) is the same whatever the concentration of the electrolyte may be; actions (*a*) and (*c*), on the other hand, involve that concentration. Accordingly, we may separate the energy, and, therefore, the E.M.F. of the reaction, into a fixed part, depending on (*b*), and a part varying with concentration, depending on (*a*) and (*c*). We have then to determine the energy changes involved in these processes; the method is applicable to both the total and the free energy. It would be inappropriate to go at length into the distinction between these two quantities, yet I cannot help remarking that the distinction, which has occupied physicists for a quarter of a century, is not generally enough noted even now. And as the conception of free energy is the most important of all in physical chemistry, it can hardly be insisted on too much. It is, moreover, one of which it is very difficult to form any mechanical image. When a chemical system suffers a transformation, such as that involved in the action of the accumulator, it loses a certain amount (sometimes negative) of energy, and since all energy indiscriminately is capable of transformation into heat, it is only to perform the reaction in a calorimeter to find out how much. But all energy is not indiscriminately capable of doing work—despite its name—and with a chemical change a certain amount of ability to do work is associated, this amount being distinct from the change in total energy. Moreover, it is not mechanical work merely that is in this position; many kinds of energy, perhaps all except heat, are freely interchangeable amongst themselves, and yet not with heat. We have therefore to recognise two grades of availability in energy—not an indefinite gradation, which would perhaps be easier to understand, but two planes, so to say, a higher and a lower. With regard to the former, a chemical reaction has a certain energy value; with regard to the latter, another energy value which may be either greater or less than the first. The value on the higher plane—*i.e.*, of chemical, electrical, mechanical actions—is called the *free energy* of the reaction; that on the lower plane—of thermal actions—the *total energy*. And the total energy is "conserved" in any case; the free energy is conserved if the action remains within the limits appropriate to the higher plane.

(I.) *Total Energy.*—There are many ways of expressing the composition of a sulphuric acid solution. It will be most convenient to choose the molecular fraction in the present instance—*i.e.*, if z mols. of H_2SO_4 be mixed with $1-z$ mols. of H_2O, z is taken as the expression of the strength of the acid. As an instance of the meaning of this, I take an acid of ordinary strength, for which $z = 0{\cdot}05$. This may be stated in various forms as follows:

Molecular fraction	$z = 0{\cdot}05$
Composition	$H_2SO_4.19H_2O$
Percentage by weight	22 27 per cent. H_2SO_4
Grammes H_2SO_4 per litre.....	258
Normality	5·26 equivalent per litre
Density	1·161

Let χ be the heat of reaction of the pure materials (process (*b*) above) for the quantities shown in the chemical equation, and let Q be the heat of formation of the dilute acid used as electrolyte per mol.—*i.e.*, Q is the heat evolved by mixing z H_2SO_4 with $(1-z)$ H_2O. [In the example chosen, mixing 0·05 mol. or 4·9 grm. of strong sulpuric acid with 0 95 mol. or 17·1 grm. of water.] Q is found by experiment, and we have to express in terms of it the changes of total energy involved in (*a*) and (*c*). Suppose the reaction to proceed to an infinitesimal extent, so that dz mols. H_2SO_4 are used up, and dz mols. H_2O formed, for every mol. of electrolyte. Then the concentration which was formerly z has become $z - dz$. The heat evolved (negative in amount) in consequence of the removal of acid, and that (positive) due to addition of water to the electrolyte, are together expressed by $-\frac{dQ}{dz}dz$. Hence in processes (*a*) and (*c*) the heat is $-\left(\frac{dQ}{dz}\right)$, and the total heat of reaction of the accumulator is expressed by

$$\chi - \frac{dQ}{dz}.$$

This conclusion only in a less simple form, was, I think, first arrived at by Dolezalek, to whom the theory of the accumulator owes so much. Q has been determined by J. Thomsen, Pickering, and others. I have taken Pickering's numbers in the following calculations. When Q is plotted as a function of z the curve obtained is hardly regular enough to take differential coefficients off; I have therefore adopted the artifice of combining the graphical method with an empirical formula. Over the range required—*i.e.*, from $z = 0$ to $z = 0{\cdot}25$—the curve is roughly parabolic. I therefore choose a parabolic formula convenient for calculation—not necessarily the nearest to the truth that can be found—and draw a curve showing the differences between this and the experimental data.

Before giving the numbers it is necessary to remark on the unit used. Quantities of heat are properly expressed in joules—no electro-chemist, I hope, will use the unsystematic, inconstant, and unnecessary calorie. For electro-chemical purposes it is desirable to express all heats of reaction per equivalent, and not as in thermo-chemistry, for molecular quantities; but we may go a step further and divide the result by 96,600—the number of coulombs transported by an equivalent of matter.

* Paper read before the Faraday Society.

† I have written the above equation with the quantities required to convey our "faraday" of electricity (96,600 coulombs). This, I think, is a practice that electro-chemists might adopt generally with advantage.

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The result will be a number of volts corresponding to the heat of reaction, and one may be permitted the slight inaccuracy of saying, for brevity, the "heat of reaction in volts." It must be remembered, of course, that the number of volts thus arrived at is not that actually given by the reaction, but that which would be given if all its energy were spent in producing current.

With this explanation, then, I may say that the heat of formation of sulphuric acid solutions is roughly

$$Q = 0{\cdot}8\ z - 1{\cdot}2\ z^2 \text{ volts.}$$

The deviations from this formula are too large to ascribe to errors of experiment; I have therefore plotted them on a large scale diagram. To determine $\frac{dQ}{dz}$ I calculate from the above formula $0{\cdot}8 - 2{\cdot}4\ z$, which forms the greater part, and get the small correction by tangents to the curve. The results are given in the following table:

z	$\frac{dQ}{dz}$ (volts)	
0	0·787	From Pickering's measurements. Temperature, 18deg.
0·0025	0·781	
0·01	0·765	
¼	0·680	
0·05	0·674	
⅛	0·579	
0·10	0·557	
0·15	0·440	
¼	0·407	
0·20	0·340	
0·25	0·253	

appears that this has been over-estimated: the true heat of reaction is probably less than even Streinitz's value. Taking the mean value of χ and combining it with the tabulated values of $\frac{dQ}{dz}$ as the most trustworthy final results, we get what is shown in Fig. 1, Curve A. This is the *total energy* of the reaction:

$$\tfrac{1}{2}Pb + \tfrac{1}{2}PbO_2 + H_2SO_4 \rightleftarrows PbSO_4 + H_2O$$

expressed by its equivalent in volts for various strengths of acid.

TEMP. 15°.

z	Heat of reaction.				$\frac{dQ}{dz}$	χ
0·0025	1·923				0·781	2·764 Tscheltzow
do.	1·879				do.	2·660 Streinitz
	E	$\frac{dE}{dT} \times 10^5$	$T\frac{dE}{dT}$	$E - T\frac{dE}{dT}$		
0·01	1·881	−7	−0·020	1·901	0·765	2·666
¼	2·002	+32	+0·092	1·910	0·680	2·590
⅛	2·097	+11	+0·032	2·065	0·579	2·644
⅛	2·246	+6	+0·017	2·229	0·407	2·636
¼	2·348	+4	+0·011	2·337	0·253	2·590
					Mean	2·625

(II.) *Free Energy.*—The free energy of a reaction may be estimated in various ways, and two of them have actually been worked out for the accumulator. (i.) The first is to

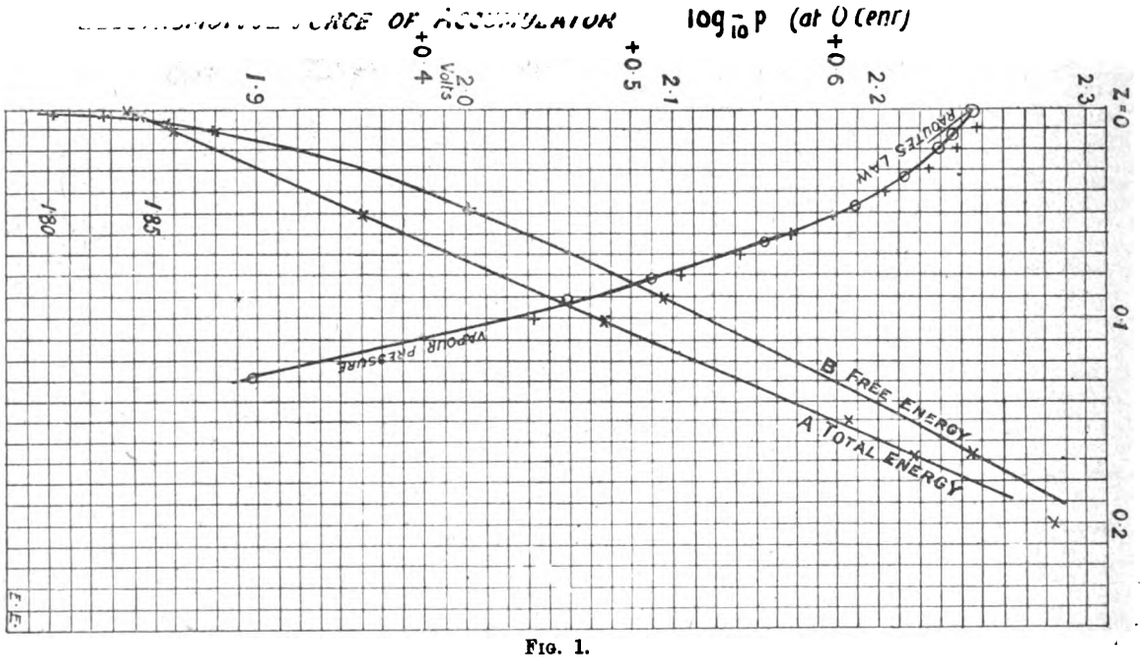

FIG. 1.

These numbers give the variation of the total energy of reaction; but we have also to find χ in order to know the total energy itself. Two methods are available. The heat of reaction has been found calorimetrically in the case of acid of strength $z = 0{\cdot}0025$. Tscheltzow gives for the molecular quantities, 88,800 calories = 186,580 joules per equivalent, or 1·931 volts; Streinitz, from a different series of reactions, 86,800 calories = 182,280 joules = 1 887 volts. Secondly, we may adopt the thermodynamic formula $\left(E - T\frac{dE}{dT}\right)H$ for the heat of reaction, where E = E.M.F., T = absolute temperature, H = quantity of electricity. If we adopt the same mode of expression for the quantities of energy as before, H = 1, and the "heat of reaction in volts" is given by $E - T\frac{dE}{dT}$ merely. The degree of consistency between the data may be judged by the following table, in which χ is calculated by both methods.

The numbers in the last column should, of course, be constant; they actually vary by 1 to 2 per cent. from the mean, which, considering the numbers and difficulty of measurements involved, is fairly satisfactory. χ, as calculated from the heat of reaction, is certainly too high, so it measure the E.M.F., E. For this multiplied by the quantity of electricity, F, flowing gives the electrical work done, E F; or, abbreviating as before, we may express the equivalent of the free energy by the voltage, E, merely. Herein lies the extreme importance of E.M.F. measurements in physical chemistry. (ii.) We may compare the free energy values in two solutions of different strength by studying a process of distillation. If two accumulators with electrolytes of different densities be put in opposition, the stronger will charge the weaker; the total amount of Pb, of PbO_2, and of $PbSO_4$ will be unchanged; but there will be less strong acid and more weak after the action is over. Now, just the same thing could be accomplished by distilling some water from the weak accumulator into the strong one, and some H_2SO_4 from the strong into the weak. I need not go into details of the process, as these have been worked out by other writers; but it is clear that if we take E as the measure of the free energy of the accumulator reaction with acid of a certain standard density, we can find what it is for any other strength of acid in terms of vapour pressures.

I have collected and recalulated the best data I can find as to these two methods, and the results are shown in the figure. Curve B gives direct measurements of E.M.F. The

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other curve shows Dieterici's measurements of vapour pressure at 0deg. But as the process of calculating electromotive power from this is not a satisfactory one I have reversed it, and calculated the vapour pressure from the E.M.F.; the results are shown by small crosses near the vapour-pressure curve. The vapour pressure for $z = 0.05$ is assumed. It will be seen that the other points lie near the curve of observation, but the agreement leaves something to be desired. The curve of free energy follows that of total energy in its general course. The difference between the two represents, as is well known, the "latent heat" of the cell; or, otherwise stated, the term $T\frac{dE}{dT}$; it is consequently a measure of the temperature coefficient of the cell. This is positive over most of the range, but negative for very dilute acid, and zero for $z = 0.006$. For that concentration alone the free energy is equal to the total energy. This point was determined by Dolezalek by direct experiment, as $z = 0.012$. Here, again, though the experiments support the theory in a general way, the agreement is not quite what might be hoped for if the constants of sulphuric acid solutions were systematically redetermined.

APPENDIX.

If Ω is the change of free energy corresponding to the reaction (in equivalents)—

$$\tfrac{1}{2}Pb + \tfrac{1}{2}PbO_2 + H_2SO_4 = PbSO_4 + H_2O,$$

when undiluted H_2SO_4 is used, and if w is the free energy of formation of the mixtures $z\ H_2SO_4 . (1-z)\ H_2O$, then the change of free energy due to the above reaction when taking place in a solution of strength z is

$$\Omega - \frac{dw}{dz}.$$

The E.M.F., E, of an accumulator is, therefore, found by dividing this quantity by the "faraday" F (= 96,600 coulombs)—or,

$$E = \frac{1}{F}\left\{\Omega - \frac{dw}{dz}\right\} \quad . \quad . \quad . \quad . \quad . \quad (1)$$

Now, $\frac{dw}{dx}$ may be found in terms of vapour pressures as follows: Give 1 mol. of mixture of strength z, and a small quantity dz mol. of H_2SO_4, mix these, and remove from the mixture dz mol. of H_2O. We have then obtained 1 mol. of mixture of strength $x + dz$, or in chemical symbols—

$$z\ H_2SO_4 . (1-z)\ H_2O + dz\ H_2SO_4 = (z+dz)\ H_2SO_4 . (1-z-dz)\ H_2O + dz\ H_2O.$$

The change of free energy in this reaction is, therefore, $\frac{dw}{dz}$. To evaluate it, suppose the acid added and water removed reversibly by isothermal distillation. Let $p_0\ p$ be the vapour pressures of pure water and of water in the given mixtures respectively; $p'_0\ p'$, the vapour pressures of pure sulphuric acid and of sulphuric acid in the given mixture respectively; R, the gas constant; T, absolute temperature. Then it is well known that

$$\frac{dw}{dx} = RT\left\{\log_e \frac{p'_0}{p'} - \log_e \frac{p_0}{p}\right\} \quad . \quad . \quad . \quad (2)$$

Hence

$$\frac{d^2w}{dz^2} = RT\left\{\frac{d\log_e p}{dz} - \frac{d\log_e p'}{dz}\right\} \quad . \quad . \quad (3)$$

But in virtue of the thermodynamical relation

$$z\frac{d\log_e p'}{dz} + (1-z)\frac{d\log_e p}{dz} = 0 \quad . \quad . \quad (4)$$

We may eliminate from (3) the vapour pressures of sulphuric acid, which are too small to measure, and obtain

$$\frac{d^2w}{dz^2} = \frac{RT}{z}\frac{d\log_e p}{dz},$$

or, from (1)

$$\frac{dE}{dz} = -\frac{RT}{zF}\frac{d\log_e p}{dz} \quad . \quad . \quad . \quad . \quad (5)$$

This equation may be made use of either to determine E from p, or p from E; but in practice, allowing for the difficulty of obtaining trustworthy empirical formulæ, it is the latter that is more satisfactory. For this purpose we may write

$$\log_e p = -\frac{F}{RT}\int z\frac{dE}{dz}\,dz.$$

Direct evaluation of this integral involves the impracticable process of obtaining differential coefficients of the observed E.M.F.'s. It is therefore necessary to integrate by parts

$$\log_e p = \frac{F}{RT}\left\{\int E\,dz - Ez.\right\}.$$

The results given in the text and accompanying plates have been obtained graphically from data given by Dolezalek. They are given in terms of the cadmium cell as 1·0220 volt. I have therefore reduced them in accordance with more recent determinations of the standard cell as being 1·0187 volt. Thus reduced they are

z	E	z	E
$\frac{1}{101}$	1·881	$\frac{1}{11}$	2·096
$\frac{1}{21}$	2·001	$\frac{1}{6}$	2·245

COST OF ELECTRIC LIGHT IN SMALL HOUSES.

BY R. S.

In many towns where an electric supply is available numbers of small houses are now being built which are wired for electric light instead of having gas-piping put in, and it may be of use to intending occupiers of such houses to know the actual yearly cost of electric lighting from the experience of one who has tried it.

A year or two ago the writer took an eight-roomed house in one of our Midland towns at a rent of £30. The house, which was a new one, was wired for electric light, and had no gas-piping laid on, so that the choice of illumination lay between electricity and oil. The following table gives the sizes of the rooms, number of lamps installed, and number actually used, and it will be seen that the total candle-power installed is 152; but the maximum candle-power of lamps alight at any one time would probably not exceed 100. The lamp in the scullery was found to be unnecessary, and was taken off, as the scullery was sufficiently illuminated by the kitchen lamp.

Room.	Size, feet.	Number and candle-power of lamps installed.	Number of lamps actually used.
Dining	13 × 13	three 16-c.p. lamps	one, all evening
Drawing	14 × 12	ditto	one, occasionally
Hall	—	one 8-c.p. lamp	all evening
Kitchen	13 × 12	ditto	ditto
Scullery	9 × 8	ditto	removed
1st bedroom	18 × 13	one 8 c.p. lamp	every night
2nd ditto	14 × 12	ditto	ditto
3rd ditto	12 × 10	ditto	occasionally
Landing	—	ditto	ditto
Bathroom	9 × 6	ditto	ditto
Attic	—	none	—

The current is supplied at a voltage of 200, and was charged for the first six months of the year under discussion on a maximum demand system commencing at 6d. per Board of Trade unit, and for the remaining six months at a flat rate of 5½d. per Board of Trade unit. The average price for the year worked out to 5·34d. per Board of Trade unit, and the number of units registered by the meter during the 12 months ending June 30, 1903, was 193, the electric light bill for the same period being £4. 6s. The current is supplied by the Corporation, and no meter rent is charged.

As the writer's family retire to rest early, and are careful to switch off all lights when not required, the above number of units may be taken as the minimum required for the yearly lighting of a small villa such as the one described above. The author estimates the cost of electric lighting in his case at about 33 per cent. more than gas lighting, but in many towns the cost of current is less than in the case above. Of course, the cost of new lamps must be added to the electric light account, but this is not a large item. With lamps costing 9d. each, the author finds that those downstairs last nearly a year, and the bedroom lamps 18 months or more, before they become too dim for use. He is now experimenting with 5-c.p. lamps in the hall and bedrooms, and finds that these give quite sufficient light in places where it is not required to write.

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ELECTRIC AUTOMOBILE ACCUMULATOR CELLS FOR QUICK CHARGE RATES.

BY E. KILBURN SCOTT, M.I.E.E., A.M.I.C.E

Much interest is being manifested at the present time in the question of accumulator cells for automobile work. The tyre difficulty, which previously gave so much trouble, has apparently been overcome, and in the matter of motors and controllers the new electrical vehicles are practically perfect. It only requires a thoroughly satisfactory cell to place the electric automobile in front of every other for general convenience, ease of and quietness of running, and possibly also durability and cost of upkeep. The great desideratum of an automobile cell is a *high charge rate*, so that when making long journeys the car can run to any electrical station and have the battery completely charged in, say, three-quarters of an hour. The ideal thing would be to drop half-a-crown in a slot and get juice forced into the cells whilst the driver is having a drink, but possibly this is asking too much at present; it will no doubt come to something like that in time.

Practically all cells at present on the market have the objection that the plates buckle under a quick charge or discharge. Let us consider for a moment what are the mechanical reasons for a plate buckling. All plates so far have consisted of a rectangular lead grid or plate, or else a rectangular frame, as in the D.P. cell, with strips of sheet lead laid across. Now during charging, expansion of the active material takes place, and if the charge is too rapid such expansion is proportionately great. As the actual lead plate or frame does not expand so quickly as the active material, there is nothing for the latter to do but to bend outwards, or, in other words, buckle. By a proper recognition of the simplest laws of mechanics it should be possible to design a plate in which the active material may expand and contract quite freely. Yet for some reason or other this has not been done. The situation, in fact, reminds the writer of the time when the diamond-frame safety bicycle was introduced, and those associated with its manufacture had not the engineering gumption to employ a cross-bar, and so change a redundant frame into two *rigid* triangles. A few minutes' study of a five-barred gate would have shown the reason why. Accumulator manufacture appears to have been through much the same stage, for the designers have been so busy with chemical equations and methods of making lead porous, etc., that they omitted to look at the plate itself simply as a problem in mechanical design. The men in accumulator work, as in so many other branches of electrical activity, have, in fact, been too much the electrician and too little the engineer.

The writer has had an opportunity recently of investigating two forms of cell which are about to be put on the market in which this buckling trouble is done away with. The first is the Elieson plate cell, and the second a solidly-built cell designed by Mr. Niblett. The Elieson plate is on the lines of the D.P., but the strips of lead are alternately straight and crimped. They are united together by a central core of lead, from each side of which the strips extend like the hairs from a feather. At the top and bottom cross pieces of wood give support to the ribs or vanes. As the strips are only held at one end, the oxidised material is absolutely free to *expand and contract*, and consequently buckling is obviated. An Elieson cell containing three negatives and two positives, measuring 8in. by 5½in. by ⅜in., and weighing 22½lb. complete with acid, is rated at 115 hours' capacity on a five hours' discharge rate. Such a cell was tested at the Reading electricity works, with the following results: The cell being nearly fully charged, was discharged at a rate of 20 amperes down to a voltage (on load) of 1·50 volts. It was then completely charged in 75 minutes, commencing at a rate of about 120 amperes and finishing at a rate of 45 amperes, the total charge being 110·69 ampere-hours. It was again discharged at the 20-ampere rate, and continued until the voltage dropped to 1·5, the total discharge capacity being in this case 101·66 ampere-hours, thus showing an ampere-hour efficiency of approximately 92 per cent., which, considering the high rate of charge, is remarkably good. The discharge was then continued at the 20-ampere rate until only 0·50 volt was registered, and the cell was then short-circuited and left for 48 hours. A charge of 128 ampere-hours was again made in one hour, the rate for about 20 minutes being nearly 150 amperes. An extra 40 ampere-hour charge was then made in one hour, and the cell left for four days. At the end of this time a discharge made at the high rate of 50 amperes for 1½ hours, and for a further 45 minutes at lower rates, showed a capacity of 106 ampere-hours, clearly demonstrating that no loss of capacity had been caused by the severe ill usage to which it had been subjected, the overcharge having been sufficient to reduce all the sulphating caused by the over-discharge, and to restore the cell to its normal condition. Sir W. H. Preece tested a similar five-plate cell, and found that it could easily absorb its charge in three-quarters of an hour, and this high rate of charge had no apparent deleterious effect on the cell, for the whole current consumption of the charge is so absorbed that there is, even after 250 amperes going in, no gas given off.

The new Niblett cell is being made at Horton Kirby, Kent. It mainly consists of a lead-lined box, the lining forming one pole, a porous pot containing and being surrounded by active material, and a central solid rod of lead for the other pole. The distance between the rod and inside of the porous pot is about 1in., whilst the space outside the porous pot to the lead lining varies from 1in. at the shortest point to 2in. at the corners, due to the pot being round and the containing box square. The active material consists of alternate layers, each about 1in. thick, consisting of pieces of lead rendered flaky by being melted and dropped into water, and of pellets of litharge about $\frac{3}{16}$in. diameter. These are pressed down fairly tight, first a layer of lead and then one of litharge, until the whole space, both inside and outside the porous pot, is quite full. The acid finds its way into the small spaces left between the pieces of lead and of the litharge, and expansion is taken care of by these spaces. There is, of course, no question of any buckling in such a cell, but unfortunately weight is against it, whilst the porous pot increases the internal resistance, and is, of course, liable to get cracked. At the same time this seems to be the only feasible way of making a pasted cell without having the buckling trouble. The Crowdus plate is a pasted one, and has given some good results, yet the writer considers that paste is not really feasible for automobile work unless the material is packed in solid as in the Niblett cell. If a plate is employed at all, it seems to the writer that it *must* be of the Planté type, and, judging by the results obtained by Mr. Elieson, a Planté cell can be made to compete with the lightest form of pasted plate cell in the direction of capacity in watt-hours per pound of weight.

TURBINE-GENERATORS.

The expiration of the original patents of the Hon. C. A. Parsons for steam-turbines is opening the market to a large number of firms who are taking up new types of turbines. This in the long run must result in a largely extended use of these prime movers. Amongst the firms to embark on this kind of work are Messrs. Willans and Robinson, of Rugby. We understand that they are building for Messrs. R. and W. Watson, of Linwood, N.B., a steam-turbine which is to be capable of giving 1,000 kw. from a continuous-current generator on the shaft. The generator is to be built by the British Schuckert Electric Company, and will give 4,000 amperes at 250 volts. Instead of being one machine, it will consist really of two 500-kw. dynamos placed in tandem on the turbine shaft. In this connection it will be borne in mind that the design of turbine-driven alternators is a comparatively simple matter, but that the question of commutation renders the construction of large output, high-speed, direct-current dynamos by no means easy. After giving careful consideration to this point, the British Schuckert Company have guaranteed that these machines shall run sparklessly with fixed brushes at all loads. Details of the machine we hope to give at a later date. Another firm which has taken up the same class of work has found it necessary to add subsidiary poles over the armature wound with a few turns of wire carrying the main current, in order to get sparkless commutation under the above conditions. We believe, however, that the combination above referred to will be the largest direct-current turbine plant in the United Kingdom.

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NOTES.

Felling Trees by Electricity.—Our Continental exchanges state that successful experiments have been made in various forests in France in the felling of trees by electricity. A platinum wire is heated to a white heat by an electric current and used as a saw. In this manner the tree is cut through much easier and quicker than in the old way, no sawdust is produced, and the slight carbonisation which results acts as a preservative of the wood. The new method is said to require only one-eighth of the time consumed by the old sawing process.

A New Telegram Code.—Messrs. W. Clowes and Sons announce the production of a new telegram code for use in cipher telegraphy. The work, of which Messrs. C. A. Moreing and Fredk. G. McCutcheon are the joint authors, is in three volumes. The aim has been to prepare a practically universal combination cipher code which shall facilitate and economise cable correspondence. It is claimed for the new system that its use will effect an average saving of something like 65 per cent. over ordinary methods. The price of the complete work is £21.

The Metric System.—Since this question was discussed before the Institution of Electrical Engineers last session, it has been debated with more or less vigour in many another assembly in different parts of the country. We understand that a conference will be held in London at the end of the present month of representatives of local authorities who have come to a decision by resolution on the subject. The conference will be invited to appoint a representative deputation to meet the Board of Trade to discuss the question of the compulsory use of metric weights and measures in this country.

Vesuvian Electric Railway.—An electric railway has been built up Mount Vesuvius to act as a feeder to the existing cable railway. The line is nearly five miles in length, and is divided into three sections. The first and third sections are ordinary lines, on which self-propelled electric cars are run. The middle section differs from the other two in that it is a rack railway, on which the cars are pushed up by an electric locomotive. The cars accommodate 24 passengers sitting. The journey up the mountain side is an exhilarating and enjoyable one, providing magnificent views of the surrounding country.

Brighton Municipal Telephones.—The extension of the Brighton Corporation telephone system to Burgess Hill was successfully inaugurated on Saturday afternoon. Congratulatory messages were exchanged between the Burgess Hill Urban Council offices and the Theatre Royal, Brighton, and also with London. The Corporation telephone exchange has now over 1,300 subscriptions, and new connections are being asked for at the rate of over 50 a fortnight. The ultimate success of the undertaking is looked upon locally as already assured. The Brighton system was recently described in this journal.

Electric Lighting in Rome.—Many ancient and historic buildings are now losing some of their antiquity by the introduction of the electric light, whose subtle encroachments apparently no hand can stay. Among the latest to succumb to the anachronistic illumination of electricity is no less a venerable pile than St. Peter's in Rome. The installation has recently been completed. Current is supplied at 2,000 volts alternating, and is reduced to a lower voltage by transformers situated in a chamber on the level of the main cornice round the dome. The interior lighting consists of 628 incandescent lamps of 25 c.p., and a large number of others of 10 c.p. The total illumination at present is 14,000 c.p. The installation, however, is capable of being increased to a maximum of 80,000 c.p. An interesting feature of the work is that the high-frequency mains are two miles in length, while the copper wire used in the building itself extends to a total length of 15 miles.

Institution Provisional Arrangements.—A provisional programme of papers proposed to be read before the Institution of Electrical Engineers in London up to the end of the current year, was announced at the opening meeting yesterday week. It is as follows: Nov. 26—"The Testing of Electric Generators by Air Calorimetry," by Mr. R. Threlfall, F.R.S., member; "The Edison Accumulators for Automobiles," by Mr. W. Hibbert, associate member. Dec. 10—"The Ondograph," by Mr. E. Hospitalier, foreign member; "On the Magnetic Dispersion in Induction Motors, and its Influence on the Design of these Machines," by Dr. Hans Behn-Eschenburg. Dec. 17—"The City and South London Railway: Working Results of the Three-Wire System applied to Traction, etc.," by Mr. P. V. McMahon, member. This programme is necessarily subject to alteration, but in its present form it will serve to indicate the nature of the subjects which are to be brought before the Institution for discussion up to Christmas.

Selective Wireless Telegraphy.—We understand that some important experiments are being carried out in the States with a system of wireless telegraphy devised by Mr. John Stone. The feature of the Stone system is that it is an attempt to secure selective signalling by the use of simple harmonic electrical oscillations. The practical application of the method was not easy, but the initial work of Mr. Stone has resulted in the construction of apparatus by which he is able to signal selectively across a difficult piece of country between Cambridge and Lynn, in Massachusetts, without being interfered with at all by other electrical disturbances. It is stated that the selectivity of the system can at present be controlled within 10 per cent., but this will, no doubt, be improved by further work. It is thought that once a selective system has been brought to a commercial point, it will not be difficult to secure secrecy also. The Stone system of wireless telegraphy is fully illustrated and described in the issue of the New York *Electrical World* for Oct. 24. We have yet to learn that tuning gives secrecy.

International Wireless Telegraphy.—An official note has been issued of the proceedings of the Berlin Conference on Wireless Telegraphy containing the text of the final protocol. As everyone knows, the conclusion arrived at by all the countries represented, with the exception of England and Italy, was that an international convention should be drawn up binding all coast stations to receive and transmit messages from and to ships without distinction of the systems employed by the vessels, and fixing the basis on which the rates should be charged. It now transpires that the objection of the British delegates to any such agreement was based on the ground of the uncertain position of wireless telegraphy in Great Britain at the present time. On the other hand, Italy would not sign the protocol because of the clause binding the contracting States to make public all technical information of a kind to facilitate communication with ships. The Italian Government, it will be recalled, in its agreements with Signor Marconi has agreed to keep secret all details of installations. We understand that it is proposed to hold another international conference on the subject next year.

Electricity in Australasia.—Electrical developments in our most southern colonies is not so rapid as we should like to see it. Recently published statistics show that the

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total number of electric supply stations in Australasia has increased in the past 12 months by only two. The new stations are the municipal plant which has been laid down by Dunedin Corporation, New Zealand, and another at Devonport, in Tasmania. The total plant capacity has increased in the same period from 14,303 kw. (19,000 h.p.) to 16,877 kw. (22,500 h.p.). This does not include the extensive electric tramway power-houses of Sydney, Brisbane, Perth, Kalgoorlie, Auckland, and Hobart. Of the 36 stations, 23 are privately owned and 13 are municipally owned. Rapid progress is being made in the modernisation of the systems in operation. Sydney is introducing a new three-phase, four-wire, low-tension distribution, and Launceston is changing over from a single-phase, 2,000-volt, 100-cycle, to a three-phase, 5,000-volt, 50-cycle system, with a four-wire, low-tension network. There are three three-phase systems, four combined alternating and direct current systems, 12 single-phase systems, and 17 direct-current systems. A large proportion of the low-tension networks are now operating on the three-wire system. Every effort is being made to standardise the low-pressure voltage to 110 or 220.

Tunbridge Wells Telephones.—"The work of transferring the wires from the late Corporation system to that of the company has now been completed, and it is hoped that the subscribers are in consequence getting a more rapid service." Thus the National Telephone Company in their latest circular to the inhabitants of Tunbridge Wells concerning the telephone system. The hope expressed therein, however, appears to be ill founded, for at the present time we hear of complaints which are being made by the subscribers against the inefficiency and slow working of the company's undertaking in the town. An attempt is being made to throw the blame for this on the old municipal system, for, in the words of the circular, "during the recent continued wet weather, owing to the faulty construction of the late Corporation lines, their insulation has proved to be so defective that when connected to the company's more sensitive system they have developed faults which have seriously interfered not only with their own working, but with that of the whole system." This, of course, may be the *ex parte* statement of the company in want of an excuse. In any case this would not prevent the subscribers getting replies to their calls if there were proper attention at the exchange. It is useless at this time to throw discredit on the late municipal lines—which, by the way, the company were anxious enough to buy—and the subscribers at Tunbridge Wells are acting quite within their rights in insisting in their demands for a more efficient and expeditious service.

Slaby-Arco Wireless Experiments.—In connection with the recent international conference on wireless telegraphy at Berlin, a preliminary report of Prof. Slaby's experiments has been presented to the council of the Jubilee Fund of German Industry, which granted that experimenter a subvention of £1,000 for continuing his researches. These experiments first dealt with the question as to the part played by the earth in connection with space telegraphy. By means of extensive zinc plates on the ground of his laboratory the author was able to construct a sort of artificial earth and to study the propagation of electric waves along the ground. He announced the presence of stationary waves, giving evidence of the important rôle played by the conductive surface of earth. The theory of closed sending apparatus was not so far able to account for the distance effects of such sender types. Prof. Slaby now succeeds in reducing these effects to the action of the upper harmonics, and in establishing a novel theory, the results of which are in a most satisfactory accord with experiments. The author further dealt with the design of instruments, enabling even unskilled persons to measure the wave-length of a transmitting apparatus. About a dozen different types have been experimentally studied and shown to be fully suitable. The author, we learn, is at the present engaged in studying new sender types, it being anticipated that a better method of tuning different stations will be derived from these experiments, which are shortly to be recorded in an extensive treatise.

Speed of Electric Tramcars.—Mr. R. Moffat Ford, who has at length succeeded in obtaining convictions against four drivers of electric tramcars in West London for exceeding their legal speed limit of 10 miles an hour, writes us an explanatory letter of his action in the matter. He repudiates the suggestion of vindictiveness which has been thrown out against him, and declares his motive to have been to show in some practical fashion the absurdity of putting it in the hands of local authorities to enforce a speed limit of 10 miles an hour in the case of motorcars under the new Act. He wanted to show the public what a speed of 10 miles an hour really is, and in pursuit of his object he selected the popular electric tramcar for the "demonstration." We do not know whether he succeeded in showing that a speed of 10 miles an hour is altogether too slow in these days of rapid transit, but in any event the question remains whether the end justified the means. But although Mr. Ford expressly repudiates any such motive as vindictiveness on his part, his letter leaves no doubt that he is incensed, to say the least, at the campaign of "motor-catching" which, he says, has been indulged in for the past seven years by the police all over the country, although all element of danger has repeatedly been admitted to be absent. If the charge of vindictiveness may not be lightly laid against Mr. Ford, we should be inclined to conclude from this that he is at least a disciple of the retaliatory doctrine which His Majesty's Government is so anxious that the country should adopt in its future fiscal policy.

New Books.—"Cylinder Oil and Cylinder Lubrication," by Messrs. Henry M. Wells and Wm. Scott Taggart, M.I.Mech.E. Part I. (the Henry Wells Oil Company, Manchester. 3s. 6d.).—To all engineers who desire to gain a further knowledge of the complex subject, cylinder lubrication, we commend this book. Mr. Henry M. Wells, joint author with Mr. Wm. Scott Taggart, is a well-known cylinder oil specialist, and the value of the work is enhanced by an interesting introduction written by Prof. Hele-Shaw, F.R.S. In this Prof. Hele-Shaw testifies to the great importance and, at the same time, the difficulty and complexity of the subject, and refers to some tests which the Henry Wells Oil Company have carried out, and from the results of which presumably the present issue has been compiled. These experiments are still proceeding, and from time to time the results will be published. The book treats of cylinder oil, its origin and production, and the processes through which the crude oil passes from the well to the finished product. A valuable feature is an analysis of numerous cylinder oils giving results hitherto unobtainable, and most of which were previously non-existent. Deductions from these analyses and a section dealing with some practical aspects of cylinder lubrication will be found to be among not the least interesting pages of the work. The book is illustrated by drawings of the chief types of British, Continental, and American steam-engines, and shows also some examples of the most important types of cylinder lubricators. That the present methods of judging a lubricating oil by analysis and physical tests are very fallacious, if not foolish, is only one of the many useful

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morals to be drawn from this interesting work.—The author of "Tube, Train, Tram, and Car" (Geo. Routledge and Sons. 6s.) is Mr. Arthur H. Beavan, not Beaven, as previously stated.

Photometric Tests of Nernst Lamps.—The fourth report of the N.E.L.A. Committee of America for investigating the photometry of arc lamps, etc., has recently been issued, and some valuable tests of Nernst lamps are recorded. The work has been carried out by Prof. C. D. Mathews at the Purdue University. The Nernst lamps experimented with were of the one, three, and six-glower types, equipped with shades and accessories as put upon the market by the manufacturers. The report calls attention to the need for constancy of voltage when operating Nernst lamps. Thus, a special test revealed the fact that near the working voltage 1 per cent. variation made a change of 14 per cent. in candle-power. With the lamps experimented with a constant current of 0·4 ampere per glower gave a most satisfactory result from a photometric standpoint. The report deals most fully with the distribution of light from the three types of lamps, and finally with the mean hemispherical and spherical candle-power. With clear globes the average watts per mean hemispherical candle-powers for the three types of lamps were as follows: with one glower, 2·31; with three glowers, 2·33; and with six glowers, 1·88. The mean spherical candle-power is, of course, less, and the watts expressed as per mean spherical candle-power with a clear globe of six glowers were 3·30. These figures clearly show that the six-glower lamp is considerably more efficient than either the one or three glower. The reason for this would appear to be that with a number of glowers in close proximity mutual radiation allows them to operate at a higher temperature than would an isolated glower, with the same expenditure of energy. The result is an increase of light output, in spite of screening effects between different glowers. In a curve given in the report the Nernst lamp is compared with both alternating and direct current arcs. The difference in the polar diagram of candle-power is very considerable, and the result does not give much hope that the Nernst lamp will be able to replace the arc lamp of equal candle-power.

Obituary.—It is with great regret we have to record the death of Mr. James Hookey, late engineer-in-chief at the General Post Office, which took place at his London residence on Saturday. Our readers will remember that Mr. Hookey retired from the responsible duties which attach to the office of head of the engineering department at St. Martin's-le-Grand only last year, when he was succeeded by Mr. John Gavey. His numerous friends in the profession we are sure will join with us in extending our deep sympathy with Mr. Hookey's family in their bereavement. Born at Bristol on Dec. 30, 1839, he was thus in his sixty-fourth year. At the age of 15, after being educated at Bath, Mr. Hookey commenced his professional career with the old Electric Telegraph Company, in six years attaining to the position of engineering inspector and assistant superintendent of the company's West Midland section. A year later, in 1862, he was transferred to the London headquarters, serving as chief officer under the late Cromwell F. Varley and his successor, Mr. Richard S. Culley. Thus, at the early age of 22, he was called upon to fill one of the highest positions it was possible to reach in his profession in those days. When the telegraphs were taken over by the State, Mr. Hookey went to the Post Office, notwithstanding a tempting offer he received from one of the great railway companies as superintendent of its telegraph system. From 1870 until 1882 he retained his position as chief officer, first under Mr. Culley, who also went to the Post Office, and afterwards under Mr. Graves, who succeeded Mr. Culley. In the latter year he was appointed principal technical officer under Mr. Graves and Mr. (now Sir) William Preece, these two gentlemen being respectively chief engineer and electrician. Ten years later he became assistant engineer-in-chief on the death of Mr. Graves, when the two offices were combined in Mr. Preece. On the retirement of Sir William Preece in 1899, Mr. Hookey was appointed engineer-in-chief, in which position he was succeeded by Mr. Gavey, as already stated, in 1902.

Electrical Power in West Africa.—The use of electrical power in gold mining is a comparatively new application, and up to the present but few such installations have been put into operation. The one notable instance of employing electricity for this purpose is, of course, at the Kolar goldfields, in the Mysore State of India, where the electric power is transmitted over a distance of 92 miles from the Cauvery Falls. A scheme which promises to be the parallel of this one both in importance and scope is now projected for the West Coast of Africa, better known as the Gold Coast. In the absence of coal or other suitable fuel it is recognised that if electric power is to be utilised, it must be generated by water power. It is therefore proposed to harness the River Tano, the second largest and longest river on the Gold Coast. The electric power produced would be used for hauling, pumping, and crushing as well as for operating light railways. Some particulars of the scheme appear in our contemporary *West Africa*. The Tano River, we are told, possesses a fall of over 75ft. within a distance of one mile, the largest fall being considerably over 40ft. in a distance of 100 yards, and competent mining engineers are convinced that what is practicable in India is practicable in West Africa. There is, of course, the question of the distance of transmission, but it is not thought likely to prove an obstacle to the adoption of the present scheme. From the Cauvery Falls to the Kolar mines is over 92 miles, whereas the approximate distance from the Tano to the Tarkwa centre does not exceed 40 miles. At any rate it will be safe to place the total distance, including distributing lines, at about 60 miles, which in time could easily exceed 150 miles, sufficient to tap any of the colony's goldfields. The cost of a 5,000-h.p. transmission plant is roughly estimated at £140,000, the capital required for its erection at between £20 and £30 per effective horse-power, and the operating expenses, taking into consideration the local conditions, at £28,500. The output of such a plant operating on a mixed load 24 hours per diem for 300 days per annum would be, say, 21,480,000 kilowatt-hours per annum, which brings the net cost to less than 2d. per horse-power per hour. The writer says the cost of horse-power per annum of steam power generated by coal and wood fuel would in West Africa exceed £40. Therefore, in placing the average price of an electrical horse-power per annum at £25 for 5,000 h.p., the gross income would be £125,000, less working costs £30,000—total, £95,000 profit, or 25 per cent. on £300,000 nominal capital, with 6 per cent. per annum for the amortisation, which would allow the capital being paid off in 15 years. Over two dozen mines, it is said, are at least rapidly approaching to a stage when the necessity for a cheap power will become inevitable, and it is contended that if 20 odd companies are the only consumers available under the outlines of the scheme, they will benefit to an extent proportionately higher than the 11 Kolar mines, which are expected to save well over £50,000 in working expenses during the existence of their 10 years' contract. We gather from the article that a syndicate has been formed to develop the Tano River scheme.

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A Graphic Recording Ammeter.—Before the American Institute of Electrical Engineers at the end of last month, Mr. A. H. Armstrong described in detail the construction of a graphic recording ammeter for use on electrical cars. It seems that a dynamometer construction is employed, in which the current to be measured is carried by the fixed element, and the moving element carries a constant current supplied preferably by a small storage battery. The moving coil is a small rectangle made up of several turns of wire, surrounding an iron core of cylindrical shape, carrying about one ampere. This coil and core are enclosed in the fixed coils. The moving coil is suspended by a control spring, and held in position by this spring at the top and by a small steel shaft at the bottom. The bottom bearing is so made that when in use the moving system hangs freely from the control spring, but its vertical motion is so limited that any excessive vibration cannot damage the instrument. Current is led into and out of the moving coil by two spiral conductors of negligible elasticity in comparison with the control spring. The latter is adjustable by changing its length. The ampere-turns in the fixed coil of the ammeter are about 2,400, the ampere-turns in the moving coil about 80, and by this combination a torque at the end of the scale of about 200 gramme-centimetres is secured. This is from 80 to 200 times the torque usually employed in measuring instruments in which the indications of a pointer on a scale are observed, and from 3 to 15 times that employed in the usual integrating or curve-drawing instruments. With this high torque the friction due to the pen moving over the paper is practically negligible. The pen used consists of a capillary tube supplied by a siphon filled from an ink reservoir carried some distance from the recording point toward the axis of the instrument. In testing with such instruments it is usual to employ at least two, an ammeter and a voltmeter, and in order that the line can be accurately marked on the paper a time-marking clock is employed. It is thus possible to obtain simultaneous readings by the instruments placed upon different cars in a train, a valuable feature where the different cars are each equipped with their own motive power. The recording instrument in this service is estimated to replace the labours of several men required by the old method of two-second readings, and gives results of greater accuracy. The following general data with which the author concludes the paper are of considerable interest: Length, 32½in.; width, 13½in.; height, 11¼in.; approximate weight, 100lb.; torque of ammeter, 210 gramme-centimetres (full scale 24deg.); torque of voltmeter, 200 gramme-centimetres; period, 0·33 second for complete cycle; ampere-turns in fixed coil of ammeter, 2,400; ampere-turns in fixed coil of voltmeter, 950; ampere-turns in moving coil of ammeter, 80; ampere-turns in moving coil of voltmeter, 189; watts consumed in moving coil of ammeter, 1; watts consumed in moving coil of voltmeter, 3·3; watts consumed in fixed coil of ammeter, 130; watts consumed in fixed coil of voltmeter, 33.

Electric Haulage on Canals.—What is practically the first example in America of employing electric haulage on canals has recently been put into operation in the case of the Miami and Erie Canal in Ohio. The total length of this waterway is 244 miles, and runs between Cincinnati and Toledo. The first section to be put into operation by electrical methods is that between Cincinnati and Dayton, a distance of about 68 miles. An excellent illustrated description of the installation is given in the current number of the *Street Railway Journal* by Mr. Chas. W. Ricker, from which we are able to gather the following main details. The work is of peculiar interest, both as constituting the first attempt at mechanical canal haulage in the States, and as the first serious application of three-phase traction motors on that side of the water. Briefly, the plan of operation is the haulage of tows of eight or ten canal boats by a locomotive running on a track beside the canal. So far this is in accordance with the present Continental practice. The locomotive, however, in this case uses three-phase motors, and takes current from a pair of trolley wires at high voltage, which is reduced by transformers on the locomotive itself. The transmission of power is necessarily over a long stretch, having regard to the length of the canal, and everything pointed to the use of high-voltage working conductors fed by a relatively small number of sub-stations, and feeding in their turn alternating-current motors upon the locomotives. Power for the section now in operation is taken from the lines of the Cincinnati Gas and Electric Company as a matter of convenience. The power, as 4,200-volt, 60-cycle, three phase current, is received in a motor-generator station, which changes the frequency to 25, and separates the haulage system from the local lighting and power system. Part of the output, at 390 volts, feeds directly the first section of working conductors. The remainder is stepped up to 33,000 volts, and transmitted along the canal bank. At four sub-stations transformers receive the 33,000-volt current and deliver it to the working conductors at 1,170 volts. The locomotive receives the current and transforms it to 390 volts for use in the motors. The principal interest in the system centres in the locomotive itself. This is of the compact type designed for mining work and weighs 55,000lb. It has four 33in. wheels mounted on 6in. axles with 5in. journals, and to each axle is geared with a double-speed reduction an 80-h.p. three-phase induction motor. The two motors are normally operated in tandem. The primary winding of the first motor is connected to the transformer secondaries, its secondary winding to the primary of the second motor, and the armature of this last is closed through a controller and a set of iron grid resistances. This controller serves for reversal and speed variation when required, although the motors in tandem are designed to give the 3 m.p.h. to which the speed is at present limited by statute. In this normal operation the motors give 40 h.p. each, and a horizontal effort with 25 per cent. coefficient of adhesion of 9,600lb. In view of the exceptionally large weight of the locomotive, specially heavy rails are used in the construction of the track, which, of course, is also of special design. Electric traction on canals has been proved on the Continent to be both feasible and practical, but it would be well to wait for authoritative figures of operation before the failure or success of the special system in question is discussed.

Institution of Electrical Engineers.—The attendance at the opening meeting of the new session of the Institution of Electrical Engineers on the night of the 12th inst. was quite worthy the occasion. Mr. Robert Kaye Gray, the president, was to deliver his inaugural address, and in anticipation of what was to be expected from an engineer of Mr. Gray's wide reputation and high status in the profession, the members came in their hundreds, so that every seat in the commodious lecture theatre at the Institution of Civil Engineers was occupied shortly after 8 o'clock. Mr. James Swinburne, the late president, sat on the left of Mr. Gray, and there were also present, among others, Sir Henry Mance, Profs. Ayrton, Perry, J. Grylls Adams, and S. P. Thompson, Mr. J. Gavey, Mr. Alex. Siemens, and Mr. J. W. Swan. The address which Mr. Gray delivered will long be remembered by the members for the masterly way in which it reviewed and described the progress

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in the numerous fields of electrical engineering as they exist to-day, including electric lighting, electric traction, transmission of power, submarine and overland telegraphy, and electro-chemistry, but for nothing so much as the advice it contained for the future welfare of the Institution. Mr. Gray's references to a "temple of engineering" at Westminster were enthusiastically welcomed by the meeting, and the absorbing interest with which this question of providing a permanent home for the Institution is being met was well reflected in the later speeches of Prof. Ayrton and Mr. Gavey. The suggestion thrown out by Mr. Gray in favour of establishing a "London Section" on the same lines as the provincial local sections as distinguished from the parent body, and the reasons which he gave for advocating such a proposal, will be read with interest by those who were unable to attend the meeting. In accordance with custom, before Mr. Gray delivered his address the prizes and premiums awarded for papers read last session were distributed by Mr. Swinburne, under whose *régime* they were mostly gained. To Prof. Ayrton—lately returned from his tour in America as a member of the Education Committee—was assigned the pleasant duty of proposing a hearty vote of thanks to the President. He remarked that while singing the praises of electricity in this country, Mr. Gray had warned them that they ought to improve. They all joined with their President in his wish that Westminster might see the rising of a temple of engineering, but he feared that the history of that project would be the history of so many others. England organised the idea, America adopted and developed it, and then later on England reimported it. More than 20 years ago Sir Wm. Siemens proposed that there should be such a temple of engineering, and he was generous enough to offer to start the subscription list with a sum of £10,000. In New York, mainly through the generosity of Mr. Carnegie, there was to be provided a great hall for the use of four large engineering societies, and the land and money had already been provided. He supposed that later on England would import this idea with the privilege of paying a duty under the Chamberlain protection tariff. The reference of the President to submarine telegraphy was to him pathetic, for it brought back the image of many a past president, now dead, sitting in the chair—men who made England distinctly first in the manufacture and laying of submarine cables, and in which, thanks to such men as their President, this country was still first. He asked the meeting to extend to their President its best thanks for the instructive, interesting, and even amusing address he had given them. Mr. J. Gavey, in seconding the vote, recalled the time when the Institution was essentially a telegraph society, and when the electrical industry was practically comprised in the word telegraphy. Seeing that their President was one of the pioneers of submarine telegraphy, it was with the very greatest pleasure that they saw him occupying the presidential chair that night, and it was with the utmost pleasure that he seconded the resolution. Needless to say, it was carried by acclamation, and the President having briefly returned thanks, the meeting broke up.

City and Guilds Institute.—A very interesting, but in some respects disappointing, volume is the report just issued on the work of the department of technology of the City and Guilds of London Institute for the session 1902-3. It is signed by Mr. Wm. Bousfield, chairman of the Technology Committee, and Mr. Philip Magnus, the superintendent of the department, and provides an excellent insight into the progress which is being made in the teaching of technological subjects in London. In point of numbers a substantial advance is shown. The number of registered classes in technology has increased from 2,320 last year to 2,789 this year, and the number of students from 36,189 to 38,638. Glancing through the report our attention is arrested by the following sentence: "The large percentage of failures in all the preliminary examinations is an indication of the unprepared condition of the candidates on commencing their technological instruction." The unpreparedness of the students appears to lie chiefly in their inability to reduce their knowledge to expression, which seems to indicate that the standard of mental training in the preliminary schools is not a high one. It is obvious that students whose elementary education is defective cannot be expected to benefit by higher instruction in mathematics, science, or technical subjects. Passing on we come to the programme arranged for the present session, and find that in telegraphy and telephony and electric light and power the syllabuses have been revised, in order, presumably, to keep pace with the times. Further, the former syllabus of examination in electro-plating and deposition has been replaced by an extended syllabus covering electro-metallurgy, including electrolytic refining, electric smelting, and electro-plating. After the general report are given a number of tables of statistics, followed by a collection of extracts from some of the examiners' reports on the results of the last examinations. With regard to telegraphy and telephony, the rather laconic remark at the end of the report is that "on the whole the standard of work is about the average." This, however, cannot be regarded as a very satisfactory state of things in view of what the examiner has to say about the general capabilities of the students. Even the best informed of the candidates, it seems, can rarely deal satisfactorily with more than six of the eight selected questions, and very simple calculations are quite beyond the capacity of the average student. Generally speaking, even the most simple questions are very feebly dealt with, and the examiner notes with dissatisfaction that, as a rule, the honours candidates are little, if at all, in advance of the ordinary in the quality of their work. In electric lighting and transmission of power there has been an increase in the number of candidates, especially in wiremen's work, where the increase is nearly 80 per cent. The examiner reveals a more satisfactory state of things in regard to this subject than in telegraphy. Some of the papers at the last examination were exceptionally well done. A marked difference was noticeable, however, between the answers to questions relating to direct currents and those dealing with alternating currents, the answers to the former being very much better than to the latter. In the honours grade none of the papers sent in were sufficiently meritorious to warrant the recommendation of any first prizes. The average quality of the wiremen's work was not so good as last year, less skill being shown in making metal joints, etc. Insufficient attention was paid to effective insulation in the majority of cases, many of the candidates using prepared tape as an insulator instead of as a mechanical protection only. The chief defects in the work may be enumerated as follows: tape left on original rubber between metal and braiding, length of original rubber between metal and braiding insufficient, new rubber not extended far enough over original rubber, too much solution used, want of cleanliness, original rubber cut through in removing braiding, etc. As regards electro-plating and deposition the work at this year's examinations was inferior to that done last year; there was no pre-eminently good paper in either grade, and the average was anything but satisfactory. This result is all the more disappointing after the very marked improvement shown in the papers submitted by candidates last year.

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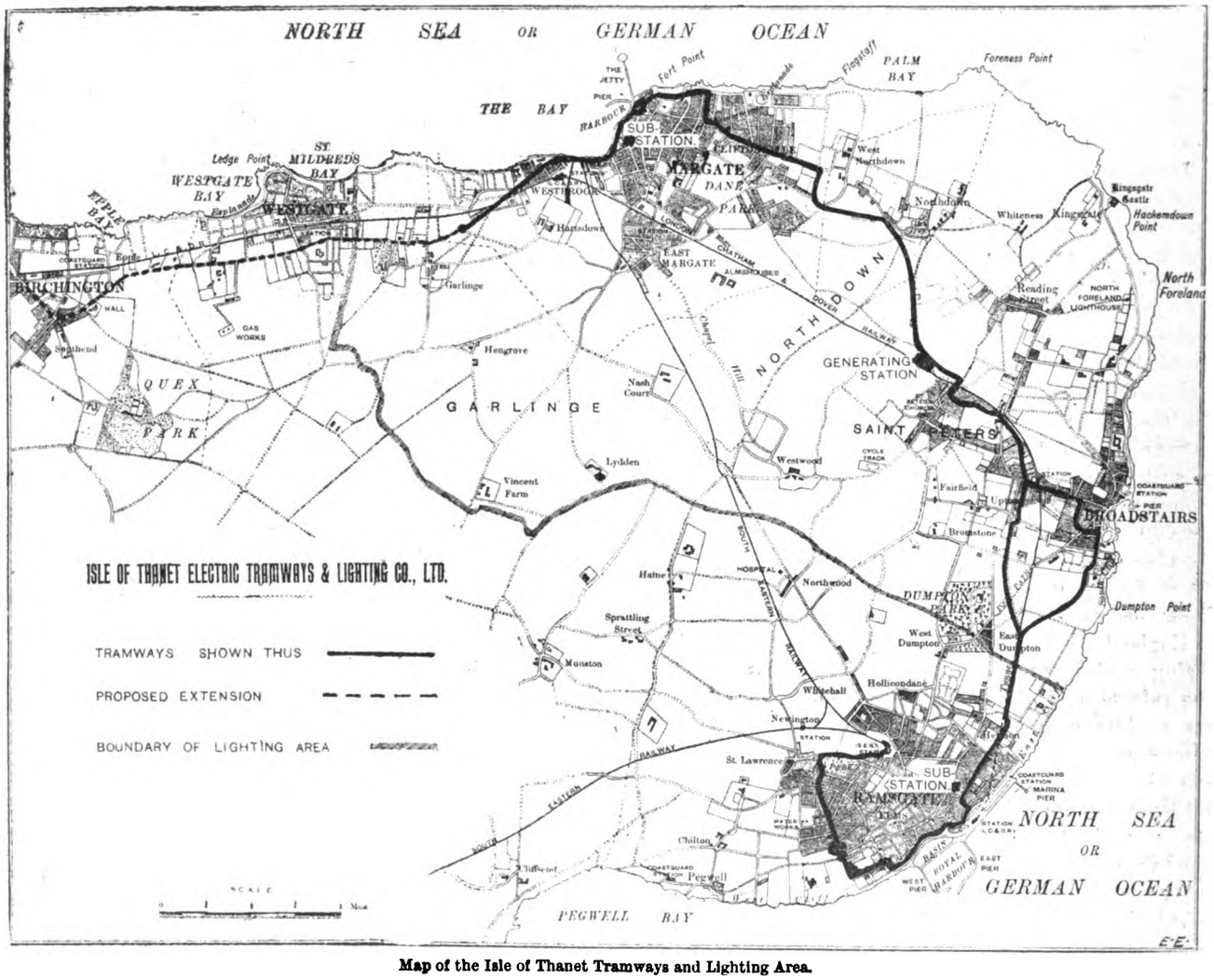
ISLE OF THANET ELECTRIC TRAMWAYS AND LIGHTING COMPANY.

BY B. PONTIFEX.

The Isle of Thanet tramways form an excellent illustration of the best sphere of usefulness for a service operated by one controlling authority. There are several boroughs in the island, but none of them is sufficiently powerful to absorb the remainder and provide municipal control for any common scheme, which is, consequently, best carried out by an independent company. For example, at present three boroughs, together with some outlying parishes, are traversed by the tramlines. What confusion and inconvenience would be caused if, supposing the lines were run by the separate borough councils, one of those councils withdrew its portion of the route from service during the winter season, when traffic is barely sufficient to clear running expenses? This is quite apart from any consideration of economy in the cost of generating power for the line, which naturally works out more cheaply with one big station than with three small ones.

The company operating this light railway was formed by Mr. W. M. Murphy, to whom the Commissioners of Light Railways granted an order in December, 1897, which was confirmed by the Board of Trade in August, 1898. The local authorities concerned have the right to purchase the undertaking after a period of 42 years, but compulsory acquisition cannot be enforced unless two-thirds of the Councils of Ramsgate, Margate, and Broadstairs agree to the terms of sale. The local improvements which have been carried out by the company include over three miles of new road, while nearly another two miles of highway have had to be reconstructed, with the result that large areas of new land along the Foreland cliffs has been made available for building purposes and are being rapidly occupied. The consulting engineers for the scheme were Messrs. Kincaid, Waller, and Manville for the construction work, and H. F. Parshall, Esq., for the electrical equipment.

At present the tram route extends from Garlinge, a short distance from Westgate, through Margate, along the sea-front to Cliftonville, thence to St. Peter's (where the power station has been built), passing on through Broadstairs to the sea-front at Ramsgate. After passing Ramsgate Harbour the line turns sharply to the right to the present terminus at the S.E.R. Station. There is also a loop line at Broadstairs, which passes under the railway to the sea-front and rejoins the main route at Dumpton. The construction of this loop line necessitated the building of a new railway bridge without interrupting traffic, and lowering the roadway to enable the cars to clear the bridge with safety to outside passengers. The lines, as a whole, are fairly level, but what gradients there are make up for this by their steepness, as there are a few of 1 in 18, and also a length of 100ft. of 1 in 11, which is the maximum (quite enough, too!). The curves generally are easy, but some are, unavoidably, of short radius, the worst



Map of the Isle of Thanet Tramways and Lighting Area.

of these being 40ft. An awkward feature with the narrow gauge in use (3ft. 6in.) is the extreme amount of "overbang" of the car bodies when rounding curves, which has caused much trouble with new drivers when the streets are crowded with other traffic in the summer.

Since the line serves a district which relies entirely on "holiday" attractions, there is naturally an enormous difference between the summer and winter costs and revenue; in winter 14 cars run with 15 minutes interval, but in summer a service of 56 cars is maintained. The results are shown by the following table of costs:

Expenses per Car Mile, in Pence.

	Winter, 1902-3.	Summer, 1903.	Average.
Power	2·16	1·35	1·75
Maintenance	1·16	0·67	0 91
Traffic	2·27	2·20	2·23
General and management	0·76	0·29	0·52
Total	6·35	4·51	5·41

From April 4, 1901, to Sept. 30, 1902, which completed

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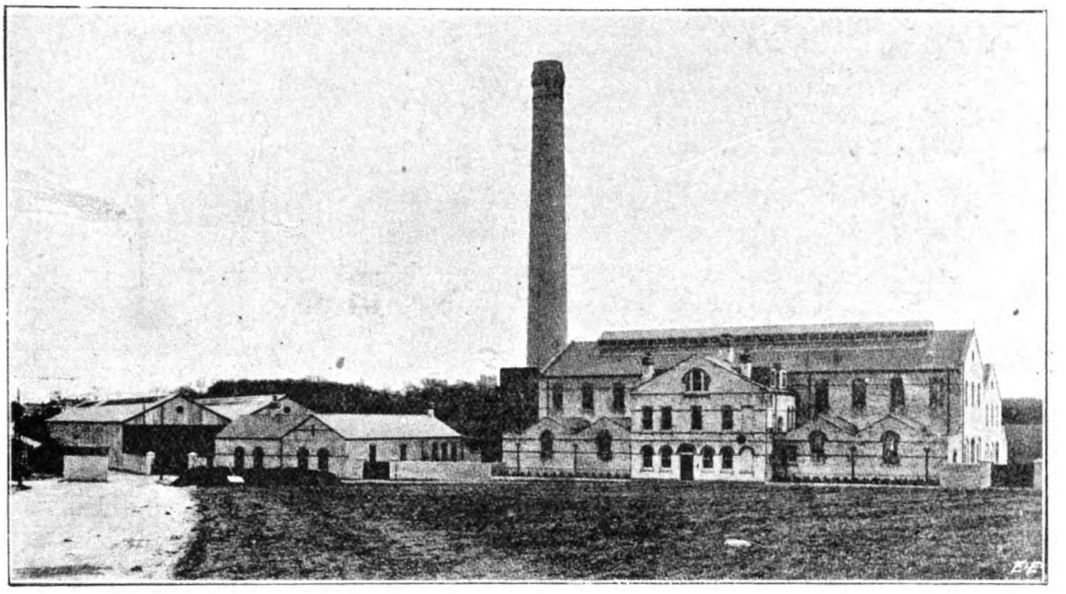
the first 18 months of working, the following results were obtained:

Traffic.—Miles run	1,324	790	
Passengers	7,500,245		
Units used	2,008,208		
Expenses.—General	£20,689	8	8
Power	10,680	8	4
Maintenance	5,019	2	8
Receipts.—Traffic	60,298	19	5
Lighting	128	19	5

the other at Margate, an arrangement which is enforced both by the length of track and by the existence of electric lighting orders. The generating plant consists of two 200-kw. direct-current generators and two 300-kw. three-phase alternating-current generators, two Tudor batteries, and a rotary converter. The sub-station plant consists of 100-kw. rotaries with static transformers, and Margate sub-station also has a Tudor battery.

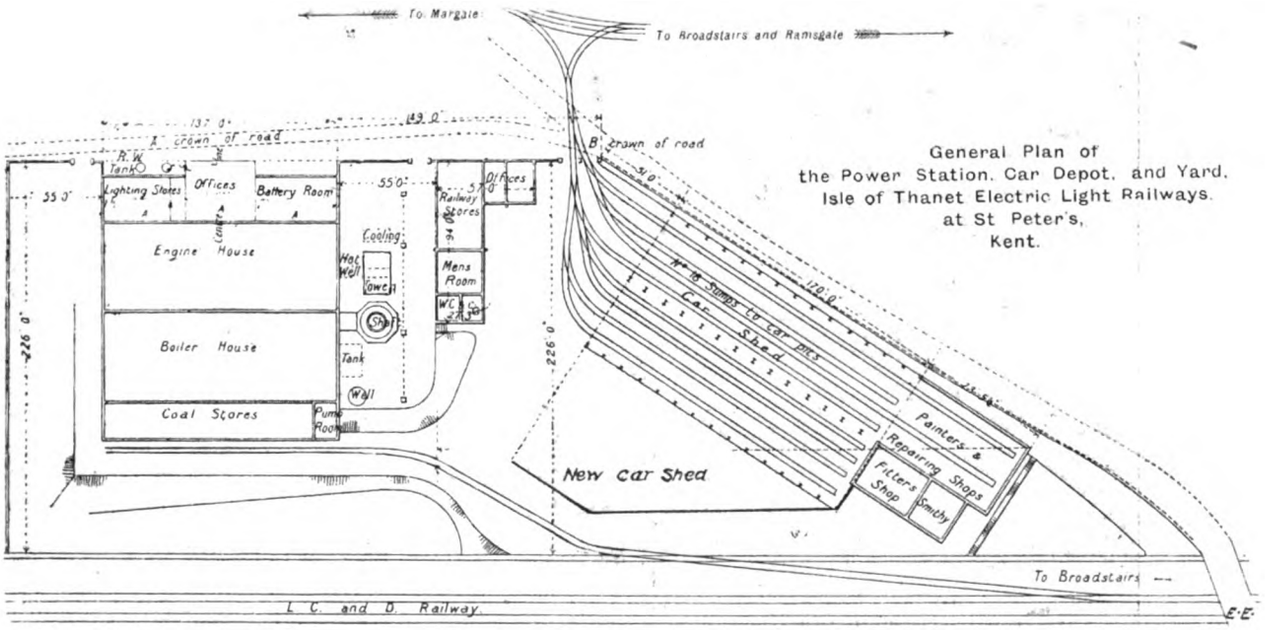
The generating station is built of yellow brick, made locally, and the boiler and engine houses are each 134ft.



A General View of the Isle of Thanet Power Station and Car Sheds.

Extensions of the line are contemplated through Westgate to Birchington, while the lighting of these towns has also been undertaken. At present the electric lighting provisional orders for Margate and Broadstairs have been taken over, and supply is being given in these towns from sub-stations described below as fast as the necessary mains can be laid, while 25 arc lamps are supplied in Broadstairs for public street-lighting.

by 50ft. in area. There is a coal store, 20ft. in width, along the back of the boiler-house, where the private siding is brought up so that coal can be discharged from the trucks straight into the store. In the boiler-house are four Babcock and Wilcox water-tube boilers, arranged two in a battery, with space to instal four more; they are worked at 160lb. per square inch, and have each 3,140 square feet heating surface. They are hand-fired—in fact,



Power-House.—This is placed near the middle of the line in the parish of St. Peter's, Broadstairs, and is connected with the Chatham and Dover Railway by a private siding, but, as an alternative, a track has been laid on the quay at Ramsgate Harbour, and material and supplies can be brought over the company's own line from ship to the power-house—a rod in pickle which should ensure prompt delivery even from our old friend the Chatham and Dover Railway. The track is fed directly from the generating station and from two sub-stations, one at Ramsgate and

there is no mechanical coal-handling anywhere in the power station. The feed piping is duplicate throughout, while the steam-pipes are laid on the single header system with section stop-valves. All expansion is taken up by large U-bends. The pipes are of lap-welded mild steel, with flanges screwed on to the ends, which are afterwards expanded. There is an economiser of 240 tubes in two sections, made by the Claycross Company, with scrapers driven by belt from a small engine. The chimney shaft is 162ft. high with 8ft. 6in. internal diameter.

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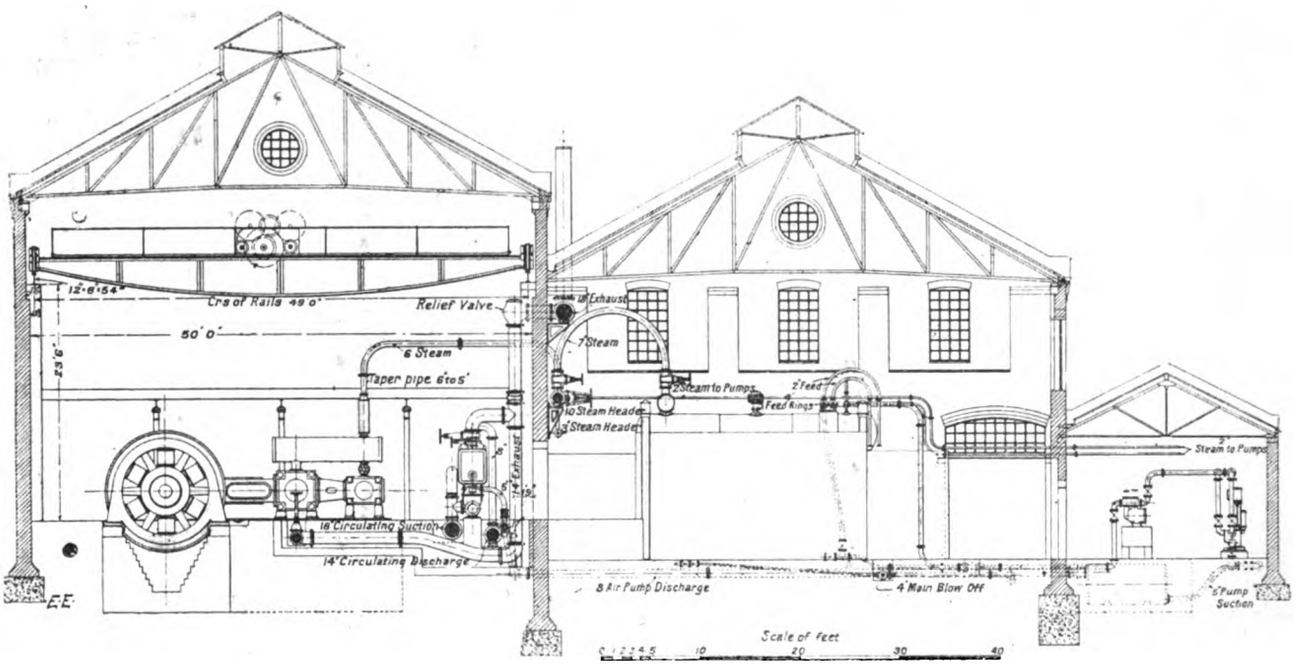
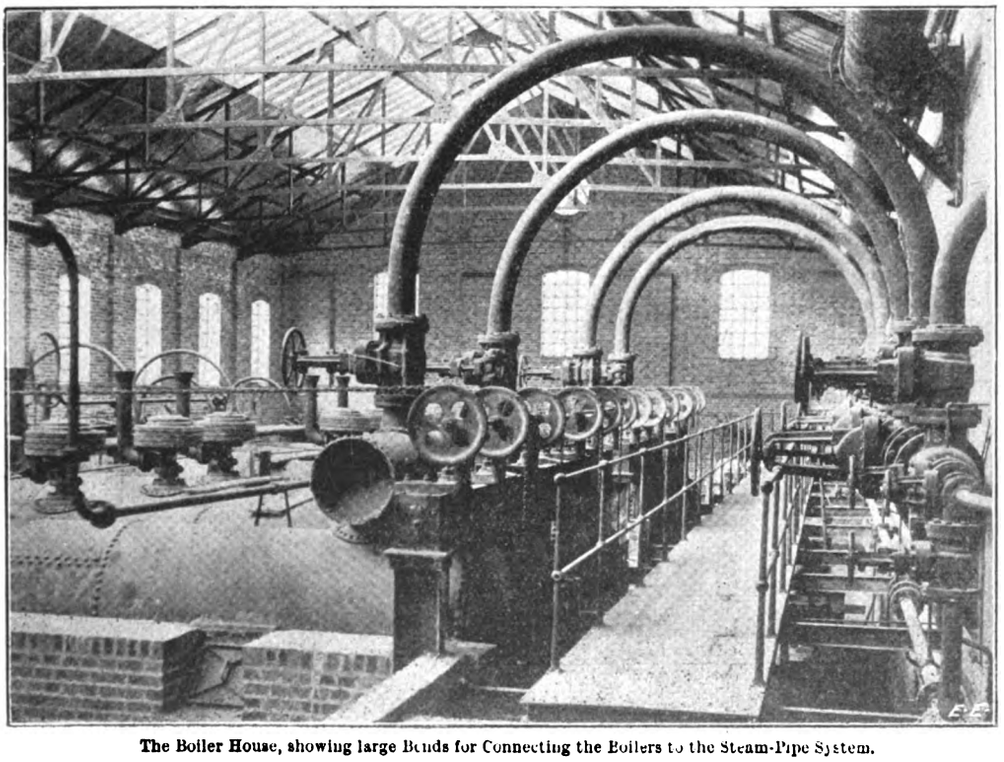
The pump-room contains two Blake-Knowles vertical, duplex, ram feed pumps, capable of delivering 4,000 gallons of water per hour with a piston speed of 50ft. per minute. Railton and Campbell filters are installed to deal with impurities in the feed water—mostly oil when the hot-well is in use. The feed water is taken from a storage tank outside the boiler-house, which is supplied from a well 180ft. deep by a Worthington deep-well steam-pump with a total lift of 150ft. The same pump supplies the making up water for the condensing system. Since the water comes from the chalk, a water softener is a necessity, and one has been erected by the Desrumaux Water Softener and Purifier, Limited, of Bradford, to deal with this. In emergency there is an alternative supply from the water company's mains.



Cross Section of Engine, Boiler, and Pump Rooms, Showing General Arrangement of Pipes.

In the engine-room there are two three-crank tandem compound vertical enclosed engines by Messrs. Belliss and Morcom, running at 300 revolutions per minute, with a steam pressure of 150lb. per square inch. It was laid down that the speed should not vary more than 1½ per cent. from normal, consequently the flywheels are heavier than usual. Direct-coupled to each engine is a British Thomson-Houston three-phase generator with stationary armature, the fields being excited from the 500-volt direct-current 'bus bars. Iron collector rings and carbon brushes are used. The machines develop 300 kw. at 2,500 volts, and have 20 poles, which at normal speed gives a frequency of 50 cycles per second. There are also two single-crank, tandem, compound, horizontal Allis engines of 320 i.h.p, running at a normal speed of 135 revolutions per minute under 150lb. pressure. The cylinders are 14in. and 28in. with a 30in. stroke, and the intermediate receivers are jacketed with live steam at



The Boiler House, showing large Bends for Connecting the Boilers to the Steam-Pipe System.

boiler pressure. An expansion governor is fitted which regulates the cut-off in both high and low pressure cylinders. The valve gear is the Reynolds-Corliss pattern with vacuum dashpots. These engines are allowed 2½ per cent. speed variation; while the more powerful British engines are only allowed 1½ per cent. The direct-current generators coupled to these are by the

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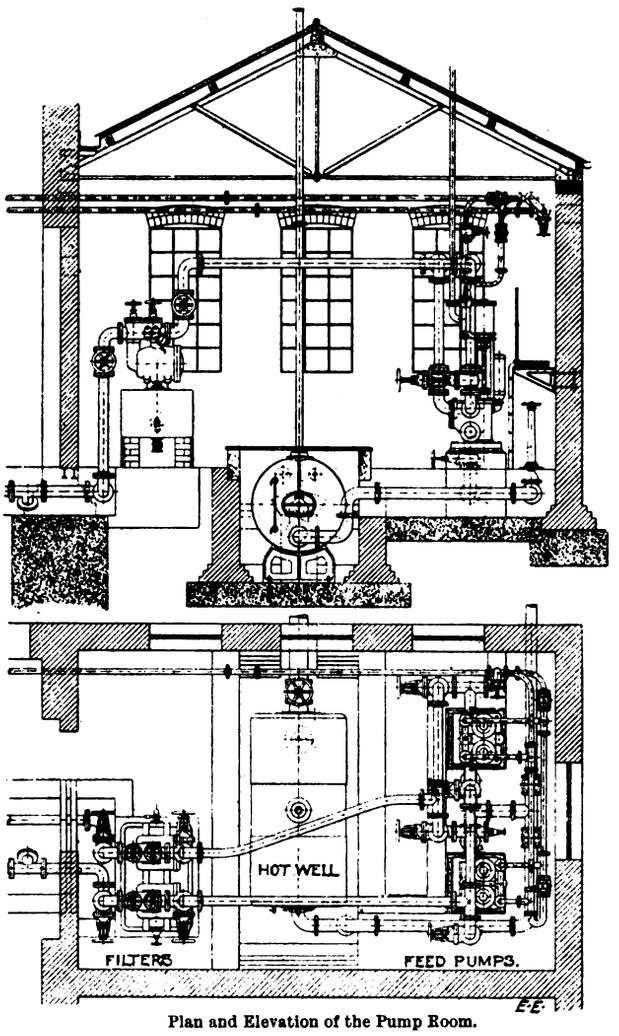
General Electric Company, U.S.A., and are designed to work as shunt machines on the lighting circuit and compound wound on tram work. The output of each is 200 kw. at 500 volts at normal speed; they are six-pole machines with drum armatures.

The condenser plant consists of three Wheeler standard pattern surface condensers, with compound steam circulating and air pumps mounted under the condensers, which have



Plan and Elevation of the Pump Room.

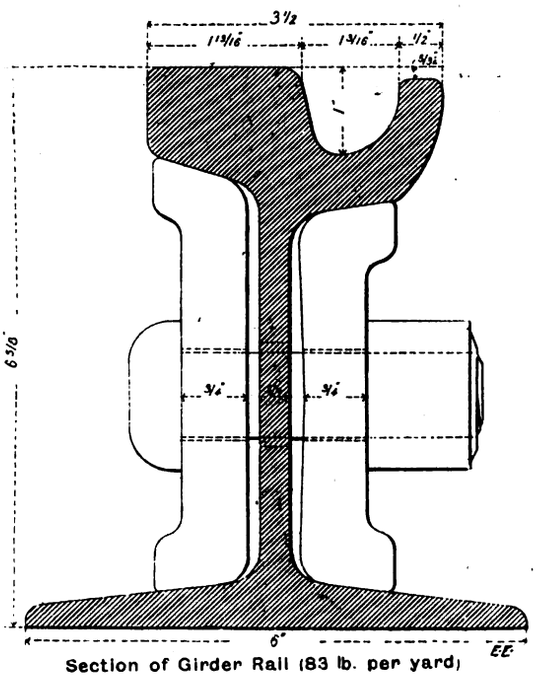
each 1,300 square feet cooling surface. There is also one of their cooling towers fitted with two sets of fans, each driven by a motor in the engine-room.

There is one 100-kw. rotary converter with three static transformers and regulator for use, in conjunction with the batteries, on the Broadstairs lighting, which is supplied from the power-house.

The battery consists of two sets of 265 Tudor cells with a capacity of 280 ampere-hours, if discharged to a minimum voltage of 490 with a maximum discharge rate of 72 amperes. The maximum charge rate is 40 amperes. They are of the central-station type, L A pattern, in lead boxes, nine plates in a cell. These batteries are charged by the aid of positive boosters.

The switchboard, of enamelled slate, is carried on a gallery at the end of the engine-room. It is divided into sections for the high-tension three-phase current, traction circuits, and lighting and battery circuits. There are separate panels for each generator, the boosters, balancer, and high and low tension feeders. The high-tension switches are of British Thomson-Houston long-break pattern, and there are also some of their oil-break switches fitted, one in particular being arranged to separate the high-tension 'bus bars so that Margate and Ramsgate sub-stations can be fed from separate generators.

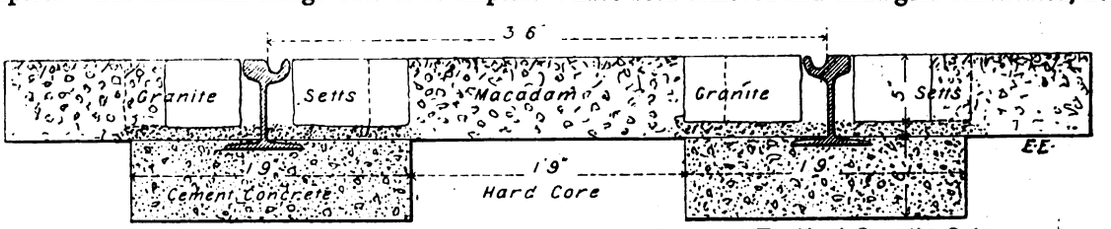
The high-pressure three-core, paper-insulated cables run each way, two to Margate and two to Ramsgate to supply the sub-stations. They are laid solid, and are manufactured by the British Insulated Wire Company. The cross-section is ·05 square inch. The traction feeder cables are supplied by the same firm and are laid in the same way. These are ·2 square inch in section, and are laid in either direction from the power-house to within about half a mile from the termini.



Section of Girder Rail (83 lb. per yard)

The lighting cables are triple-concentric supplied by Callender's Cable Company and are laid solid; the feeders are ·5 square inch and distributors ·1 square inch section. These are laid in Margate and Broadstairs only, since electric lighting has not yet been developed in other parts of the district. The three-wire system is in use with 480 volts across the outers.

Sub-Stations.—At Margate sub-station there are two 100-kw. eight-pole rotary converters by the British Thomson-Houston Company, with room for two more. These machines are supplied with low-tension alternating current at 310 volts from oil-cooled static transformers, and in their turn supply at 500 volts to the traction feeders or lighting switchboard as required. There is accommodation for six more static transformers when the extra rotaries are put in position. Automatic regulators worked by small three-phase motors are in use for keeping the alternating-current pressure constant, but the motors have been removed and hand-gear substituted, not because they failed, but because they were too sensitive. The lighting board is separated from the traction board entirely, and it will be worth while to study the booster connections on the switchboard diagram because the booster is reversible, and if necessary all the cells can be discharged with the booster working against them to keep the voltage at the declared pressure at consumers' terminals. The battery regulating switches are of the screw type worked by hand. The battery is of the same pattern as those at the power-



Section of Permanent Way (Single Track) with Macadam and Toothed Granite Sets.

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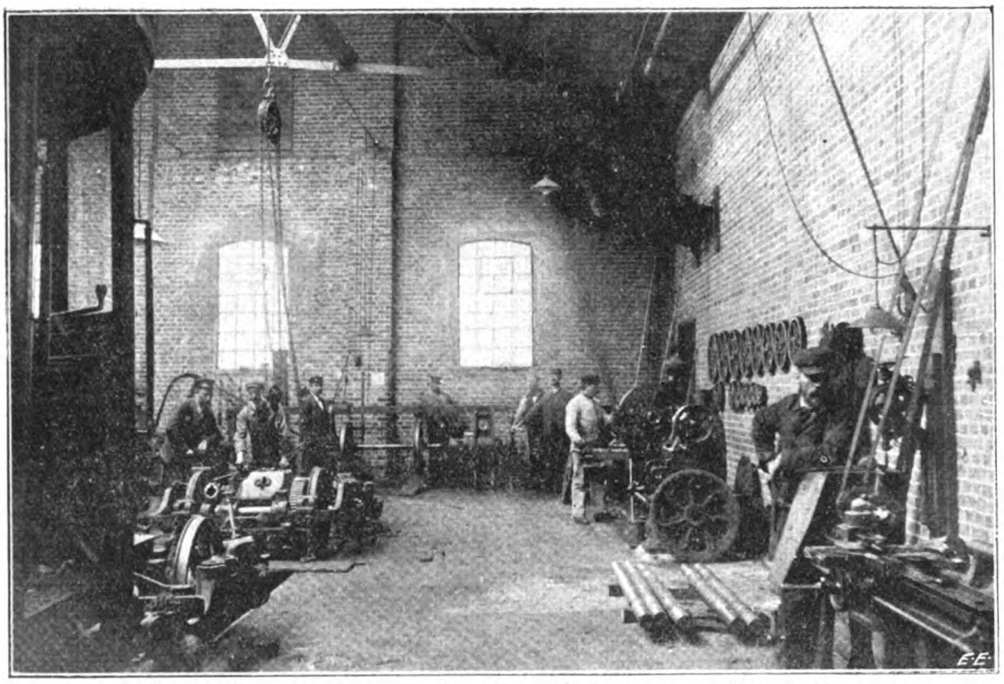
house, but with a capacity of 420 ampere-hours with a maximum discharge of 108 amperes. At Ramsgate sub-station there are three 100-kw. rotary converters with nine static transformers, all of the same size and pattern as the Margate machines, but there is no lighting load and no battery.

Permanent Way.—There are 10 miles of double track and one mile of single. The gauge is 3ft. 6in. laid with girder rails which weigh 83lb. per yard. They were supplied by the Lorain Steel Company in 30ft. lengths; the groove is $1\frac{3}{16}$in. wide and 1in. deep, while the rail is $6\frac{5}{8}$in. deep with a 6in. base. The fishplates are of the usual pattern, and the bolts are held by Helicoid lock-nuts, which are reported to be holding well against vibration and jars. Through the towns the track is paved with jarrah laid on 6in. of cement concrete extending 18in. each side of the track. Between towns macadam is used between the rails, which have granite setts on each side; concrete is in that case laid 1ft. 9in. by 6in. deep under each rail. All points are of crucible cast steel, supplied by Messrs. Askham Bros. and Wilson, of Sheffield. Double bonding is carried out at every joint, bonds being 6/0 L.S.G., while cross bonds of the same gauge are fixed every 120ft. The trolley standards are planted at 40 yards intervals; they are 30ft. long and weigh 990lb. Side arms are used over nearly all the route, except along the parade at Margate, where centre poles have been adopted. The trolley wire is double throughout, suspended over the centres of the tracks; the gauge is 00 L.S.G., and the breaking strain is 4,500lb. Flexible suspension is not used; the hangers can swing from the bracket arms, but there is no up-and-down motion possible, but, of course, it is not so material on a line where speed is cramped by considerations of stability due to the narrowness of the gauge. Section insulators are fitted every half mile, with the necessary feeder boxes and cables, etc.

Rolling-Stock.—The company possesses 60 cars in all, made by various firms—namely, 20 bogie cars (with pony wheels leading) and 20 single-truck cars with 35-h.p. motors, G.E. 58, and B.T.H. controllers, manufactured by the St. Louis Car Company, U.S.A.; 10 single-truck cars, by Messrs. Milnes and Co, and 10 by the British Electric Car Company, with Brill underframes. All these cars have enclosed vestibule ends and top seats, with the trolley standard in the centre line of the cars, and are fitted with hand-power track-brakes. The St. Louis cars have cast-steel side frames on the trucks.

The car-shed is situated at the generating station, and is 230ft. in length, with ample accommodation for all the cars, with pits running the full length of each track. The painting and repair shops open out of it. There is a small additional car-shed at Garlinge for convenience in saving long journeys when starting up in the morning and when closing the service at night.

I must express my thanks to Mr. J. Barber Glenn, the secretary of the company, and to Mr. R. Humphries, the resident engineer, for their kind assistance in the preparation of this article.



A Corner in the Repairing Shop of the Isle of Thanet Electric Tramways and Lighting Company.

INDEPENDENT TELEPHONY IN GREAT BRITAIN.

BY GARDNER AND HOLME.

(Continued from page 719.)

(5) Underground Construction.

The underground construction, including excavating and laying of pipes, building manholes and brick boxes, drawing in, jointing, and numbering cable, is best done by the corporation's staff or local contractors under the direct supervision of a capable resident engineer, as the persons doing the work are afterwards responsible for the maintenance of the system, and consequently good construction is ensured. The position of the exchange being decided upon, it is of great importance to select a building suitable for such a purpose; in the past little attention was generally given to the ultimate requirements of an exchange, some building being taken which in a short time proved totally unsuitable.

The buildings should be laid out as follows: the basement for the reception of the main cables; the first floor for office, stores, battery, power plant, test and distributing rooms; the second floor for operating and operators' cloak and retiring rooms. The arrangements of the rooms being laid out, all builders' and joiners' work should be completed before any of the apparatus or cables are installed. A brick or laced iron shaft of ample dimensions should be built for the reception of the main cables, from the basement to the test and distributing rooms, where angled iron frames and distributing racks are fitted ready for their termination. From these frames suitable conduits should be laid out and prepared ready to receive the switchboard cables from these frames to the switchboard. In the designing out of the Portsmouth exchange these details were all arranged for before any of the electrical equipment was installed.

The system to be adopted being decided upon and the number of lines for installation known (this is generally obtained from the result of an active canvass of the towns in the alloted area), it is well to plot out the obtained subscribers' lines in groups or blocks on a large scale plan of the town. From this plan the general distribution of the cables, number of pairs of wires in each cable, the

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number of spares which should be allowed for, and the position and number of the distributing poles will be arrived at. Tracings should be prepared in the form of a diagram, as shown in Fig. 21, giving all details as to the conduits, position and size of each manhole, draw-in and junction box, the length and number of pairs in each run of cable and sizes, the number of through and T-joints, and the position and length of each sub-main and distributing cable. This system adopted, there will be no difficulty in checking the progress of the work, and in arriving at the exact lengths of cable to order forward in each case. It is also a great help in the checking of the contractor and in balancing the schedule of quantities.

shown in Fig. 23. From these cable potheads the wires are run overhead or inside the buildings to the various subscribers' offices. Joint-boxes should be arranged for throughout all the cable runs about every 180 yards in order to facilitate the handling and drawing in of the cables. The manholes and joint-boxes should be built with Staffordshire brindle brick or a good local brick on a flooring of cement and concrete, and bellmouths for the termination of the pipes built into the sides. They should be roofed in with covers, supported on steel joists capable of taking the strain of the road traffic. All conduits should be laid from 18in. to 2ft. under the surface, and cast-iron pipes used for the reception of the main cables. The best

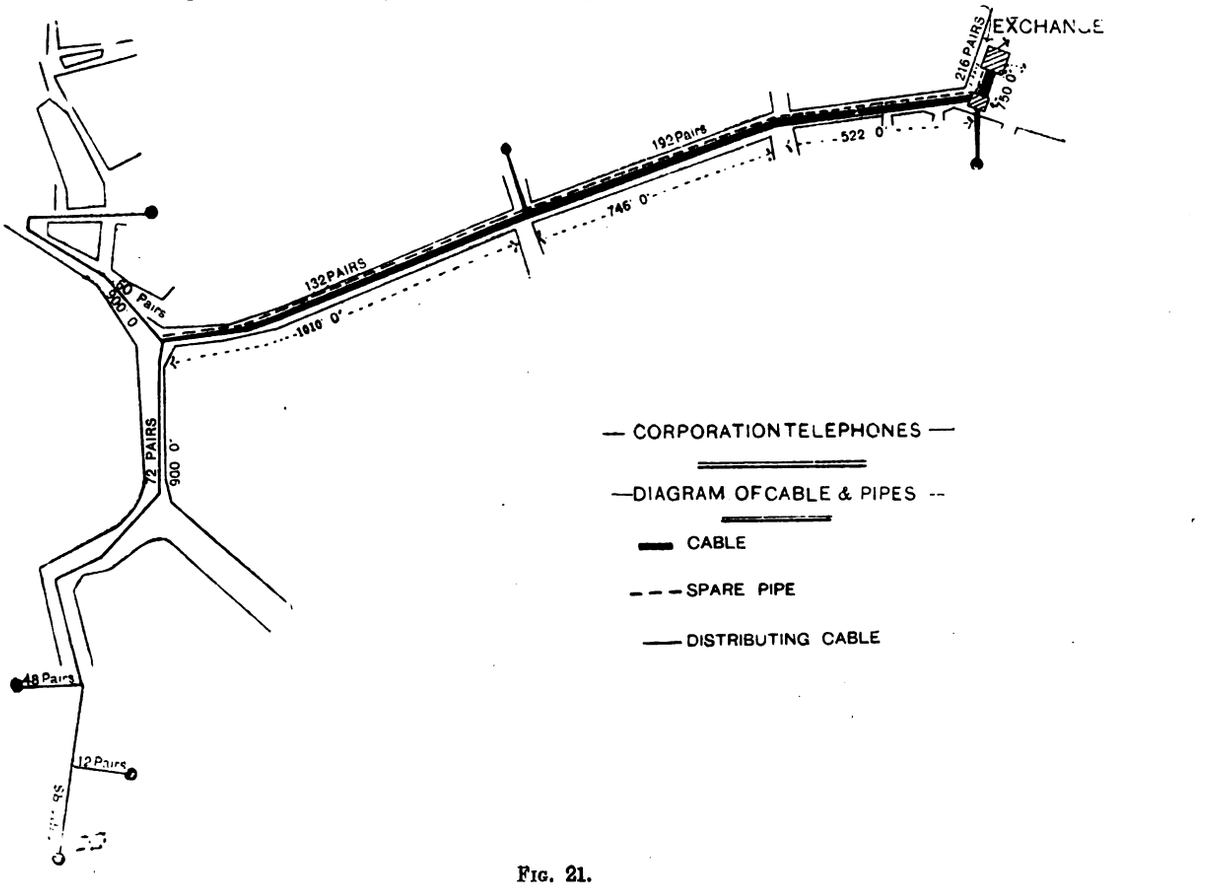

FIG. 21.

The scheme having been laid out and the position of the cable shaft decided upon, an underground passage should be built from the shaft to the main cable chamber in the street. This should be of sufficient size to admit of the cables being easily handled and examined, and be built of Staffordshire brindle brick with ventilating cover. From

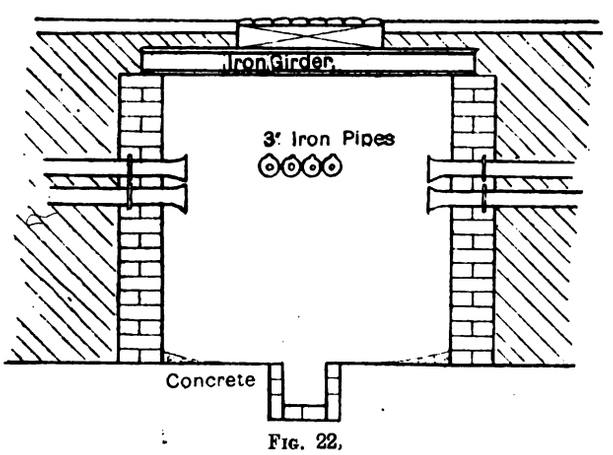

FIG. 22.

this chamber the main cables radiate in all directions to manholes; as shown in Fig. 22, placed in the main streets, from whence the sub-mains are taken through joint-boxes to the several distributing points. From these points armoured cable is laid in specially prepared creosoted wood troughings or conduits to the distributing potheads on poles or in large buildings. A pothead on a building is

pipes for main cables are the ordinary 9ft. cast-iron spigot and sockets, 4in. internal diameter, coated with Angus Smith's compound, and jointed with spun yarn and caulked lead so as to be thoroughly gas and water tight. Terminations in manholes should be made, as already mentioned, by bellmouths with cross connecting lug, as shown in Fig. 24.

The sub-main conduits may be either cast iron or earthenware pipes 2½in. or 3in. internal diameter. Some good three-way earthenware conduits are made, and if well and truly laid and bedded in cement mortar upon a foundation of concrete, and afterwards surrounded with concrete, are very suitable. For armoured distributing cables creosoted wood troughing, consisting of ploughed quartering laid together so as to form a 3in. conduit, and bound with soft-iron tape and the joints lapped, forms an excellent conduit. Comment has been made regarding the use of creosoted wood for conduits, but if a good quality of creosote oil is used no fear need be anticipated. As conduits are laid, a draw wire should be threaded in for use when pulling in the cables. This is of great importance, as it is an expensive matter to have to rod the conduits.

All conduits between boxes should be laid as straight as possible, so as to facilitate drawing in the cable, as a sharp bend puts an enormous strain on a telephone cable (which is entirely different to power or light cables), and ultimately the cable or rope will break, necessitating heavy expense in digging out. As the conduits are laid, wood plugs should be inserted in the ends whenever the work is left, so as to prevent stones or foreign matter entering the pipes. As the work is in progress, careful measurements and details should be entered in a book and drawings kept.

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From these actual measurements the cables are ordered forward, about three yards being added on for jointing and spare end for drawing in. On arrival of the cable, the drawing in, jointing, and numbering is then proceeded with. The drums of cable as they arrive should bear the number of the test certificate, lengths in yards, number of pairs, size of conductors, and class of cables. This being done, it will be an easy matter to organise the drawing in without error.

Proceeding with the drawing in, here the importance of having the draw wire in the pipes will show itself. This wire is securely fastened to a chain, or better to a $\frac{5}{8}$in. steel-strand flexible rope, and drawn through to the manhole, where the cable is ready on the drum waiting to be pulled in. Before drawing in the cable, the ends should be examined to see the lead sheath is thoroughly watertight and sealed up. To fasten the steel wire or chain to the cable many devices have been tried. The best practice is to prepare the cable end by employing a practical jointer's plumber to fit a cable clip provided with swivel and ring for attachment to the steel-strand flexible rope or chain. To pull through a large cable requires power and care in handling, and should not be attempted without proper

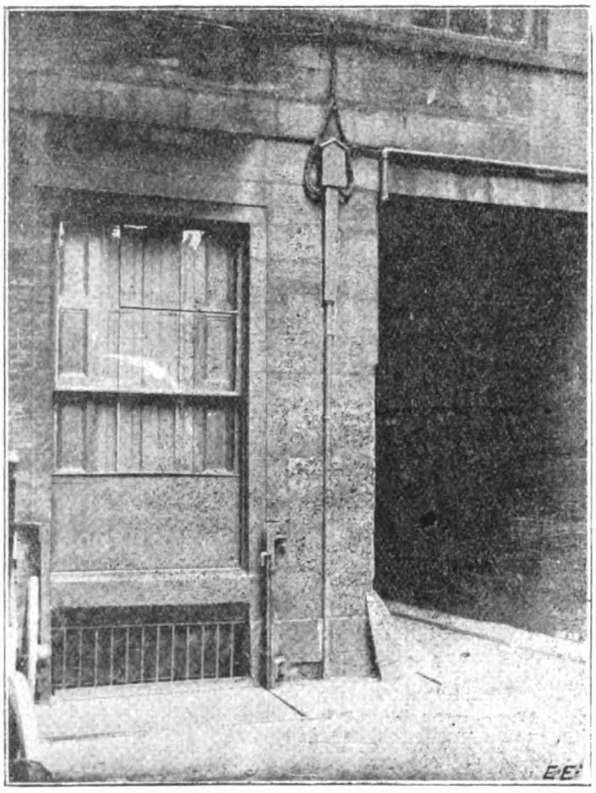

Fig. 23.

tackle. A good strong winch should be used, securely fastened down with weights or bars to the ground, the cable drum being set up near to the entrance to the manhole, and in such a manner that the cable will pay itself off from the top of the drum and pass through the manhole into the pipes without obstruction. Care should be exercised in assisting the cable entering the pipes, and plenty of good lubricant used, petroleum jelly being the best, as it gives a good body, and is free from any injurious substances. Cables in passing through boxes should be supported, and on the completion of the drawing in of each length, sufficient should be left for the purpose of jointing. The ends of the cable under no circumstance should be allowed to hang down, but be supported in case of fracture of the lead. Fractures of the lead happen if the cable is allowed to hang down, and as the fracture is generally several inches in the pipes, it does not show itself until long afterwards. The centre of the box should be kept clear and accessible for jointing by arranging the drawing in of the cables in proper order, and supporting them at the sides.

When the cables are laid the jointing of the wires is proceeded with, and the following description of the method of making a through joint applies to all the paper-insulated cables: (1) Place a tent over the joint-box where the joint is to be made. (2) Thoroughly clean the lead sheath with oil and waste. (3) Then, with a plumber's knife and hammer, take off the lead covering (leaving 3in. of lead on each side), care being exercised so that the insulation is not damaged. (4) The braid or tape to be stripped to within 1in. of the lead on each cable. (5) Bind round several turns of 1in. selvedge tape under the edge of lead so as to ensure the lead not damaging the wires. (6) Tie back on to the cable the outer layers of wires. Great care must be

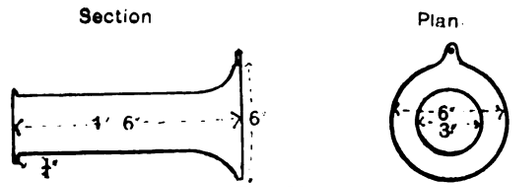

Fig. 24.

taken to see that each pair of wires are well twisted together, and also that each wire has its corresponding wire in the pair. Care should also be taken to see that the pairs are not crossed: the crossing of the wires sets up self-induction, which gives rise to "cross talk." (7) Tie back other layers or flakes in a similar way, putting a layer of tape round each flake. This will keep the layers or flakes from getting intermixed. (8) Bring the two pilot wires of the centre flake together. Strip off the insulation of these two wires and pass a paper sleeve over one of the wires to be jointed. (9) The ends are now tightly and evenly twisted together for a length of $\frac{3}{4}$in. at right angles to their length. Solder for a distance of $\frac{1}{2}$in., using patent solder. If the whole length of the twist was soldered, it would tend to make the copper wire brittle. Care should be taken when soldering to see that the iron is sufficiently hot, so as to ensure that the solder will properly take on the wire; if the iron is not hot the solder will not take, but only the resin: this will cause a fault of high resistance to be set up, thereby throwing the circuit out of balance. See that no loose solder is allowed to drop on to the underneath flake, as this is liable to cause a cross-contact fault. (10) Bend the twist parallel to its own length, care being taken that the wire is not nicked by the pliers. (11) See that the paper covering comes well up to the twisted copper. (12) Draw up the paper sleeve, so as to quite cover the twist. These joints should not all come together, but should be alternated so as to keep the circumference of the cable as small, and even as possible. (13) Tape binders or snuggers are to be taken off as each flake is finished. (14) Each flake is to be lightly bound with one coat of $1\frac{1}{2}$in. selvedge tape, edge to edge. (15) The joint should be thoroughly dried at intervals to get rid of any moisture absorbed while it is being made, the frequency of the drying depending upon climatic conditions. (16) Bring the wires to be jointed over those already jointed, and lightly tie them down, then take a sheet of stiff brown paper and cover over the joint. Bore a few holes in the paper, then place two lighted blow-lamps under the joint, so that the

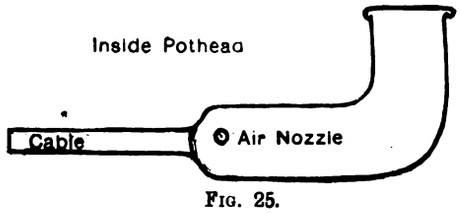

Fig. 25.

whole of the heat plays on joint, the distance of the lamps from joint being 18in. Care should be taken that no dampness arises from the ground under the joint. This can be obviated by laying down several layers of felt or other material. When all the pairs of wires are jointed up, a final drying-out should be given; the paper sleeves should be quite stiff, and the paper insulation quite crisp. (17) The joint is to be then wrapped round with one lapping of $1\frac{1}{2}$in. selvedge tape. (18) The joint is now ready for the plumber to wipe on the lead sleeve, which in the case of an armoured cable will be a split sleeve wiped longitudinally,

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as well as at the two ends. When there is no armouring a lead sleeve should be slipped over the lead on one side before jointing, this doing away with the longitudinal wipe, involving, as it does, greater mechanical skill and more labour.

It is absolutely essential that all joints in the lead covering be perfectly air-tight and no moisture allowed to enter. After the joint is wiped an airtight nozzle is fixed 3in. from the end of the wipe. Air is then pumped in by a small hand-pump through a drying cylinder. This will help to dry the joint, and also show if the wiped joint is sound. Any local escape of air will be noticeable by putting soft soap round the wipes. The construction of a T-joint where two small cables branch from one larger one is practically the same as for a straight-through, with the exception of the lead sleeves. The ultimate termination of the cables is in pothead joints, where the paper-insulated cables are jointed to the vulcanised indiarubber-covered wires for distributing to the subscriber's premises either inside large buildings or overhead from poles, and the following points should be observed: (1) A lead sleeve should be slipped over the vulcanised-indiarubber, lead-covered cable, the diameter of the sleeve being 1in. larger than the diameter of the cable. (2) The lead on the two

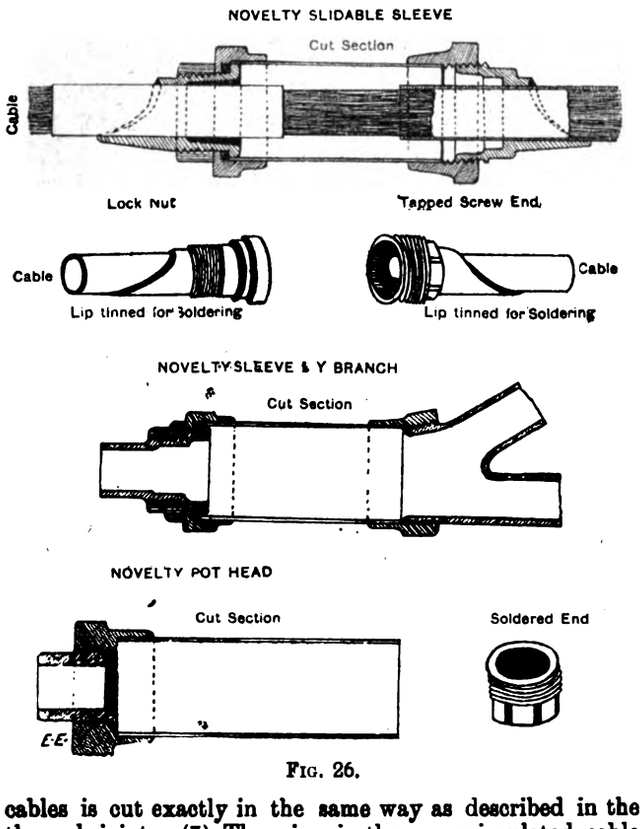

FIG. 26.

cables is cut exactly in the same way as described in the through joint. (3) The wires in the paper-insulated cable are opened out, wadding being packed down between the wires and the lead. (4) Boiling compound is then poured over the wadding and wires; this will prevent dampness from creeping into the cable while the joint is being made, and will also help to keep the hot compound from running into the cable. (5) The V.I.R. wires should have their tape or braiding taken off for a distance of 4in. and the rubber cleaned with naptha. (6) The joint is now made in exactly the same way as a straight-through joint. (7) The lead sleeve is then pulled carefully over the joint, so as not to disturb the paper sleeves, and is made permanent by a plumber's wipe at the bottom. (8) Heat the sleeve with a blow-lamp so that the compound when poured in will adhere to the inside of it. (9) Open out the V.I.R. wire so that the hot compound may fill up all the interstices. (10) Fill up the sleeve to within 1in. of top with boiling insulating compound. Great care must be exercised in pouring in this compound so as to hermetically seal the cable, and the compound must not be allowed to set hard. (11) The top of sleeve is now beaten in and then wiped. (12) It is advisable to put an air nozzle within 3in. of the pot joint. This air nozzle can be used for drying-out purposes or testing for air pressure on pot joint. For pot joints in the exchange Fig. 25 is a good pattern. These pots should be shaped and beaded at the top.

Several attempts have been made to overcome the necessity of wiping joints, and Fig. 26 illustrates a sleeve and pothead manufactured by the New Haven Novelty Machine Company in America, and so far as we can see there is no reason why it should not be used in England, as it has several advantages over the sleeves and potheads now used. In comparing the first cost between the Novelty system, which does not require skilled labour, and the lead-wiped joint, consideration should be taken of the fact that the Novelty slidable sleeve gives a flexibility which the wiped joint entirely lacks, in that inspection can be had at any time and as often as desired. To disconnect and reconnect again requires nothing but a wrench and a few moments' labour. The advantages of the slidable sleeve are still more apparent when the T branches are considered, not only on account of the saving of time and labour, but by the decrease in cost through not having to wipe the joints. The Novelty pothead also has the advantages of the slidable sleeve, and further, should occasion require, the Novelty, being made of brass, can be heated and the composition contained therein allowed to run off. The pothead further commends itself for the reason that it is not necessary to bend the pipe in order to wipe the joint, as at present, nor carry the molten metal up the poles. All that is required is a hot iron to cause the solder in the hub to flow. In cold weather the compound generally hardens, flowing into the pothead too thick, with the consequent result that it will not be properly or evenly distributed. By the Novelty system, the pothead being made of brass, a blow torch or lamp can be applied which will heat the compound to a boiling point, and thus ensure the desired result. This could not be done with the present lead pothead.

QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any questions should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

637. With maximum traction trucks, what proportion of the weight should be put on the pony wheels to ensure reliability in operation? What is the best method of placing the brake shoes—both inside, outside, or alternating? What is a reasonable power consumption per car mile for closed cars 25ft. long, mounted on maximum traction trucks, and equipped with two motors of about 40 h.p. each?—C. H. S.

638. Explain and give best and safest methods of dealing with accidents which might happen as under. Supposing in a three-wire station, with voltage 440 and 220, you have a machine on the 440-volt bars, you have only one set of feeders connected +, 0, −. There is also a balancer capable of doing 50 amperes out of balance with maximum circuit breakers and starter on each outer and shunts cross-connected. If at some time you have 100 amperes each side on, and one of the outer main fuses happens to burn out, explain and give sketch as to what would happen, and the best and quickest way of righting things without the use of a battery and without damage to lamps. Also with circumstances as regards load same as above, and your machine minimum circuit breaker accidentally falls out, explain how to bring load on again with safety, your shunt resistance not being large enough to bring voltage lower than 300.—ELECTRO.

ANSWERS.

Question No. 629.—Describe what you consider to be the best lifeguard for electric tramcars at present on the market.

Best Answer to No. 629 (*awarded* 10*s.*).—The minds of authorities are considerably interested just now on the

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subject of lifeguards, and to all tramway companies and to the public generally, one of the imperative needs of the times, in order to reduce the liability of accidents by electric cars, is the provision of a perfectly reliable lifeguard. There are a great number of lifeguards on the market just now, but the one which I consider to be the most reliable at the present time is the Philippson lifeguard, which has been known to save life on several occasions recently. This lifeguard is composed of a series of flat steel springs about 3in. wide by ¼in. thick, each one being

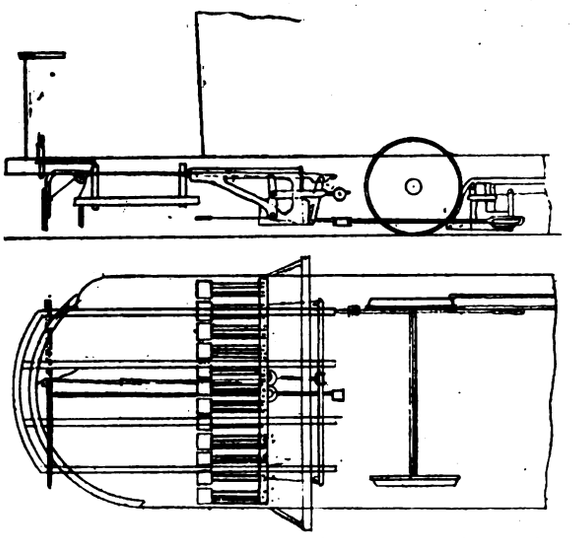


FIG. A.—Plan and Elevation of the Philipson Lifeguard and Brake.

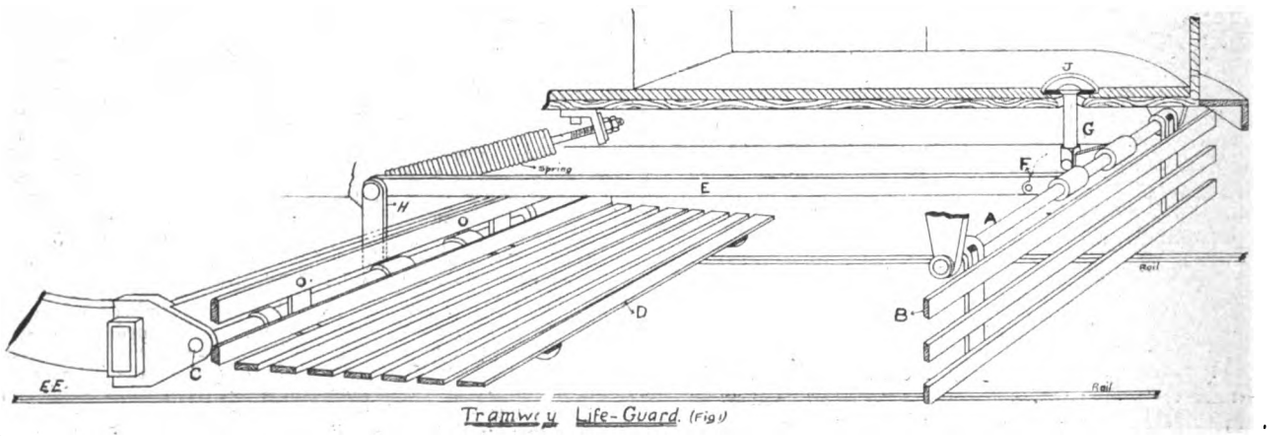
tipped with soft pliable indiarubber. These springs, which are made of the very finest steel, form 16 to 17 spades, and are divided so as to protect the full width of the car, and when brought into action each spade adapts itself as closely as possible to any inequality of the track immediately beneath the same, making it impossible for anything to get under. It is quite obvious that if the object in the way is to be picked up, there must be no possibility of any part getting underneath the guard, or it will become a "trap," and not a life saver. Not only so, but it is necessary that the object should be picked up with the least possible injury, and to do this something thin, soft, and pliable is required. This requirement is fully met by the rubber-tipped springs or spades. On the front of the lifeguard is suspended, the whole width of the car, a gate or trigger, which, when coming in contact with any obstruction on the trap, automatically drops the guard. This is so made that it forms two gates or triggers so as to act equally underneath the step, and also the full width of the car, and is also arranged that they are made to move backwards, and can be set very near the track without danger of being broken off when the car is going backward. It is necessary that this gate or trigger should not be fixed nearer than 2ft. in front of lifeguard, so that the two parts come into action without the possibility of any part of the obstruction getting under the guard.

It has been proved over and over again that children have been trapped and killed by falling sideways under the car between trigger and lifeguard. To prevent this, a side guard, free to allow any obstacle facing the car to go under and be picked up by the lifeguard is used, whilst anything falling sideways would be kept clear and cannot possibly get underneath the guard or wheels of car. Directly an object comes in contact with the hanging gate or trigger, not only does the lifeguard come into operation, but the car is immediately brought to a standstill by the automatic action of the emergency brake. This brake is a most powerful one, and although it stops the car very quickly, does so without any shock being experienced by passengers.

The sketch (Fig. A) clearly shows the form of the brake and its application. An important feature in connection with this brake is the fact that it can be operated by the motorman quite independently from the lifeguard, so that should any obstruction be seen a short distance ahead, the car can be stopped immediately, without waiting for the lifeguard to be brought into operation. Another point in connection with the automatic working of this brake is the fact that it can be set by the simple movement of a lever to act upon a car likely to run back down a steep incline. In this case it remains out of action whilst the car is ascending the hill, but directly a backward movement is made, the brake immediately comes into operation and stops the car. This brake is fitted to go under the wheels and get the weight of the car in a moment, and may be brought into contact in either case, between or outside the wheels. This lifeguard has engaged a large amount of attention at the exhibition held some time ago in London, and elsewhere, and has been put through a successful experiment before one of the Board of Trade inspectors. A very useful object lesson was furnished as to its utility some time ago. A young child, whilst crossing the track, fell right before an oncoming car fitted with this type of lifeguard, but without brake. The driver had not time to pull up, but as the child lay with its legs across the metals, the guard in question diverted him safely off the line, and thus probably saved his life, as he was able to get up and run away, suffering from nothing more serious than a fright.

This lifeguard can be fitted to any tramcar, and one of the principal tramway authorities of Lancashire are going going in for this type of guard, and have already fitted a number of their cars with same, and I believe are contemplating equipping the remainder also.—R. J.

Answer to No. 629 (*awarded* 7*s.* 6*d.*).—Since the development of electric tramcars, whose speed for average running exceeds that of the old horse trams, the requirement of a good, reliable, and, it may be said, harmless lifeguard for the protection of the public has been the cause of a great number of inventions and experiments. Although most lifeguard trials consist of placing a dummy on the track



Tramway Life-Guard. (Fig 1)

and running the car up to it, thereby picking up the lifeless body, it does not follow that in the case of a human being (who, not like a dummy, has feelings), the unfortunate person will be picked up unhurt; anyhow, it is better to be picked up with a slight injury than to be mangled under a car. There are practically only two types of lifeguards—viz., the cow-catcher type, and the swing-gate and carrier type. Of these two, the latter type is mostly used in this country. The former type has a decided unsightly appearance, projecting out in front of a car. The accompanying diagrams show the construction of a very simple yet efficient lifeguard of the swing-gate and carrier

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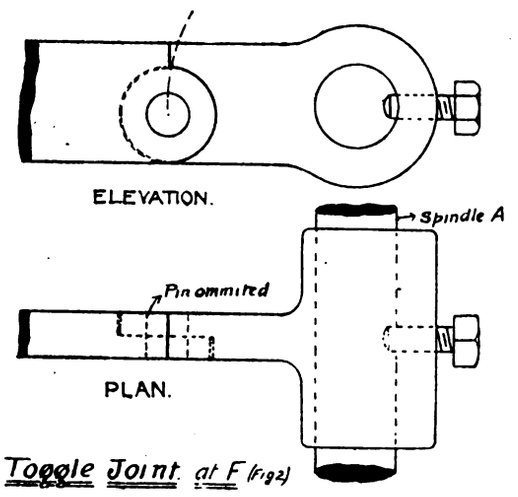
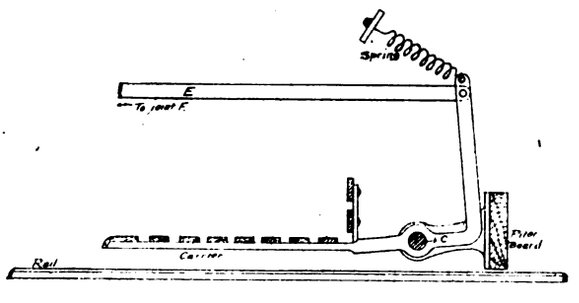
type, manufactured by Messrs. Hudson-Bowring Company, of Manchester, and most of the cars of that city being equipped with this type. The gate, B, which hangs from the bar, A, underneath the car fender, is so lightly balanced that at the least touch it falls inwards, thus turning the bar, A. Attached to this bar are two collared levers, F and G, so that, as the rod A turns the levers turn upwards. In doing so the first lever opens the toggle joint at F, and the rod E is pulled forward and actuates the bell-crank lever, H, on which the cradle or carrier is fixed. Thus the carrier is brought into an inclined position, the front edge resting on the track. The cradle is kept down on the rails by means of a strong spring, S,



Toggle Joint at F (Fig 2)

which serves a double purpose not only in keeping the cradle down, but gives a compressive action to the bar E, and thus preventing the toggle joint from opening unless the swing gate is pushed inwards, then after the gate has moved slightly inwards, thus opening the toggle joint, the spring is assisting the action, and brings the gate horizontally, and the cradle is lowered ready for picking up the obstructing matter. In order to reset the lifeguard, the driver of the car simply presses his foot down on the circular knob, J, which has been raised by the crank G; thus the toggle is kept shut owing to the additional tension placed on the spring by the backward movement of the lever H. Another feature of the spring is that of quickening the action of the lifeguard, also should the obstruction not be very high, and thereby only catching the bottom part of the swing gate, the mechanism will not fail to cause the cradle to drop



Side View of Carrier and Lever (Fig 3)

down. This type of lifeguard is found from experience to be very reliable in its action, which is mainly due to its simplicity of construction; it is also not a very expensive type, which is another consideration on behalf of the tramway companies. Of course, there is no lifeguard yet invented which eliminates the danger of injury to a person through being knocked down by the car. Their chief object is to prevent further injury from getting entangled with the car mechanism. In the author's opinion the "cow-catcher" type of lifeguard is positively dangerous, as it is generally several inches above the level of the rails, and the event of a broken ankle or crushed arm is highly probable, even though this guard, due to its shape, may be of some use in pushing aside the obstruction.—H. R. G.

Answer to No. 629 (*awarded* 5*s.*).—There are principally two systems of lifeguards—one for picking up the person, the other rolling the same out of the way. The first system is again divided into those worked by the motorman and those working automatically by means of a front shield suspended below the dash-board, which, when touched, causes the guard or fender fixed in front of the wheels under the platform to drop on to the permanent way, and thus intended to pick up the person. Further, in regard to the picking-up system, there are again those that are fixed and projecting in front of the dash-board, and which are generally worked by the motorman, chiefly used in America, but also on some lines here. The automatic picking-up system, mostly in use in this country—viz., London United Tramways Company, Blackpool and Wolverhampton Corporations, etc.—seems to be preferable to the system worked by the motorman, as accidents chiefly arise not in view of the motorman, but by passenger and vehicular traffic suddenly coming from side streets or crossways, consequently the motorman has not the time to give preference in working his brakes or lifeguard release stop. Further, at night the difficulties of observing anything coming in dangerous proximity to the car are augmented. This automatic guard system is well represented in the Wilson and Bennett, the Tidswell, the Royles patent guards, and others. Of these, the Tidswell is the cheapest, the fender being constructed of wooden laths, while the others are made of iron or steel netting. The type of guard worked by the motorman, fixed in front of the car dash-board, is represented by the patents of the Providence car fender of the Consolidated Car Fender Company, the G. Hepwood patent fender, the Parmenter fender, and others, which seem to give greater opportunity to collisions with vehicular traffic than the fenders fixed below the car. In reference to the efficiency of both these systems of fenders, much depends on the method of attachment to the car. If the same be fixed to car body they necessarily are exposed to the oscillations of the car body, and, therefore, are less reliable in picking up than those fixed to the car truck frame. Nevertheless, it was found, through some unfortunate accidents occurring at Liverpool, this picking-up system was unreliable, and the authorities ordered a change to be made to the rolling-out system—*i.e.*, pushing the person away from dangerous proximity to the car. In this latter method a pair of wedge or V-shape form boards are fixed stationary to frame of truck under car body, fitting as close as permissible to the permanent way. Such a system is now in use at Liverpool—known as the Bellamy patent guard—and resembles greatly a similar apparatus of a wedge-shaped elastic cushion patented in 1884 and tried then for horse cars. The great point in lifeguard construction or design is to reduce the blow struck to a minimum, in either the pushing away or picking-up methods, which necessitates some part of the guard to be constructed of an elastic nature material. From the writer's experience, consisting of a very varied tramway construction experience in different parts of the country, both the above systems seem to have their good and bad points, leaving very little to discriminate as to which is the better or more efficient. However, summing up the conclusions to be drawn from the merits of the two systems, the rolling-out method offers a better range as regards reducing the blow struck, less mechanism to get out of order, therefore less maintenance in comparison with the other system; yet, perhaps, it may not be so reliable due to its not sliding on the line, and so allow a small limb, arm, or leg to get underneath and be pinned down. But cases have occurred where the pick-up system has not only failed to pick up, but actually rolled over the object on the line, thus allowing the same to get underneath the wheels. Considering, finally, all these different points, the solution of this problem seems not to have reached finality and absolute perfection, thus being still liable to great improvement.—E. S. CONRAD.

Question No. 630.—Describe the action of the sight-feed lubricator for cylinder lubrication. Give sketch.

Answer to No. 630 (*awarded* 7*s.* 6*d.*).—A section of a sight-feed lubricator is shown in Fig. 1. B is a brass cylinder with a hollow piston rod, A, and piston, C, with oil on one side and steam on the other side; S is the sight feed, regulated by valve E; and Z the connection to the steam supply, regulated by the valve Q. In cases where

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the lubricator is fitted near to the cylinder a condensing coil, M, is placed in circuit between the steam-pipe and lubricator, as shown in Fig. 2,, where N is the steam-pipe

The action of the lubricator is as follows: Having filled the cylinder, B, with oil and the sight-feed, S, with water, the valves, E and Q, are opened and also the steam-cock, R.

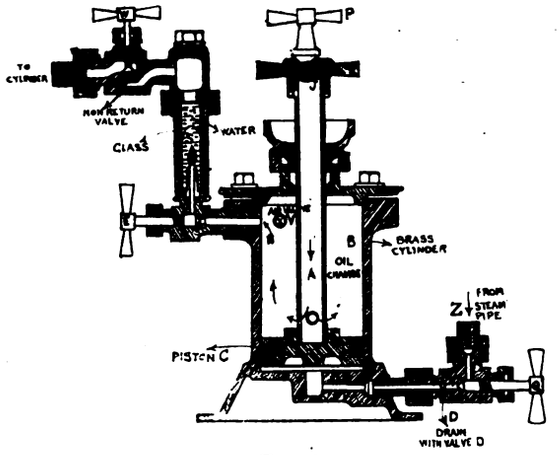

FIG. 1.

The steam being condensed in the coiled pipe, M, forms water, and forces the piston upwards. This forces the oil through the glass sight-feed chamber drop by drop, and which rises through the water in S, than which it is specifically lighter, and thence to the cylinder. The method of filling the lubricator is to remove plug, P, and open air-valve, V, and pour oil in at J until it shows at V; then screw down the plugs, and open inlet valve at Q half

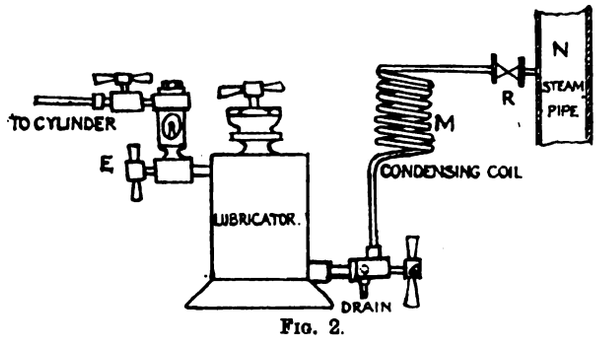

FIG. 2.

a turn. Open valve W, and then slowly open E and regulate to feed required. To refill, close valves E and Q, then open D to relieve the pressure and V to allow the piston to descend, and fill as before. In cases of low pressures (50lb. and under) the piston rod is extra large to give it increased area, and on compound engines a separate feed is usually supplied to each cylinder.—L. B. H.

Answer to No. 630 (*awarded* 7*s.* 6*d.*).—Sight-feed lubricators are of two kinds, known as single-connection type,

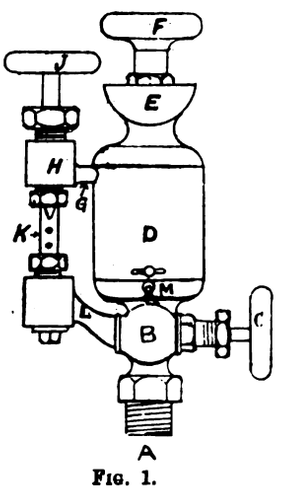

FIG. 1.

shown in Fig. 1, and double-connection type, shown in Fig. 2. In the single-connection type the receiver, D, is filled by unscrewing the plug, F, and pouring oil through the cup, E, and then reinserting the plug. On opening the valve B by handwheel, C, steam is admitted at A, and is conducted by a small pipe through the centre of the receiver to the top of the chamber; here it comes in contact with the cold oil, and is condensed and falls to the bottom, causing the oil to rise by displacement and overflow by the pipe G and valve H, through the sight tube, K, along the pipe L to opening at A, where it flows into the steam-pipe leading to the cylinder, the rate of feed being regulated by the valve H. When the supply of oil has been exhausted, the receiver, D, has become filled with water of condensation; this is drained off by the small drain tap, M, and the lubricator is ready for filling again. In this type the oil drops downward through the glass tube, which is filled with steam when working.

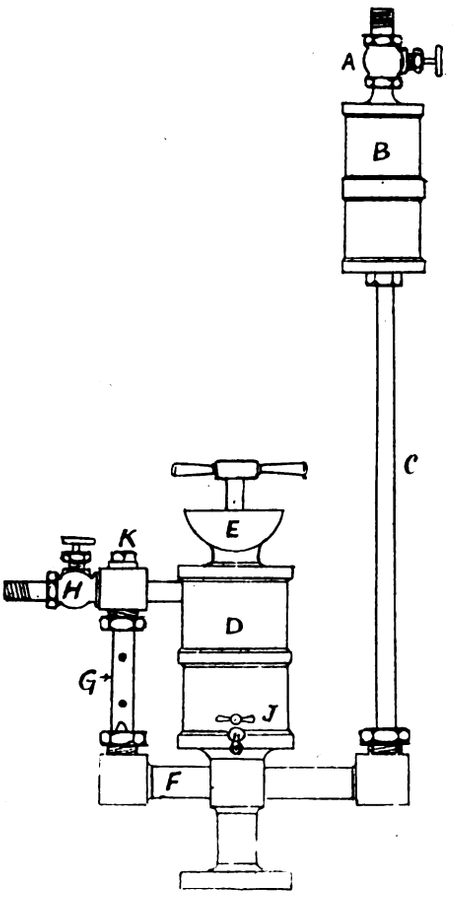

FIG. 2.

In the double-connection type the oil receiver is filled in the same manner as in the previous one. The sight tube is then filled with water by removing the plug, K. The valve A is connected to the boiler side of the engine stop-valve, the valve H being connected to the engine side of the same. Steam is then admitted at A, and on entering the condenser, B, is condensed, and fills this and the vertical pipe, C, with water. On opening the valve H, the pressure on both sides of the oil-chamber is equal, but the hydrostatic head formed by the water in B and C causes the water to rise to the top of the chamber, D, and forces out the oil along the pipe F, through the sight tube, G, and valve H, to the steam inlet to cylinder, the rate of feed being regulated by the valve H. When the supply of oil is exhausted, the water in the receiver is drained off by the small drain-tap, J. In this type of lubricator the glass tube is filled with water, and the drops of oil float upward through this when working. It is capable of more regular adjustment than the single-connection type. The condenser, B, is made in various shapes, and in some cases consists of a spiral coil of copper pipe, the object in all cases being to obtain a comparatively large cooling surface to procure efficient condensation.—STOW.

Answer to No. 630 (*awarded* 5*s.*).—By reference to the sketch herewith of a sight-feed lubricator, or "impermeator," as it is sometimes called, the various parts can be clearly seen and its action followed. In lubricators of this type

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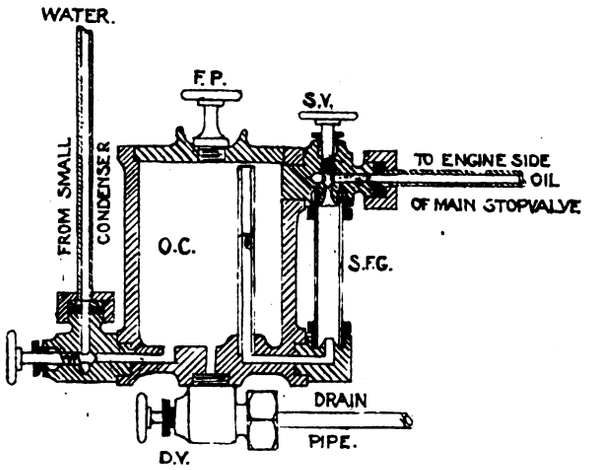
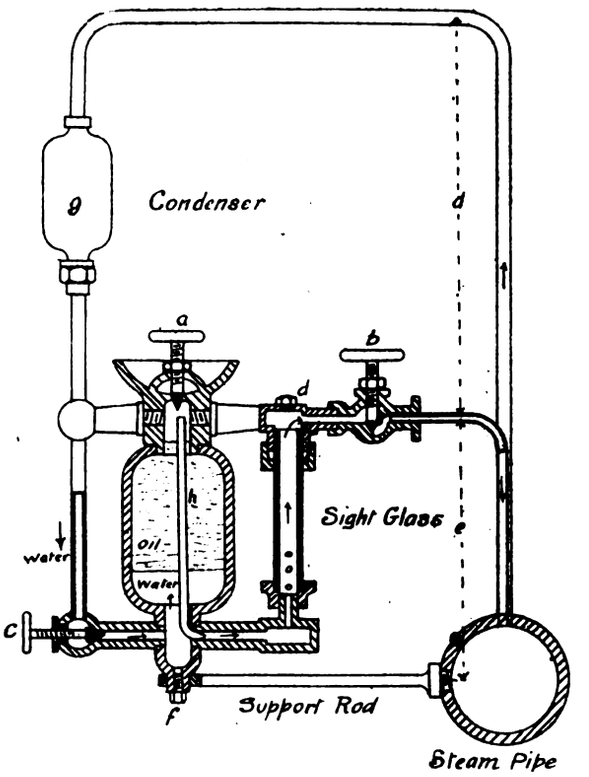
advantage is taken of the fact that oil floats on water when the two are mixed, it being the lighter of the two liquids. In the sketch it will be observed that the apparatus consists of a cylindrical case with a glass tube at one side of it, and various valves for controlling the oil and water. There is a pipe connection from the steam-pipe, the steam in which is to be lubricated, to a small condenser (usually situated a foot or two, sometimes more, above the lubricator) which is generally in either of two forms—namely, a small coil of the connecting pipe, or a small brass chamber which forms part of the pipe, and is really only an enlargement thereof The steam from the main steam-pipe is condensed in the condenser owing to loss of heat due to radiation from the external surface of the afore-mentioned coil or chamber. The water resulting from this condensation flows down the pipe to the regulating valve, R V. On the other side of the lubricator there is a pipe leading in most cases to the engine side of the stop-valve on the engine to which the lubricator is attached, this pipe being provided with a stop-valve close to the engine. The valves, R V, D V, and the one on the pipe leading to the stop-valve being shut, the following is a description of the method of charging and working the lubricator. The sight-feed glass, S F G, is first filled (through the aperture at top of it when the S V valve spindle is removed) with either water, glycerine, or a concentrated solution of salt in water. The spindle is then replaced and this valve shut. The oil chamber, O C, is next filled with cylinder oil (when the filling plug, F P, is removed). When chamber is full the plug is replaced, and the lubricator is now ready for action. The valves, S V,



and the one at engine stop-valve are now opened full, and R V is opened very gently, allowing the water in pipe from the condenser to enter the bottom of the oil chamber. The oil floats on this water until it overflows into tube, T, and thence to the bottom of S F G, where it can be seen ascending on the way through S V to the pipe leading to the engine. The amount of oil required (usually a predetermined number of drops per minute) is regulated by R V until the proper rate of feed is obtained. If the pressures in the two connecting pipes are equal, the pressure on the oil due to the head of water in the condenser forces the oil into the engine, and by connecting condenser pipe to main steam-pipe and the other pipe to engine side of valve on engine, there is a difference of pressure in the two pipes, which further assists the action. In some lubricators of this type the condensation of steam takes place in the oil chamber itself, but the action is just the same as already described. When the oil has all been fed to the engine, the water which has displaced it is run out through the drain valve, D V, making room for a further charge of oil.

There is another type of sight-feed cylinder lubricator, which is a kind of force pump, the plunger being pressed down on the oil in the chamber by means of a ratchet and screw mechanism worked from some reciprocating part of the engine, and the oil forced through a sight-feed glass into the steam-pipe. This type is not so much in use in central stations, but is common on marine engines.—J. WALKER.

Answer to No. 630 (*awarded* 5*s.*).—The importance of an effective system of cylinder lubrication is realised by all steam users. The cylinders of steam-engines of small and medium size are usually lubricated by the introduction of oil into the steam-pipe or steam-chest. Thus the steam becomes saturated with oil and carries it to all points which are to be lubricated. An important feature in cylinder lubrication which is sometimes neglected, is that of a uniform supply of oil and at the proper rate; for this object the sight-feed lubricator is undoubtedly an essential type Insufficient oil to the cylinder increases frictional wear between the walls of the cylinder and piston; on the other hand, if too much oil is admitted it becomes the source of a positive nuisance in clogging up the valve chest and steam passages, and if the exhaust steam is condensed and pumped back to the boiler in an impure condition, the oil which is mixed therein would deposit on the inner surface of the boiler plates, thus being another source of trouble. However, to carry out the old saying, "Prevention is better than cure," it is always advisable to use an oil separator to rid the condensed water of oil. The accompanying sketch shows one of the numerous types of sight-feed lubricators, although they are nearly all of the "displacement principle." The oil chamber is charged from the screw plug, *a*, and the sight glass is filled with glycerine or strong salt and water solution; *g* is the



condensing chamber, which is in communication with the steam-pipe, water being formed from the steam runs down the pipe to the valve *c*, and when this valve is open it finds its way into the oil chamber, consequently lifts the oil until it overflows down the tube, *h* It then passes up through the liquid in the glass sight tube, and passing the valve *b*, away to the steam-pipe, where it is intermingled and carried over to the steam-engine cylinder by the steam supply. In this arrangement the pipe leading to the condenser must be taken from a point in the steam-pipe at least 6in. further away from the engine than the discharge pipe of the lubricator. In order to start the lubricator the valve *b* should first be opened, and then gradually open the valve *c*. The drops of oil will be seen to rise in the sight glass, and by adjusting the valve *c* the quantity of lubrication can be varied to any desired extent. Both valves, *b* and *c*, should be closed when the engine is stopped.

DIMENSIONS.

Approx. capacity in pints	½	¾	1	1½	1¾	2¼
Outside diameter of oil reservoir in inches	2⅜ ...	2½ ...	3 ...	3½ ...	3⅝ ...	4
Shanks screwed, gas thread	⅜ ...	⅜ ...	⅜ ...	½ ...	½ ...	½
Dimension *d*.....	13¼ ...	12⅜ ...	11½ ...	17¼ ...	16½ ...	15¾
Dimension *e*.....	6½ ...	7¼ ...	8 ...	9¼ ...	10 ...	10¾

The accompanying table shows the relative capacity and dimensions of this type of lubricator.—H. G.

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TO CORRESPONDENTS.

All Rights Reserved. *Secretaries and Managers of Companies are invited to furnish Notices of Meetings, Issues of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration*

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TRADE.

There has been a plethora of presidential addresses during the past few days, each of which is well worthy of careful consideration, but to present them fully to our readers is a matter of impossibility. We shall, however, try to deal with some of the points raised as opportunity presents. Mr. E. W. Cowan's address to the Manchester Section deals somewhat exhaustively with the all-absorbing topic of the day—home and foreign trade. Every paragraph is worthy of discussion, in that he deals seriatim with particular phases of the question, each of which has its own bearing upon the subject. The text relating to the home trade is fairly given as follows: "If we look down the published share lists of our electrical manufacturing companies, we can, I think, only come to one conclusion, and that is that our industry is sick." The address then goes on to give reasons why this is so. By implication we are told the investing public does not rush into these concerns; thus we infer many works are carried on with too small a capital. Investors do not forget the twelve million pounds lost in the early days of the boom in electric lighting, and we have the dogmatism "that ordinary share capital in manufacturing companies should bear an interest of not less than 10 per cent. to justify its being rated at par value." Influences such as the late war, over-production, and consequent dumping from competing countries, and the mistaken notion that money circulation, and not utilisation productivity, may be good, and their bearing on the industry is discussed. One point of the utmost importance at the present moment is mentioned. This country used to find its own capital and invest largely abroad. Of late years other nations have largely invested their capital in this country—a fact undisputed and undisputable, much to our detriment, for if it was a sign of prosperity here to largely invest abroad in order to get interest on those investments and increase our prosperity, it must follow that it is to our disadvantage and the benefit of someone else if foreign investments are made here. It is said that "fools rush in where angels fear to tread." Nothing could be clearer than this when one considers the average speech on the fiscal question. How often do we read that England cannot be in a bad way because she imports large amounts of gold. If foreigners are investing here, it is easy to account for these imports. Assume a newly-discovered island in the Pacific. Assume that some wanderer finds fertile tracts—finds mineral wealth. Does it follow that the island must share the total prosperity because it imports gold? Surely the prosperity is a divided quantity, the investor getting his share. The island may be exploited for the benefit of non-residents. Hence in England we may—it does not follow that we do—import gold to our own detriment. But to go back to Mr. Cowan. He points out that the manufacturer ought to be insured against the chances and risks of the business, and then once more calls attention to certain badly-worded clauses often met with in specifications, also to the losses incurred by the lock-up of capital through delayed payments. These are questions which have been discussed *ad nauseam*. The parent Institution has taken cognisance of the subject and issued model clauses, which if generally accepted will assist in overcoming these difficulties. Two other points of the greatest importance may be mentioned—the imposing of conditions upon British manufacturers both as to design and construction which are not and cannot be imposed upon foreign manufacturers. A standard type is more often than not accepted from the foreigner, but not at home. Perhaps the foreign type is really better than

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that at home, but all our investigations go to show that perfection or non-perfection has little or nothing to do with the matter. Mr. Cowan thus sums up the consulting engineer: "A consulting engineer does, in my opinion, too much and too little. There are, of course, notable exceptions, but I am speaking generally. He will declaim against English manufacturers neglecting to standardise, and in his own work make standardisation impossible. I have referred to the fact that in general the consulting engineer takes no responsibility—every manufacturer has had experience of this. I will give one instance, which is a typical one. A consulting engineer having overlooked in his drawings to make provision for head-room for a travelling crane, one of his contractors was put to considerable expense in remaking some apparatus to suit the actual conditions, consenting, as usual, to make no charge for doing so. In carrying out the alteration the contractor's man broke a window, whereupon the consulting engineer wrote to the contractor to the effect that he was rendering an account for the repair of the window. That consulting engineer was lacking in a sense of humour, but his attitude is typical of that of the general body of consulting engineers. It must have been a consulting engineer who invented the clause to the effect that the contractor was bound to satisfy himself that there were no mistakes in the drawings issued for him to work to." The other point is thus put, "Why is it that resident engineers are often selected only upon the grounds of their technical experience? Many resident engineers have been installed who have had no experience or training in business." That is so, and is a misfortune; but, on the whole, the resident engineers have shown an immense capacity for business. A resident engineer to a company is in a different position to one for a municipality. It is the latter that have evoluted great business capacity. Indeed, all we know of organisation, of business methods, of improvements or mistakes, come from them. Here, then, are some of the views concreted in this address The longer portion deals with the fiscal question, but that we leave for the present. Mr. Cowan has put the manufacturers' view; the other, that of the engineers, will undoubtedly be put forward ere long as a reply. There cannot be too much discussion upon the various points.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

SUPERHEATED STEAM.

SIR,—Mr. George Wilkinson's experience with reciprocating steam-engines, as I gather from his letter published in your last issue, appears to have been unhappy. While one can be sorry for him, his conclusions are really too hasty to be passed without remark. There is at least one electricity works where steam superheated very considerably more than 50deg. F. has been in regular use for the past five years in quick-revolution reciprocating engines. The engineers running the plant are quite happy about it, and would be glad to get the steam at a higher temperature if the superheaters would only give it. There has not been an accident in the five years due to the use of superheated steam other than the failure of a copper bend inadvertently left in the main steam-pipe when the use of saturated steam was discarded. Valve faces, cylinder liners, piston rods, etc., that have been subjected to superheated steam for five years are still in excellent condition, and the cost of engine repairs will compare favourably with that of most undertakings using the same type of plant. During the whole of this period the cylinder oil used has not cost more than 1s. 10d. per gallon delivered at the works, and the quantity used is strictly moderate.

There seems generally to be considerably more fear of superheated steam among engineers in charge of steam-engines than there is any occasion for.—Yours, etc.,

E. LL. I.

THE "PHIELASHOK."

SIR,—Our attention has been drawn to a letter in your issue of the 6th inst. from Mr. J. Isaacs with reference to our instrument called a "Phielashok," and it is evident that that gentleman has not understood the method of applying the instrument. Your other readers will have no doubt grasped the fact from your article that the "Phielashok" consists of such a high resistance placed in series with the body as to reduce a violent shock to a slight one, or to a tingling only. We are surprised that anyone should place a hand *directly upon* any terminal that *may be* "alive," as Mr. Isaacs would apparently do, when he should touch it with a "Phielashok," in which case, should there be an earth, it would be indicated at once.

If the operator follows our directions, or even uses ordinary common-sense when applying the instrument, there is no fear whatever of receiving a violent shock, even on earthed systems, which your correspondent regards as dangerous; and it was for such systems especially that the "Phielashok" was designed. We do not claim that it is any *better* for testing, whether certain wires, etc., are "alive" or not, than the old-fashioned method of using an incandescent lamp; but it stands to reason that it is far more convenient and more easily and rapidly applied.

We do not know whether Mr. Isaacs has used a "Phielashok." We should think not; but if he will let us know whether he is particularly susceptible to shock or not, and the approximate voltages of the circuits with which he has to deal, we shall be happy to send him one of the instruments to try.

In conclusion, we would mention that we have received numerous orders for the "Phielashok," more especially from corporation electrical engineers for their own and their staffs' use.—Yours, etc., OLIVER AND CO.

STEAM TURBO GENERATING PLANTS.

SIR,—Permit us to assure Mr. Wilkinson that we have not intended to insinuate anything beyond what we have said in our letter. We called the statements extracted from his paper misleading because these incorrect statement were largely used in his argument. As he does not in his reply dispute the inaccuracies, the remarks in our previous letter still apply to the facts. Mr. Wilkinson is evidently not aware of the extent to which superheated steam is being used with reciprocating engines in central stations. Hundreds of our engines working under superheat, some for four or five years, show that the troubles Mr. Wilkinson anticipates are purely imaginary. Our triple-expansion engines, expressly built to use superheat without risk, have shown benefits so great that nearly all up-to-date central-station engineers have insisted on superheat for some time past in their specifications.

The difficulty with the turbine under superheat is due to the expansion, which necessitates a considerable increase of the usual clearance to avoid the risk of stripping the blades when the maximum possible superheat comes on. This might be arranged for if the superheat could be kept constant, but as this is impossible, there must, on account of the excessive clearance, be a large increase of leakage under the normal working conditions.

As Mr. Wilkinson prefers to compare results "under actual daily working conditions" and to have "the outcome of every-day practice," we submit the accompaning Table A, giving the results of a year's working of all the provincial central stations we know of where steam-turbines are used to any extent for electric lighting. The figures are taken from the latest official returns, and the costs are given in pence per unit sold published in the electrical papers, and for comparison we give from the same official returns an equal number of stations with reciprocating engines under approximately similar circumstances as to costs of labour, fuel, output, etc. The results are interesting, and show that the steam-turbine stations on the average are quite 50 per cent. worse than the reciprocating engine stations,

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TABLE A.

—	Station.	Kilowatt capacity.	Total units sold.	Coal and other fuel.	Average ditto.	Oil, waste, and stores.	Average ditto.	Works cost.	Average ditto.	Total costs.	Average ditto.
				d.	d.	d.	d.	d.	d.	d.	d.
Steam-turbines ...	Blackpool	3 050	2,169,463	·91	·84	·10	·11	1·52	1·7	1·76	2·37
	Newcastle District..	2,500	1,619 671	·69		·12		1·22		1·63	
	Jambridge.....	1,500	419 005	·66		·14		1·57		2 40	
	Scarborough	1,085	431,777	·85		·08		1·61		2·65	
	West Bromwich.....	650	285,848	·55		·11		1·10		1·79	
	Morecambe.....	700	202 967	1·28		·14		2·61		3·31	
	Melton Mowbray ...	150	43,742	·93		·12		2·19		3·05	
High-speed reciprocating steam-engines...	Leeds	8,740	4,448 650	·28	·51	·03	·07	·62	1·0	·89	1·38
	Halifax	3,000	2,557 548	·48		·10		1 09		1·47	
	Bootle.....	850	1,619,129	·41		·03		·70		·88	
	Taunton	1,080	646,273	·70		·06		1·05		1·54	
	Darwen	900	545,856	·65		·10		1·10		1·34	
	King's Lynn	520	286,678	·59		·09		1·26		1·75	
	Salisbury	200	150,222	·46		·07		1·21		1·80	

not only in the fuel used, but in the total cost per unit of electricity produced.

These official returns if brought up to date might possibly modify the results in favour of the reciprocating engine or otherwise by a decimal point or so, but the superiority shown by the reciprocating engine is too large to enable steam turbine advocates to quibble it away at present. We may say that the reciprocating engine stations have been chosen by us with as much absence of bias as possible, and we might have selected for example 38 stations showing an average of ·41 for fuel cost, instead of the ·51 we have accepted for comparison sake. These figures are the only official ones at present published, and they should, in our opinion, at least give pause to the enthusiasts who want to rush the steam-turbine for central-station work.

Turbine enthusiasts appear to lose sight of the fact that the steam-engine has not been standing still during the last few years, but has been largely improved by the judicious use of superheated steam in specially designed engines. The reciprocating steam engine, in fact, is still far ahead of either gas-engines or turbines for economy of fuel on the average station loads; and for comfort and reliability of running, on which the reputation of the station more immediately depends, there is no question as to the superiority of the steam-engine.—Yours, etc.,

BELLISS AND MORCOM, LIMITED.

MANCHESTER LOCAL SECTION, I.E.E.

The inaugural meeting of the present session of the above section took place on Tuesday night, and was quite a record gathering, over 250 members being present. A happy thought had given a double-barrelled character to the proceedings, which consisted of Mr. E. Cowan's address as chairman, and a demonstration of the properties of radium by Dr. Schuster. Mr. Cowan's text was "The Manufacturer's Worries," and he dealt, firstly, with the necessary evil of consulting engineers' peculiarities; and, secondly, with the unnecessary evil (according to Mr. Cowan) of Protection. On the general subject of progress he remarked that a glance down the published share lists of electrical manufacturing companies showed that the industry was sick. Taking the ordinary share capital of the companies manufacturing only electric light and power apparatus, which in the dozen or so companies listed in the electrical Press amounted to something more than 3½ millions, they found that nearly half the capital was bearing no interest at all. He maintained that the manufacturing industry had been hindered and hampered at home in its development, to the material detriment of the industry as a whole. The first part of the address was enlivened by anecdotes of consultants and their generally recognised one-sidedness in dealings between producer and purchaser, and it was fortunate for the peace of mind of the chosen of the profession present that there was no discussion. Note was made of the awkward position of a contractor when having to deal with both a consultant and a resident engineer when the two did not agree; and the very safe tip of backing the seemingly less important resident was given. With regard to the opinion which was held in some circles as to the unprofitable nature of municipal contracts, Mr. Cowan instanced the system of deferred payments, that is so rife in specifications, as a means of unprofitably locking up money to the detriment of trade. The likelihood of manufacturers combining to withstand unjust clauses in contracts was shown to be small, on account of the potentiality of foreign competition and the lack of business. Another point which Mr. Cowan said is injurious to the home manufacturer is that he is hindered in standardisation owing to the demand for alterations in designs, according to the opinion of the engineer. He proceeded to pass some criticism upon resident engineers, complaining that many are installed merely on account of their technical experience, and have no experience or training in business. A grave injustice is thus often done to contractors. The second part of the address was a review of the fiscal question, in which a hydraulic simile did service, and a great number of general conclusions were arrived at. Mr. Cowan finally summed up for Free Trade, on the general grounds that English manufacturers wanted "bucking up," and that Protection would cause them to go to sleep, with bad results to the industry.

A hearty vote of thanks was proposed by Dr. Bowman, seconded by Mr. C. D Taite, and carried with acclamation; and in reply to this Mr. Cowan absolved all the consulting and resident engineers present from connection with his remarks upon their class, as being the necessary exceptions to the rule.

Dr. Schuster's demonstration, though interesting to the physicists present, fell rather flat with the general body of engineers and commercial men, and the experiments were hardly clear or conclusive enough to do more than amuse. The placing of a piece of radium between opposite poles to induce a discharge therefrom, for instance, would have been equally successful with any piece of metal used as an arc striker; and the much-marvelled-upon luminosity of the substance in the dark reminded one of common or garden phosphorus. Dr. Schuster answered questions on the subject afterwards, when the unknown properties of the metal were very much in evidence. A vote of thanks to the professor concluded the proceedings.

NEWCASTLE LOCAL SECTION, I.E.E.

The following is an abstract of Mr. Gerald Stoney's address to the Newcastle Branch of the Institution of Electrical Engineers, delivered on Monday, Nov. 16, 1903:

This branch of the Institution of Electrical Engineers has now been is existence for four years, and the membership has risen steadily from 93 at the time of its inauguration to 152 at the present time.

A subject in which great interest is being taken is the education of engineers, and this has produced most diverse opinions. All, however, are practically unanimous that it is necessary to combine practice with theory, but as to the best way of doing this there is much difference of opinion.

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The best way, however, seems to be the "sandwich" system, in which the theoretical and practical training are carried on concurrently. Stress should be laid on the importance of letting a boy early in life learn the use of tools, and this can, as a rule, be best accomplished by letting him have an amateur workshop, in which the average boy will, with a little encouragement, spend a part of his spare time.

Modern languages also are of great use to an engineer, and he should be taught both to read and speak them. Latin and Greek may well be left out, and it is maintained that the German grammar is as good an education for the mind as the Latin grammar, besides being of practical use to an engineer. Mathematics should also be taught from a practical point of view, so as to enable the student to make use of them in the actual problems which occur in practice.

In thus, however, urging a practical education for an engineer, no one more than an engineer is aware how much is owing to those who pursue science for itself apart from mere monetary gain. Without the investigations of the immortal Faraday, out of which he deliberately refused to make any monetary gain, where would the whole of our modern electrical engineering be? Without the investigations of Faraday, Maxwell, Herz, Fitzgerald, Lodge, and many others, Marconi could not have made wireless telegraphy the brilliant success it has been. In almost all cases the way has been paved for the engineer and the commercial man by seekers after knowledge, which they have given to the world freely and without stint, and it is hard to say what bearing investigations in pure science may have in the future. Such discoveries as the fixation of atmospheric nitrogen, and thus the formation of nitrogenous manures, may be of great importance to agriculture, and the formation by electrolysis of many of the organic compounds found in plants may eventually give us a clue to the mystery of life, which, along with gravitation, is one of the great mysteries of Nature still to be solved by man.

The distribution of electricity for power, lighting, and traction has made enormous advances, and there is no sign of this rate of progress slackening. In this district we have the first of the great power stations at Neptune Bank, Wallsend-on-Tyne, and soon a second one at Carville will be at work. During the past 15 years the size of engines and dynamos used had steadily risen from about 100 kw. to from 4,000 kw. to 5,000 kw. at the present date. In this connection the Parsons steam-turbine has taken a notable part. This was invented by the Hon. C. A Parsons, F.R.S, in 1884, and the first engine was of about 10 h.p., while now turbines up to 8,000 h.p and 10,000 h.p are being made. The low first cost, small steam consumption, absence of reciprocating parts, and small foundations, as well as reduced attendance and upkeep, have made this type of engine largely adopted for driving dynamos and alternators, as well as for the propulsion of ships and other purposes.

A great field is opened up by the discovery of cathode and other rays, in which we seem to be dealing with individual electrons instead of with masses of them. Recently there is the marvellous discovery of radium, which not only gives forth three distinct sorts of rays, but also is warmer than objects surrounding it, and is, therefore, constantly pouring energy, the exact source of which is still in dispute. These researches in molecular physics may some day enable us to deal with individual molecules instead of with masses of them, and thus it may be possible to tap the great source of energy existing in the atmosphere by the help of the "Sorting Demon" pictured by Clark Maxwell, and thus utilise for the service of man the energy of the atmosphere without the consumption of coal or other fuel. And looking back on the advance made in the last 100 years, who will say it is impossible? Fancy our grandparents in the "Flying Scotchman" at 60 miles an hour. What they would think of telephone, telegraph, or gramaphone? What would the effect be on a stage coach if it met a bicycle or motorcar? Some of these things would have been declared impossible even within the memory of many of those here present.

TRADE NOTICES AND NOVELTIES.

Lundberg's Accessories.

The recently-issued catalogue of Mr. A. P. Lundberg, of 477 to 487, Liverpool-road, N., contains some new electric light accessories which will be welcomed by electrical engineers. Of the well-known standard switches and other accessories made by the firm we cannot again give a description, but the following improvements in detail are worthy of illustration. The first of these (Fig. 1) shows a new and patented method of

FIG. 1.

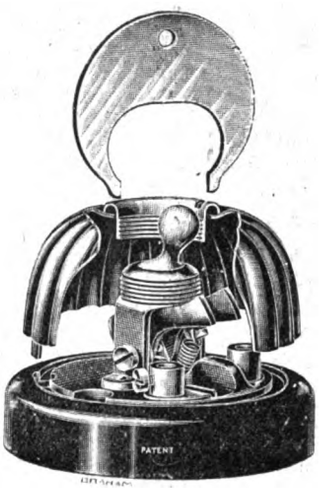

FIG. 2.

securing china switch covers on to either the "Pivot" or "Century" switch. For this purpose a screwed collar which keys with three projections into the china cover is used. The result is more mechanical than the usual method, and it relieves the roof of the cover from strains which frequently have caused fractures. The china cover secured in this way is much more satisfactory than one in which the material of the cover has a thread formed in it. A variation of this method of securing any switch cover is shown in Fig. 2, which gives the locking so often required. In this case the nipple is not keyed into the cover, but holds the same in position by means of its upper flange. The nipple is screwed into place by means of a key, shown in the illustrations, and without which the cover cannot be removed. This feature is of great service in switches which have to be placed in office corridors, asylums, schools, hospitals, etc. Fig. 3 illustrates one type of the Pivot

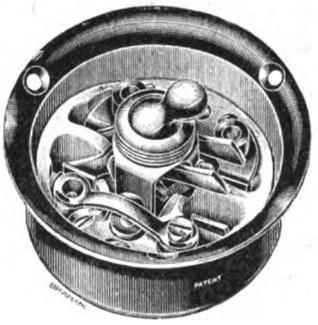

FIG. 3.

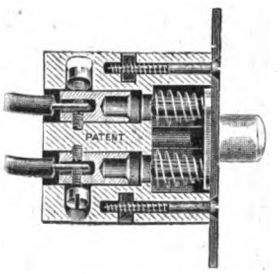

FIG. 4.

switch arranged for two-way working. As will be seen, it is contained in a brass box for sinking into the wall. Fig. 4 is a section of Mr. Lundberg's improved door contact for lavatory lighting. The general design of this is not new, but it has been slightly altered so that it may be constructed in porcelain instead of in fibre, which is a great improvement. As will be seen, the terminals are exceptionally well shielded, and the contact made when the plunger is forced in is good. The illustration is full size, and the contact can be sunk into any door frame.

PHYSICAL SOCIETY.

At the meeting of the above society on Nov. 13, Dr. R. T. Glazebrook, F.R.S., president, in the chair,

Sir Oliver J. Lodge read a paper on **"Means for Electrifying the Atmosphere on a Large Scale."** Twenty years ago the author was engaged with Mr. J. W. Clark on an investigation of the dark spaces seen near hot bodies placed in illuminated smoke. The existence of these dust-free spaces was discovered by Tyndall, and the phenomenon had been investigated by Lord Rayleigh. Tyndal worked with high temperatures, and attributed the effect to the burning of the dust near the hot body. Such, however, cannot be the case, as the spaces exist

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when inorganic dust, such as oxide of magnesium, is used. The conclusion at which Messrs. Lodge and Clark arrived (see *Phil. Mag*, 1884) was that the result was due to an aerial bombardment from the hot wire which drove the particles away, and they tried the effect of electrifying the hot body to see if there was any modification of the dark space. A new phenomenon was discovered, the whole of the dust being driven to the sides of the containing vessel. This experiment was shown by the author at the British Association meeting in Montreal in 1884, and subsequently, on a larger scale, at the Royal Institution. In the latter experiment two pieces of wire gauze, connected to the terminals of an electric machine, were placed opposite each other in a smoke-filled chamber, through which a current of smoke was slowly passing. Upon electrifying the plates the smoke ceased passing, the dust particles cohered, hovered in the air, and were either driven to the sides of the chamber or fell to the bottom. In the case of mist electrification of steam in a bell jar converted it into fine rain. It seems, therefore, possible that rain might be produced by the electrification of a cloud. Sir Oliver Lodge has tried at Liverpool to disperse fogs by discharging electricity into them. For this purpose a large mast was erected on the roof of the University College buildings. It terminated in a bundle of points, to which electricity was conveyed from a Wimshurst machine by a wire supported by specially-constructed insulators. In order to drive electricity from a point far removed from a surface a high potential is necessary, and sometimes a large gas flame was used to supplement the points. Upon one occasion the discharge of electricity from the flame was sufficient to keep a clear space of 50 or 60 yards radius in a dense fog. The author had hoped to induce the Mersey Dock Board to try the principle on a large scale, having a series of positive discharges on one side of the river and a series of negative discharges on the other; but he felt a certain reluctance in recommending the method to practical men so long as it was necessary to derive the current from a Wimshurst machine. A dynamo would be a more suitable generator if it were possible to get a sufficiently high potential. The way out of the difficulty is to rectify a high-tension alternating current, and Sir Oliver Lodge has for some time been considering the possibility of doing this by utilising Cooper-Hewitt mercury lamps. A study of these lamps has led him to believe that their rectifying power is much assisted by the outside metallic coating which surrounds the mercury electrode, and which is connected to the positive terminal of the lamp. In order to rectify an alternating discharge, four lamps are so arranged in the form of a quadrilateral that, when the leads from the terminals of an alternating transformer are connected to two opposite corners, two unidirectional currents are obtained from the other corners. Experiments have been made at Birmingham by sending the current from a high-frequency alternator (3,000 ⌢⌣ per second) through the primary of an induction coil and connecting the terminals of the secondary to the rectifiers. The length of the rectified spark can be increased by putting a number of lamps in series in each arm of the quadrilateral arrangement. Sir Oliver Lodge performed an experiment at the meeting to show the dissipation of fog by electrification. The current from an alternator was passed through the primary of a coil and the terminals of the secondary connected to the rectifiers, 12 lamps in all, three in series in each arm. This arrangement is capable of giving a rectified spark 2in. or 3in. long, the unidirectional nature of which can be proved by passing it through a Crookes or a Röntgen tube. Some magnesium wire having been burnt under a large bell jar to fill it with a cloud of magnesium oxide, the jar was then illuminated by the light from an electric lamp. Passing through the base-piece upon which the bell jar was placed was a conductor which terminated in a point inside the jar. When the terminals between which the rectified discharge was passing were separated and the other end of this conductor was joined to one of them, the electricity streaming from the point into the clouded atmosphere caused an immediate deposition of the magnesium oxide.

Prof. W. E. Ayrton congratulated the author, and expressed his interest in the experiment showing the deposition of magnesium oxide. He pointed out that the combination of four Nodon valves for obtaining a continuous current from an alternating one had been used before. Dealing with the rectifier itself, he said his feeling was that the rectification was due to a difference in the electrodes, and not to any special proximity of two electrodes through the glass, as suggested by Sir Oliver Lodge. There were many cases of rectification—a metal carbon arc, for instance. In this case the explanation of the phenomenon was probably connected with the fact that one electrode was metallic and the other carbon. In the mercury lamp both electrodes were metallic, but the metals were very different from each other. Prof. Ayrton said that Prof. Steinmetz had recently shown him some interesting experiments with mercury arc lamps, resembling in some details the Cooper-Hewitt lamp. There was, however, no choking coil, the starting being effected by an electromagnet capable of separating two tags within the tube, and causing a small arc which started the lamp. There was also no branch lead from positive electrode to the mercury end of the lamp. In his opinion this connection was only a starting device in the Cooper-Hewitt lamp. Prof Ayrton concluded by expressed his pleasure that the administrative duties of Sir Oliver Lodge had not interfered with his keen interest in scientific research.

Prof. H. L. Callendar expressed his interest in the paper and in the experiments shown. In connection with the rectification he pointed out that under certain conditions any vacuum tube would act as a rectifier, illustrating the point by an experiment with an X-ray tube. The phenomenon was noticed by Hittorf 30 years ago and attributed by him to the constriction around the negative electrode.

Mr. W. Duddell said he should like to discuss the rectifying power of mercury lamps. Any two different electrodes in air will rectify to some extent. In the case of two carbons, the diameters of which are as 2 to 1, the resistance between them varies by 5 or 6½ per cent., according as the current is passed one way or the other. With a metal carbon arc it is possible to stop the current altogether. A point and plate will also act as a rectifier. He thought that the condenser arrangement was to facilitate starting, and expressed the opinion that the rectification was due to the temperature of the electrodes and the temperature gradients near them. The temperatures of the mercury and iron in a mercury lamp were very different, and in the case of a point and plane there was a difference of temperature because of the cooling of the plane by radiation. He had also found that the best rectification takes place between electrodes having a high potential difference, and that when using the lamp for practical purposes the presence of impurities improved it by facilitating starting.

Dr. C. Chree pointed out that there was a potential gradient in the atmosphere from the ground upwards which sometimes amounted to 1,000 volts per metre, and was often 150 volts per metre. He asked if this difference of potential between the ground and the tops of high trees would have any effect upon the dissipation of fog.

Sir Oliver Lodge, replying to Dr. Chree, said it had occurred to him that atmospheric electricity must be taken into account, and said it was quite feasible that point discharges from trees might have some effect upon fogs, but not enough. Replying to Mr. Duddell, he said they had found that for high-tension rectification it was necessary to have as good a vacuum as possible, but for lamps working on low voltages it was beneficial to permit a residue of impurities. He said he was still of the opinion that the outside connection assisted the rectification in some tubes by throwing a great strain on the gas near the cathode.

Sir Oliver Lodge then described **"An Arrangement for Driving Mercury Pumps,"** designed by himself and Mr. P. Davies. The apparatus was constructed because the work necessary to make large numbers of vacuum tubes renders it essential to drive the pump hydraulically. The preliminary exhaustion is effected with an ordinary Fleuss pump and the work completed by using a Töpler mercury pump. The reservoir of the pump is suspended from the rim of a 6in. wheel, and is almost counterbalanced by a water-vessel suspended from the rim of a 2ft. wheel fixed upon the same axle. The water-vessel is capable of moving up and down between vertical guides, and mechanism is so arranged that when it reaches the top of the guides a tap is turned and it is filled with water. The increase in weight causes it to descend and raises the pump reservoir. When it reaches the bottom of the guides, a valve in the bottom of the vessel is opened automatically and the water is discharged. The vessel then rises again and the process is repeated. Keyed to the axle carrying the two wheels referred to there is a third wheel, 1ft. in diameter, over the rim of which passes a friction band. The function of this arrangement is to control the upward and downward motion of the water-vessel, bringing it to rest quietly at each end of the journey and yet allowing it to move quickly. There is also a device at the bottom of the guides for keeping the valve of the vessel open until the whole of the water has been discharged. The mercury which overflows from the pump is conducted back to the reservoir, thus giving a circulation of mercury and automatically replenishing the reservoir.

FORTHCOMING EVENTS

FRIDAY, NOV. 20.

National Cycle and Motor Show.—Opening of an eight-day show of cycles, motorcars, and accessories.

SATURDAY, NOV. 21.

Junior Institution of Engineers.—At 2.30 p.m., visit to Orchard Dock, Blackwall, to witness a demonstration of fire extinguishing, etc., by invitation of the Clayton Company.

Ipswich.—At 12.30 p.m., opening of electric generating and tramways undertaking.

MONDAY, NOV. 23.

Society of Arts.—At 8 p.m., Cantor lecture, "The Mining of Non-Metallic Minerals," by Mr. Bennett H. Brough. (Lecture I.)

TUESDAY, NOV. 24.

Institution of Civil Engineers.—At 8 p.m., ordinary meeting. Paper: "On the Distribution of Mean and Extreme Annual Rainfall over the British Isles," by Mr. Hugh R. Mill, D.Sc.

WEDNESDAY, NOV. 25.

Society of Arts.—At 8 p.m., ordinary meeting. Paper: "The Universal Exposition at St. Louis, U.S.A., 1904," by Mr. Geo. F. Parker.

Institution of Civil Engineers.—At 2.30 p.m., Students' visit to the Great Northern Railway underground stations at Finsbury Park.

THURSDAY, NOV. 26.

Institution of Electrical Engineers.—At 8 p.m., ordinary meeting. Papers: "The Testing of Electric Generators by Air Calorimetry," by Mr. R. Threlfall, M.A., F.R.S.; "The Edison Accumulator for Automobiles," by Mr. W. Hibbert.

FRIDAY, NOV. 27.

Physical Society.—At 5 p.m., at the Royal College of Science. Ordinary meeting. Papers: "An Electrical Thermostat," by Mr. Horace Darwin; "On the Occurrence of Cavitation in Lubrication," by Mr. S. Skinner; "A Lecture Experiment in Electrical Resonance," by Dr. W. Watson.

SATURDAY, NOV. 28.

Glasgow Scientific Society.—At 7.30 p.m., ordinary meeting. Paper: "Some Remarks on the Willans Engine," by Mr. J. Herbert Pocock.

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NEW COMMITTEES.

ACCRINGTON.—*Electricity, Legal, and Parliamentary*—Aldermen Cunliffe, Hindle, Lee, Rawson; Councillors Bunting, Bury, Jas. Cunliffe, Higham, Langham, W. Lupton, and Slinger.

AYR.—*Lighting*—Whole members of Council; five a quorum; Mr. Young, convener. *Tramways*—Whole members of Council; five a quorum; Mr. James S. Hunter, convener.

BARNSLEY.—*Electricity and Lighting*—Councillor Brady (chairman); the Mayor; Alderman Wilkinson; Councillors Atkinson, Carter, Cotterill, England, Harvey, Kenworthy, Rose, and Wells.

BARROW.—*Electricity*—Aldermen Bradshaw, Lee, Smith, and Townson; Councillors Ashburner, Atkinson, Cox, Dawson, Fisher, Hardy, Hewetson, Taylor, Tootill, Townsend, Wadham, and Young.

BATLEY.—*Electric Lighting, Traction, and Tramways*—Aldermen North and Hirst; Councillors Bagshaw, Childe, Ineson, and B. Turner.

BEDFORD.—*Electrical*—Messrs. Walton, Robinson, Telling, W. Wood, Brogan, and Dickson.

BIRKENHEAD.—*Tramways*—Alderman Cook; Councillors Blaylock, Curphey, Edwards, Evans, Griffiths, Laird, Litwall, H. L. Pearson, Proudman, Snape, Venables, and Cox, and the chairman of the Ferries Committee. *Electricity*—Alderman Lees; Councillors Bennett, Cox, Duckworth, M'Gaul, Nowell, Proudman, Russell, Thomas, Wall, and Watson.

BOLTON.—*Tramways*—The Mayor and Deputy-Mayor; Aldermen T. E. Smith, Harwood, and Nicholson; Councillors Battle, Fletcher, Horner, P. Higson, Maginnis, Panton, Wild (Deane), Witter, Vose, Rostron, and D. Isherwood. *Electricity*—The Mayor and Deputy-Mayor; Aldermen T. E. Smith and Fielding; Councillors Panton, Berry, W. Cooper, Duxbury, Marshall, Rothwell, Clarkson, Gorton, N. Ramsden, and Waddington.

BOOTLE.—*Electric Power and Lighting*—Alderman Brewster (chairman); Councillor Wm. Brown (deputy-chairman); Alderman McMurray; Councillors Bell, W. B. Brown, Carruthers, Clarke, Clemmey, Hanlon, King, Pearson, and Randall.

BOURNEMOUTH.—*Lighting* (to include electric lighting)—Aldermen Lane and Parsons; Councillors Burden, Gunning, Harris, Hunt, C. R. Hutchings, W. E. Hutchings, Jones, Parry-Crooke, Roberts, Robson, Rolls, Street, Youngman. *Telephones*—Aldermen Lane and Parsons; Councillors Abbott, Burden, Gunning, Harris, Hawkes, W. E. Hutchings, Minty, Wilson, Youngman. *Tramways and Parliamentary*—Aldermen Davis, Lawson, Mattocks, Stockley, Webber; Councillors Abbott, Allen Banks, Bell, Beckett, Drake, Frost, M.D., Gunning, C. R. Hutchings, Youngman.

BRADFORD.—*Tramways*—Chairman, Mr. James Hill; vice-chairman, Alderman Enoch Priestley. *Electricity*—Chairman, Mr. G. H. Robinson; vice-chairman, Mr. Tom Lister.

BRIGHTON.—*Lighting*—Councillor Bedford; Alderman Lowther; Councillors Briant, Broadbridge, Carden, Halliwell, Butt-Thompson, Galliers, Holloway, Swift, Blaker; Alderman Botting. *Tramways*—Alderman Stafford; Councillors Carden, Wilson, Blaker, Butt-Thompson, Galliers, Stone, Halliwell; Alderman Sendall; Councillor Swift; Alderman Buckwell; Councillor Holloway. *Telephones*—Councillors Beryl, Black, Carden, Colbourne, Hardy, Jarvis, Lawson, Lintott, Mayston, Pankhurst, Stringer, and Yates.

BRISTOL.—*Electrical*—The Lord Mayor; Aldermen Pearson (chairman), Lowe; Messrs. Hughes (vice-chairman), Lloyd, Elk, Chandler, Dr. Cook, Messrs. Witty, E. Collins, Langford, Perry, and Curle.

BURY.—*Tramways*—The Mayor; Aldermen Ashworth, Fletcher, Parks; Councillors T. Ashworth, W. Ashworth, Battersby, F. Bradley, Hall, Hewart, Hill, R. Kay, Spencer, and Wilde. *Electricity*—The Mayor; Aldermen Dawson and Duxbury; Councillors T. Ashworth, Battersby, Hill, R. Kay, Sanderson, Slater, P. Smith, and Spencer.

DERBY.—*Electric Lighting*—Aldermen Ann, Butterworth, Duesbury, Fletcher, Spriggs; Councillors Brigden, G. Dean, Eaton, Haslam, Shackleton, Wilkins. *Tramways*—Aldermen Butterworth, Duesbury, Fletcher, Spriggs; Councillors J. Dean, Eaton, Gandy, Haslam, Ottewell, Walker, Wilkins.

EALING.—*Electric Light*—Aldermen Green, Tyer, and Kasner; Councillors Hardman, Menzies, Peal, Purvis, and Richards.

EASTBOURNE.—*Electric Light*—The Mayor; Aldermen Pocock and Strange; Councillors Eden, Hillman, Hoadley, Martin, Colonel Mein, Rowe, Simmons, Tinling, and Wright.

GILLINGHAM.—*Electric Light and Baths*—Alderman Barnes; Councillors Holmes, Cornelius, Edwards, Parrick, Lewington, Middleton, and Hunt.

HALIFAX—*Tramways and Electricity*—Alderman Hey (chairman); Councillor Fawcett (vice-chairman); Aldermen Tyson, Booth, Walsh, Crossland; Councillors Ward, Clark, J. Whitaker, Dalton, Stansfield, Brotherton, Alderman, Oates, and Seed.

HAMMERSMITH.—*Electricity and Lighting*—Councillor C. Johnson, chairman; Alderman the Rev. Canon White vice chairman.

HEYWOOD.—*Electricity and Tramways*—The Mayor; Aldermen Hodgkinson, Maden, and Marlor; Councillors Ashworth, Cockerill, Coupe, D. Healey, W. Healey, Ingham, Jackson, Popple, and Smith.

HORNSEY.—*Electricity*—Aldermen Fox and Mackenzie; and Messrs. Grayson, Piercy, Farquharson, S. Smith, J. H. Wilson, and two new members.

HUDDERSFIELD.—*Tramways* (exclusive of the Mayor, 21)—The Mayor; Aldermen Firth, Jessop, Whitehead; Councillors Ainley, Cartwright, Cook, Coward, Dobson, Gee, Lawley, Moore, Oxley, Pogson, Rolfe, Ernest Shaw, Thomson, Alfred Sykes (North), Taylor, Whitworth, Brook, and Aston. *Electricity* (20, exclusive of the Mayor)—The Mayor; Aldermen Hellawell, Calvert, E. Woodhead, Jepson, Whitehead; Councillors Berry, Chatterton, Cook, Dobson, Gledhill, J. Holroyd, Longbottom, Pogson, Priest, Ernest Shaw, Smith, Alfred Sykes (North) Thomson, Whittell, Woolven, Heppenstall, and Hesketh.

IPSWICH.—*Electric Supply and Tramways*—The Mayor; Alderman F. Turner; Councillors S. Brand, Geo. Butcher, S. G. Howe, H. J. W. Jervis, J. Pratt, W. T. Pretty, E. P. Ridley, and Owen Turner.

LANCASTER—*Electricity*—The Mayor; Alderman Smith; Councillors Hall, Heald, Huntington, Oglethorpe, Threlfall, Dixon, Cardwell, Seward, Wright, and Bell. *Tramways*—The Mayor; the ex-Mayor; Aldermen Smith, Huntington; Councillors Hall, Wilson Heald, Threlfall, Towers, Thompson, Kirkby, Seward, and Wilkinson.

MACCLESFIELD.—*Electricity*—The Mayor; Aldermen Brocklehurst, Eaton, Fountain, Mellor, and Savage; Councillors Clayton, Cameron, Heath, Crew, Whitmore, Cross, Isherwood, Bailey, Oldfield, Brown, Wardle, and Staniforth.

MORECAMBE.—*Hackney Carriage, Railway Facilities, and Electric Light*—Aldermen Carleton, Snowden, Wilson; Messrs. Ashton, Bennett, Coulthurst, Miller, Moore.

NELSON.—*Electricity and Tramways*—The Mayor; Aldermen Reed (chairman), Hartley, Greenwood, Hudson, Edmondson, Wilkinson; Councillors Wilkinson, Hargreaves, Whitham, and Smith.

NEWPORT.—*Gas, Electricity, and Water*—Aldermen A. Oldroyd and F. Rhodes; Councillors B. Campbell, R. F. Machell, J. McCann, F. Newsome, A. Pearson, and G. Thorpe.

NOTTINGHAM.—*Tramways*—Aldermen Brownsword, Bright, Ford, McCraith, and Sir John Turney; Councillors Ashworth, Baker, Bellyeald, Butler, Houston, Hunter, Johnstone, and Loverseed. *Electricity*—Aldermen Lambert, McCraith, Sir John Turney, and Woodward; Councillors Ashworth, Cleaver, Elborne, Johnstone, and Palmer.

RIPON.—*Gas and Electric Lighting*—Mayor (chairman); Councillor Watson (deputy chairman); Aldermen Spence and Thirlway; Councillors Boddy, Savill, and Dixon.

SAFFRON WALDEN.—*Electric Lighting*—The Mayor; Alderman Bell (chairman); Councillors Atkinson, Gover, and Tuke.

SALFORD.—*Tramways*—Aldermen Halton, Jenkins, Linsley, and Worsley; Councillors Barker, Barnes, Barrett, Hodgson, Hopwood, Jones, Muir, Shaw, Stringfellow, and Yearnshaw. *Electricity*—Aldermen Frankenburg and Shaw; Councillors Barrett, Hale, Higson, Hill, Hodgson, Jones, Leach, McDougall, Rothwell, Sackville, Taylor, and Wheatcroft.

SOUTHAMPTON.—*Tramways*—The Mayor; Junior Bailiff Andrews; Aldermen Button, Dunsford, Tilling, Bicker-Caarten, Bonner, Dixon, Hancock, Hollis, Jenvey, Line, Willey. *Electricity*—The Mayor; Aldermen Button, Emmanuel, Dunsford; Councillors Aldridge, Bickers-Caarten, Blakeway, Doling, Hancock, Lewis, Tebbutt, Willey, and Wright.

SOUTHEND.—*Light Railways*—Aldermen Brightwell and Tolhurst; Councillors Barker, Campbell, Craig, Hubbard, Martin, Norman, and Roberts.

SOUTHPORT.—*Electricity*—Aldermen Hulme, Unwin, and Vaughan Councillors Ashton, Boyd, Brighouse, Foggitt, Hough, Ingham, T. Jones, H. T. Smith, Travis, and Young.

SOUTHWARK.—*Electric Light* (16)—Aldermen Cannon, Hawkins, and Haynes; Councillors Auton, Bunyard, Cook, Davies, Edwards, Hughes, Newmans Norman, Osbrees, Sharp, Westcott, Morton (Progressives), Chell and Sames (Moderates).

STRATFORD—*Electric Light*—Aldermen Hawkes, Park, and Pearce; Councillors Ballance, Barnard, Everard Tyler, and Winter.

TAUNTON.—*Electric Lighting*—Aldermen Potter (chairman), Lock, Perkins; Councillors Lewis, Norman, Sibley, Van Trump, Webb.

WARRINGTON.—*Electricity and Tramways*—Aldermen Bennett, Bolton, Smethurst, Pierpoint, and Sutton; and Councillors Ellison, John Evans, Pemberton, Tinnion, Wilkinson, Peacock, Craik, Lord, Thornton, and Maginn.

WIGAN.—*Electric Light and Tramways*—Chairman, the ex-Mayor; vice-chairman, Councillor W. Lowe; the Mayor; Messrs. T. Ashton, J. Ballard, J. T. Gee, J. Hilton, R. Leyland, W. Leyland, J. Paxton, R. Richards, S. Taylor, S. Wood, W. R. Deakin, and J. McQuaid.

WORKINGTON.—*Electric Lighting*—Messrs. M'Aleer, Wallis, Milburn, Holmes, Duffield, M'Mullen, Walker, Yeowart, and Kennaugh.

WORTHING.—*Electricity*—Alderman Piper; Councillors Fraser, Gilbert, Morcraft, Norris, Raffety, Tate, and Walter.

PROVISIONAL ORDERS.

The following notices of intended application for provisional orders appear in the *Gazette*:

ELECTRIC LIGHT AND POWER.

Lancashire Electric Power (company); Clitheroe Corporation Lighting; Leicestershire and Warwickshire Electric Power (company); London Electric Lighting (adjustment of areas); Ealing Corporation Lighting and Power; Tynemouth Corporation Electric Light; Northampton Borough Council Electric Light; Hexham Electric Lighting (E. P. Harvey); Walmer Urban District Council Electric Lighting.

TRAMWAYS.

Royton Urban District Council; Crompton Urban District Council; Leek, Caldon, Low, and Hartington Light Railways (above company and North Staffordshire Railway Company); West Ham Corporation.

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LONDON TRAFFIC ENQUIRY.

The Royal Commission on London Locomotion again sat at the Westminster Palace Hotel on the 12th inst., Sir David Barbour presiding.

Mr. Andrew Young, valuer to the London County Council, gave further evidence on behalf of the London County Council. He was of opinion that the only economical method of carrying out street improvements in London was by laying-out the projected new streets in such a way that it would not be necessary to acquire a large proportion of valuable property occupied for business purposes. He went on to say that the proposal under consideration was the construction of streets of a greater width than any hitherto projected in London—namely, 160ft.—which must involve outlays of great magnitude. If the proposal were further extended, as he understood it was suggested, so that there should be special means of locomotion by surface tramways, motor, and other fast traffic, and by tube railways, the possibilities for recoupment would not only be increased, but would extend over very large areas of these remoter districts. Questioned as to the proposed new thoroughfare in continuation of the Holborn to Strand improvement—across the Thames, through Southwark, Bermondsey, and Camberwell, to the Crystal Palace—the witness said he had formed an approximate estimate of the cost of acquiring the necessary property. The line of route was 6¾ miles in length, and he estimated the cost at £12,000 000. He had included an area of land 150ft. deep on either side of the proposed thoroughfare, and this would enable the Council to purchase and then sell with the benefit of the improvement after construction. A considerable portion of the £12,000,000 would, no doubt, be recovered by the sale of the surplus property.

The **Chairman** remarked that it had been suggested that it would be advantageous if a general scheme of street improvements to be carried out over a long period of years were laid down.

The witness's comment on this was that if such a course were practicable many advantages would accrue from its adoption, but it would be necessary for the financial success of such a scheme that any plan prepared with a view of future improvements should be treated as confidential, for as soon as it was known that property would be required for public purposes new interests were created for the purpose of obtaining increased compensation.

Sir Alexander Bruce, assistant commissioner of the Metropolitan Police, next gave evidence. He said that owing to the mode of growth of London there was an absence of plan in the construction and arrangement of streets, and no adequate provision had been made for growing needs. There seemed to be but one effective remedy—that of providing subways carrying all pipes, sewers, etc., so that they could be got at without interfering with the surface of the roads. With respect to tramways, he considered that tramway routes and termini had not always been fixed with due regard to the convenience of the public. He particularly referred to the congestion at the Westminster Bridge-road, and said that the Commissioner of Police had endeavoured to get the terminus removed to the other side of York-road. One remedy for such a state of things was to have the termini in by-streets, and another was that the tramway should, instead of stopping as it did now, go off at some by-street, form a loop, put down its passengers, and then come on to the main line.

At the sitting of the Commission the following day the witness resumed his evidence: In summing up, he said that from a public point of view the chief hindrance to a steady flow of traffic was cross traffic. So long as a street had other streets running into it carrying cross traffic, there must be frequent compulsory stoppages, and resulting annoyance and delay. Subways might be provided for pedestrians or bridges, but it was not easy to see how this could be done in the case of vehicles. It was for engineers to say whether or not it was possible. From a police point of view, it would afford more relief than any other remedy.

Superintendent Bantick, D Division, Metropolitan Police, described the kind of traffic in the main streets of that district, and his evidence was mainly directed to this point.

The Commission adjourned.

APPOINTMENTS VACANT.

Engine-Room Attendant. Salary 35s., rising to £2 per week Particulars from the Secretary, South-Western Polytechnic, Manresa-road, Chelsea, S.W.

Shift Engineer, Tunbridge Wells, £100 per annum.

Mains Superintendent, Bexhill Borough Council. Salary, £2; 21st inst. See advertisement in last issue.

Brassfinishers accustomed to switches, arc lamps, the Manufacturing Electric Company, Limited, 11, Red Lion-street, Clerkenwell. See advertisement in last issue.

Assistant Works Manager for lamp factory, Ampere, care of J. W. Vickers, 5, Nicholas-lane, London, E.C. See advertisement in last issue.

Tramways General Manager, Sheffield Corporation, Dec. 1.

Engineering Assistant, used to tramway work, Finchley Urban District Council, £1.5 per annum. Application by Dec. 3:

Electrical Draughtsman, Metropolitan Asylums Board. Salary, £2. 10s. per week. Application by 21st inst.

Clerk, Colchester Electricity Works, 23 d inst.

Assistant Electrical Engineer, Sanitary Commissioners, Gibraltar. Salary, £200 per annum. Applications by Dec. 16. See advertisement.

Under-Foreman, electric repair shop. See advertisement.

LEGAL INTELLIGENCE.

FERRANTI LIMITED.

In the Chancery Division of the High Court on Tuesday Estler Bros. petitioned Mr. Justice Buckley for the compulsory winding up of the above company.

Mr. Buckmaster, K.C., in support of the petition, said his clients were creditors on bills of exchange. The company carried on a large business, and had issued debentures for £100,000. The debenture holders had appointed a receiver and manager, who was carrying on the works, and a meeting of creditors had been called for that day to consider a scheme of reconstruction. He therefore asked that the petition might stand over for a fortnight.

Mr. O. Leigh Clare, for a large number of creditors and preference shareholders, asked that the adjournment should be for one month, because there was a hope of coming to an arrangement by which everybody would be paid in full

Mr. George Henderson, for creditors for £14,500, supported the application for one month's postponement, but

His Lordship thought that at present a fortnight's adjournment would be sufficient.

JANDUS ARC LAMP.

In the Chancery Division of the High Court on Wednesday, Mr. Justice Kekewich had before him a motion arising out of the action Jandus Arc Lamp and Electric Company, Limited *v.* Arc Lamp Company, which was in the list for trial.

Mr. W. Graham said the action was brought to restrain the infringement of two patents by the defendant company. The plaintiff company, for whom he appeared, had been advised that neither of its patents in the form in which they now were could be safely litigated upon, and the motion was for plaintiff company to be allowed to amend its specification.

Mr. Bousfield, K.C., on behalf of the Arc Lamp Company, submitted that, as the plaintiff company could not win on its present materials, the action ought to be dismissed.

In the result, his Lordship granted the application. It was directed that the action should stand over generally.

SPEED OF TRAMCARS.

At the South-Western Police Court on Monday, before Mr. Garrett, an application was made by Mr. Moffat Ford for 10 summonses against the London County Council for driving their electric tramcars along South Side, Clapham Common, at a speed in excess of the legal limit. Mr. Ford stated that he timed the cars on Sunday morning and found that they were travelling at the rate of from 17 to 24½ miles per hour. The summonses were granted.

At a meeting of the General Committee of the National Cyclists' Union, at the Union Offices, Lonsdale-chambers, Chancery-lane, the Secretary reported that he had been in correspondence with the Board of Trade, and had been informed by the Board that the regulations as to limitation of speed are in operation on the following electric tramway systems: London United, Croydon and West Ham Corporation, and East Ham Urban District Council tramways. The regulations provide that each car shall be fitted with a speed indicator and supplementary hand brakes. The speed must not exceed 10 miles an hour except on the south side of Clapham Common, where 12 miles an hour is permitted. At certain parts, where there is much traffic, the maximum speed is reduced to eight miles an hour.

MANSLAUGHTER CHARGE AGAINST A MOTORMAN.

At the Manchester Assizes Alfred Lacey, an electric tram driver, was indicted for the manslaughter of Nathaniel Leather. Leather was in charge of a lurry, and while crossing the line was run into by the car, which, it was alleged, was running at from eight to ten miles an hour. Evidence was given by passengers on the car, some blaming the accused and asserting that he had ample time to avoid a collision, and others stating that the collision was a pure accident.

The **Judge,** in summing up, said the point in question was whether or not the prisoner took notice of the road before him and adopted proper means to avoid a collision. Tramcars, added his lordship, had no more right to the highway than he had, and the drivers must exercise reasonable and proper care. They had not the smallest right to say to people, "at all risks get out of the way," but they must get out of the way themselves if the necessity arose.

After being absent two hours, the jury returned and announced that they could not agree, but at the request of the judge they retired again.

A quarter of an hour later the jury came back, and the foreman announced that they had agreed to a verdict of "Not guilty." Prisoner was therefore discharged.

The **Judge,** addressing the prisoner, said: "I say nothing but this: be more careful in driving these cars in future or you will be here again."

ASSESSMENT OF ELECTRIC LINES

At the West Riding Court, Bradford, an important rating case was heard before the magistrates. It concerned the lines upon which electric cars are run by the Bradford Corporation between Thornbury and Stanningley, and which pass through the areas of the Pudsey Corporation and the Farsley and Calverley District Councils, the case depending on the question whether such lines constitute a "tramway" or a "light railway." The local authorities of Pudsey, Farsley, and

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Calverley issued a joint summons against the Bradford City Council requiring them to pay the full extent of the rating, amounting to about £31. The Bradford City Council hold the view that the lines are a light railway, and, therefore, exempt from rating to the extent of three-fourths of the total value. A peculiarity of the case is that by an Act obtained by the Bradford Corporation in 1899 the Corporation obtained powers to construct a "tramway" along the main road from Thornbury to Stanningley, but in the same year a syndicate applied and received powers to construct a "light railway" along the same route. As the result of negotiation, the Corporation took over the powers granted to the syndicate, and ultimately elected to utilise them in place of the authority conferred by the Bradford Act, because, for one thing, the syndicate contemplated a double set of rails being laid, whilst the powers obtained by the Corporation's own Act of Parliament provided for only one set. This was one of the points advanced by Mr. Wardle for the Bradford Corporation in proof of the contention that what had been laid was a light railway. Furthermore, the certificate of the Board of Trade given at the time the lines were opened, mentioned that they were constructed under powers granted by the light railway order. The money for laying the lines had, too, been borrowed under the same order, and a separate account was made of the capital expenditure. Once a light railway, it was always a light railway.

Mr. Harrison, for the district authorities, pointed out that this line was indivisible from the whole system of the Bradford tramways. It was not a separate piece of railway worked separately, and as to which separate accounts of receipts were kept. There was no line of demarcation between the Bradford tramways and the so-called light railway which extended from the Bradford city boundary at one end to the Leeds city boundary at the other end. The same cars were run over these lines as were run over the Bradford tramlines, and the electric current was supplied from the same generating station in Bradford. He maintained that in any case the Corporation were not entitled to the three-fourths reduction, because the lines were not used "only" as a railway. Indeed, the case of an ordinary railway did not apply, because here the cars were run on the highway, and the system enjoyed all the advantages of light and the upkeep of the roads. The cost in road repairs was, in fact, much greater now than before.

The Bench came to the conclusion that, although this might be a light railway, the Bradford Corporation were not entitled to the three-fourths reduction upon the rating.

Notice of appeal was given.

SOUTH LANCASHIRE TRAMWAYS.

At the Chancery Court of Lancashire, held at Liverpool on Monday, the case of Greenhouse *v.* the South Lancashire Electric Traction and Power Company, Limited, was heard. The action was brought by certain debenture holders to obtain a decision as to whether resolutions passed at a meeting held on Oct. 7 last were within the provisions of a deed of mortgage dated Jan. 28, 1901, securing the holders of debentures. An injunction was also asked for to prevent the trustees or directors acting upon the resolutions, and for the appointment of a receiver and manager. The point at issue was whether a majority were able to carry as against a minority a resolution which reduced the present first debenture holders to the position of second debenture holders by giving the company power to issue debentures to the amount of £600,000, and place them in front of the present debentures. It was contended that as the system had been built with the money of the debenture holders, it was not reasonable to ask them to forego their priority and take the position of unsecured creditors.

Vice-Chancellor Hall decided against the claim of the debenture holders, and said, although it might seem hard to put £600,000 in front of the existing first mortgage holders, yet persons who invested in the hope of getting 4½ per cent. on the faith of a deed which said that their rights might be compromised or modified by a majority of the shareholders could not come to Court and claim those absolute rights which an ordinary mortgage gave.

The company intimated their willingness to defray the plaintiff's costs.

TRAMWAY TRACK REPAIRS.

The General Electric Tramway Company were summoned at West Hartlepool Police Court, at the instance of the Corporation, on a charge of failing to keep certain portions of the track on the West Hartlepool to Hartlepool section in a proper state of repair.

Mr. J. W. Brown, the borough engineer, said he inspected the track on Nov. 2 and 3, and found that at certain parts within the borough the granite pavement was as much as 1½in. above the rails, whilst at others the rails were considerably below the pavement. The condition of the track was, at the time he inspected it, decidedly dangerous. Since then men had been engaged repairing it, but there were still places where it was in a dangerous condition.

Mr. Tyldesley Jones, who appeared for the defendant company, submitted that that Court had no jurisdiction in this matter. He quoted Section 33 of the Tramways Act, which provides that in any case of difference between a tramway company and the local road authority as to the construction of a track, the matter should be referred to the Board of Trade.

The **Town Clerk** pointed out that in this case it was not a question of construction, but of maintenance and repair, and the Board of Trade had told the Corporation that they must come to that Court to enforce the order.

In the course of the evidence for the defence, **Mr. William John Grier,** chairman of the Hartlepools Electric Tramway Company, said that, as compared with Regent-street, London, Clarence-road, West Hartlepool—one of the places conplained about—was a billiard table.

In the end the Bench found the case proved, and imposed fines amounting to £4, and costs.

WORKMEN'S COMPENSATION ACTS.

A Departmental Committee, appointed by the Home Secretary, is now engaged in considering what amendments in the law relating to compensation for injuries to workmen are necessary or desirable, and as to what classes of employment not now included in the Workmen's Compensation Acts those Acts can properly be extended with or without modification. The committee consists of Sir Kenelm Digby, K.C.B., his Honour Judge Lumley Smith, Sir Benjamin Browne, D.C.L., M.I.C.E., Captain A. J. G. Chalmers, and Mr. George N. Barnes. Mr. R. R. Bannatyne, of the Home Office, is secretary.

COMPANIES' MEETINGS AND REPORTS.

SOUTH LONDON TRAMWAYS.

A meeting of the shareholders in this Company, called by the liquidators, was held at Winchester House on Monday. The object of the meeting was to have laid before it the liquidators' accounts and the hearing of any explanation as to the final disposal of the assets of the Company which the shareholders might desire.

Mr. George Ennis, one of the directors of the moribund company, said the liquidators were able to return a further 6s. 3½d. per share, which, with the £4. 10s. per share paid on March 31 last, would give the shareholders £4. 16s. 3½d. for each £10 share.

A vote of thanks to the liquidators concluded the proceedings.

GUILDFORD ELECTRICITY SUPPLY.

A special meeting of the shareholders in this Company was held last week at the County Hall, Guildford, the chairman (Dr. F. R. Russell) presiding.

A resolution formally agreeing to the substitution of preference shares for the founders' shares, in accordance with the decision of a meeting of the holders of founders' shares held recently, was unanimously adopted. This has been found necessary in order that additional capital, which is needed for the extension of the Company's undertaking, may be raised.

The meeting further authorised the increase of the nominal capital of the Company from £20,000 to £55,000—£25,000 preference shares and £35,000 ordinary shares.

CAPE ELECTRIC TRAMWAYS.

The ordinary general meeting of the shareholders was held at the office, London-wall-buildings, on Wednesday, Colonel Sir Charles Euan-Smith presiding.

The **Chairman,** in moving the adoption of the report, which appeared in our issue for the 6th inst., observed that it afforded the shareholders gratifying proof that their tramway systems at Cape Town and Port Elizabeth continued to exhibit that steady progress as to traffic and revenue which might be regarded as one of the most solid symptoms of stability and success. Notwithstanding the large increase which since the commencement of their working had characterised the traffic and revenue of each successive year, the period under review exhibited a still further increase of £15,837 in their gross revenue, and of 1,245,000 passengers carried, as compared with the figures of the preceding year. It was true that their operating expenditure for the 12 months had proved very heavy, and that the net profit was lower than that of the preceding year by about £15,000, but this was owing to causes against which no foresight on the part of the directors could have protected them. The great strain on the rolling-stock and permanent way from the sudden heavy development of the traffic during the war had rendered a complete overhauling of the permanent way, of the rolling-stock, and of the plant in Cape Town imperatively necessary. All this, in conjunction with the erection of additional power plant and fresh rolling-stock, had had to be carried out at a time when rates for both skilled and unskilled labour and all prices were, as they have since remained, abnormally high. This abnormal expenditure was, however, now gradually diminishing, though much still remained to be done to the permanent way, and these reductions would, it was hoped, further make themselves felt during the current year. In the meantime the directors had the satisfaction of knowing that the Company's plant in Cape Town was efficient and equal to the requirements of the traffic. In Port Elizabeth they had nearly completed the erection of an additional unit in the power-house, and had added to the rolling-stock, bringing it up to the level of the traffic requirements. The increased expenditure on those most necessary items had been provided without the Board having had resource to any measures providing for a further increase of capital. The excess of their expenditure over the original estimates for which funds had been provided had been met from the reserve fund, which now stood at £137,000, and, notwithstanding the decrease in the profit available for dividend, the net result to the shareholders was that they received 12 per cent., free of income tax, on the year's working. With regard to the lease of the Camps Bay tramways, he stated that the directors, in accepting it, were quite prepared for a little loss in the early stages of operating that system, but they were nevertheless satisfied with the terms that were arranged, including as they did the option of purchase by this Company of the Camps Bay tramway system with its parliamentary concession for 50 years. After lengthy negotiations with the Municipality of Cape Town, amended by-laws of that body were now in the hands of the Government for official sanction, whereby some wholesome modifications were made in the oppressive regulations passed in 1901 against overcrowding on cars, which, in contradistinc-

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tion to the custom prevailing all over the world, absolutely forbade the utilisation of the standing room on the platforms of their cars, and consequently provided a constant source of grievance and dissatisfaction to themselves as well as to the public at large.

Mr. L. Breitmeyer second the motion, which was carried unanimously.

EASTERN EXTENSION TELEGRAPH.

The ordinary general meeting of the shareholders in this Company was held at River Plate House, E.C., on Wednesday, Sir John Wolfe-Barry, K.C.B., presiding.

The **Chairman,** in moving the adoption of the report, said that the gross receipts for the half-year showed a decrease of £18,757. The actual falling off in the receipts from the Australasian traffic was nearly £31,000; but, fortunately, many of the local traffics showed substantial increases, and the loss on exchange had not been sustained this year, owing to the rise in silver and to the revising of rates in silver countries every three months. Working expenses showed an increase of £17,000. The expenses for the maintenance of cables accounted for over £2,000 of that increase, and the North China station, recently opened, for £4,100, but the bulk of the increase was due to the keen and unfair competition which the Company was experiencing at the hands of the British, Canadian, and Australian Governments. Although the privilege of dealing with the public direct was readily granted to private companies in Great Britain, Canada, and other countries, the Governments of Canada, New Zealand, and Queensland had strongly objected to the Company enjoying it in Australasia, and had strongly protested against the Federal Government's decision to extend the privilege to Melbourne and Brisbane. As a result of the protest, the agreement between the Company and the Federal Government still awaited ratification. The competition with the Government was being carried on energetically, and although the Company had to complain of unfair treatment, it had, so far, been successful in retaining its traffic. The Pacific Cable had not helped Australia. The only benefit accrued to the United States, as the traffic with Canada was very small. The Australian traffic was insufficient to support all the lines, and the accommodation would be in excess of the traffic for some years to come. The loss on the Pacific Cable would have to be stood by the taxpayers. At the present time the Company was suffering from two causes in Australia. The first was Government competition, and the second the drought in Australia, which had certainly reduced the volume of business. One cause would remain, but the other, there was every reason to hope, would pass away. The American cable from San Francisco to Honolulu had been extended to Manila, and the Company was now interchanging traffic. The United States, by the arrangement, had obtained access to the Far East, and the Company had obtained another route to Europe. The decision arrived at during the sittings of the International Telegraph Conference, recently held in London, not to make the "official vocabulary" compulsory, ought to put an end, once and for all, to the constant disputes between the telegraphing public and the cable companies as to the admissibility or otherwise of doubtful code words. Under the new arrangement such words, which might be real or artificial, must be composed of syllables capable of pronunciation according to the eight authorised languages, and the words must not exceed 10 letters according to the Morse alphabet. Combinations not fulfilling these conditions would be considered as letter ciphers, and would be charged accordingly—namely, at the rate of five letters per word.

The **Marquis of Tweeddale** seconded the motion, which was carried unanimously.

WEST INDIA AND PANAMA TELEGRAPH.

The ordinary general meeting of the shareholders in this Company was held at Winchester House, E.C., on Wednesday, Mr. Walter Bishop Kingsford presiding.

The **Chairman,** in moving the adoption of the report, said the total receipts showed an increase over the corresponding half of last year of £5,933. That increase was entirely due to a windfall of abnormal traffic which came upon the Company's line in consequence of interruptions to two French companies' cables. Those cables had now been repaired, and since the middle of October that source of revenue had ceased. The political events and possibilities in Panama should certainly mean additional business for the Company's line to Colon. It was the policy of the Board to pay off the arrears of dividend on the first and second preference shares when there were available profits. On Aug. 11 a cyclone swept Jamaica, and the damage to property was enormous. The Jamaican Government's land lines had been wrecked, and the Company's land lines blown down. The Company's cable house at Holland Bay was blown away and the cables dislodged. The Company's clerk at that station had, however, connected the cables up on the beach and saved delay. Such events were continual reminders of the fact that the maintenance of telegraphic communication throughout the West Indian colonies was not an easy business. Considerable trouble had lately been experienced with the cables from Trinidad to Demerara. A large sum had been spent in repairing one cable, and there would come a time when the Board would have to consider whether it would be justified in endeavouring to put that cable in working order. Three sections of the Company's system had remained unrepaired since the Martinique disaster. The repairing ship which endeavoured to repair them had nearly been destroyed, so that the completion had been postponed for more peaceful times. The repairs would be started in a very few days. Efforts were being made to revive the cotton industry in the West Indies, and the successful establishment of an improving industry could hardly fail to bring traffic to the Company.

The report was adopted.

CONTRACTS FOR ELECTRICAL SUPPLIES.

Erith.—The Council invite tenders for the wiring and fitting of premises.

Dorchester.—The Town Council invite tenders for electric lighting. Tenders by Nov. 26.

Preston.—The Borough Council require tenders for switchboards, etc. Tenders by Dec. 12.

Newport (Mon.).—The Borough Council invite tenders for three 50-h.p. motors, etc., by 23rd inst.

Pontypridd.—The District Council invite tenders for the supply of six single and six double-deck electric cars.

Middlesbrough.—Tenders are required by the Corporation for dynamos, boilers, and condensers, by 28th inst.

Brussels.—The Belgian State Railways require tenders for four lots of telegraph poles (specification No. 217). Tenders by Dec. 23.

Maidstone.—The Corporation invite tenders for the construction and equipment of light railways. Tenders by Dec. 7. See advertisement.

Canosa di Puglia (Italy).—The Municipality will receive tenders for installing and working electric lighting for 50 years. Tenders by 30th inst.

Witton (Birmingham).—Messrs Kynoch, Limited, invite tenders for electrical supplies for six or 12 months from Jan. 1, 1904. Tenders by 20th inst.

Hornsey.—The District Council invite tenders for one 300-kw. steam dynamo to be delivered in October, 1904, and another in March, 1905.

Dudley.—The Guardians invite tenders for the supply and fixing of the various appliances for the electric installation to the laundry and boiler house.

Windsor.—The Town Council invite tenders for the supply of electricity or gas for the purpose of public lighting throughout the district for a period of five years.

Wood Green.—The Urban District Council invite tenders for the erection of a power station and the buildings in connection with the Council's electric lighting scheme.

Rangoon.—The Municipal Committee have decided to call for amended tenders for the electric lighting of the town on a continuous-current system. Five tenders were received for the first call.

Batley.—The Town Council invite tenders for the erection of building for refuse destructor. Specifications, etc., may be obtained from the Borough Surveyor, Branch-road. Tenders by 30th inst.

Greenwich.—The London County Council invite tenders for six electrically-driven three-throw boiler feed pumps. Specifications, etc., at the County Hall, Spring-gardens, S.W. Tenders by Jan. 19.

Greenwich.—The London County Council invite tenders for the supply delivery, and erection of four 3,000-kw. generators with exciters. Tenders by 10 a.m. on Dec. 8. See advertisement in last issue.

Wisby (Sweden).—Tenders are invited for a private and public electricity supply estimated to cost 180,000 kroner. Particulars may be obtained from the Director of the Draetselkammaren at the above place.

King's Norton and Northfield.—The Council invite tenders for the erection of car-sheds and waiting room. Tenders by 30th inst. to Mr. Edwin Docker, clerk to the Council, 10, Newhall-street, Birmingham.

Sydney (N.S.W.).—Tenders are asked for the supply of continuous and alternating current meters. Specifications, conditions, and forms of tender are obtainable from Messrs. Preece and Cardew, 8, Queen Anne's-gate, S.W.

London, W.—The Great Western Railway Company invite tenders for the supply, delivery, and erection of water-tube boilers, engines, three-phase generators, and auxiliary plant at Park Royal, near Acton. Tenders by Dec. 7.

Kirkcaldy.—The Corporation invite tenders for one about 400-kw. combined steam-engine and dynamo for lighting or traction (vertical triple-expansion or three-crank compound and multipolar generator). Tenders by Nov. 23.

Cape Town (South Africa).—The Directors of the Cape Town Industrial Exhibition (International) invite offers for lighting the grounds, etc. Tenders to Palmerston House, Old Broad-street, London, E.C. See advertisement in last issue.

London County Council Tramways.—The Council invite tenders for the wiring and fitting for electric lighting of five sub-stations and three car-sheds in connection with the tramways. Tenders by Dec. 5. See advertisement in last issue.

Swindon (Wilts).—The Corporation invite tenders for complete traction switchboard cables, etc. Specifications, etc., may be obtained from Messrs. Lacey and Sillar, 78, King-street, Manchester, and 2, Queen Anne's-gate, Westminster. Tenders by Nov. 23.

Dartford.—The Metropolitan Asylums Board invite tenders for installing a complete system of telephones at the Darenth Asylum, Dartford, Kent. Specifications, etc., may be obtained at the office of the Board, Embankment, E.C. Tenders by 10 a.m. on Nov. 17.

Glasgow.—The Corporation invite tenders for the electric light installation, etc., for Anderston District Library. Specifications, etc., may be obtained from Messrs. Paterson and Stewart, architects, 14, Blythswood square, Glasgow. Tenders by 10 a.m. on 17th inst.

Brighton.—The Council invite tenders for six water-tube boilers; a system of steam, exhaust, feed, blow-off, and suction pipes; and

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cast-iron storage tanks. Specifications, etc., may be obtained from Mr. Francis J. Tillstone, Town Hall, Brighton. Tenders by Dec. 7.

London, N.—The Hornsey Urban District Council invite tenders for the supply of meters, indicators, and consumers' fuse boxes. Specifications, etc., may be obtained from Mr. Norman Staniland, Electricity Works, Tottenham-lane, Hornsey. Tenders by 30th inst.

Todmorden.—The Corporation invite tenders for one Lancashire boiler, two steam dynamos and balancer booster, two feed pumps and one injector, economiser, surface or jet condenser, switchboard and instruments, storage battery, cable work, and overhead hand crane

Christchurch (New Zealand).—Tenders are invited for the complete installation of electrical tramways, other than buildings Specifications, etc., may be obtained from the Agent-General for New Zealand, Victoria-street, S.W. Tenders by March 17. See advertisement.

Dublin.—The United Tramways Company invite tenders for the supply of general stores, including car fittings, iron, steel, castings, oils, paints, glass, brushes, ironmongery, harness materials, electrical supplies, timber, etc, for year ending Dec. 31, 1904. Tenders by 30th inst.

Barrow-in-Furness.—The Corporation invite tenders for the completion of the electric lighting installation at Hawcoat and Walney police stations and the pig slaughtering hall and lairage at the public abattoirs. Further particulars may be obtained from the Borough Engineer.

Belfast.—The Committee invite tenders for the supply and erection of a complete heating and ventilating system, including steam boilers, heaters, etc., engines, blowers, and electric fans. Tenders by Dec. 4 to Messrs. Young and Mackenzie, architects, Scottish Amicable Buildings, Belfast.

Warrington.—The Cheshire Lines Committee invite tenders for telegraph materials, steel fishplates, creosoted sleepers and crossing timbers, and oak keys. Specifications, etc., can be obtained from Mr. S. Saxon Barton, stores superintendent, Cheshire Lines, Warrington. Tenders by 10 a.m. on 27th inst.

Culiacan (Mexico).—Tenders are invited for lighting the town by electricity: 60 arc lamps of 1,200 c.p. and 110 incandescents of 50, 30, and 16 c.p. will be required. Propositions will be received by letter until Dec. 31 in the Secretaria del Ayuntamiento, Culiacan, where further information may be obtained.

West Ham.—The Education Committee invite tenders for the electric wiring and fittings and for the hot-water heating apparatus required at the Whalebone-lane Higher Elementary School, Stratford, E., and Shipman-road School, Custom House, E., now in course of erection. Tenders by Dec. 14. See advertisement.

Halifax.—The Tramways Committee invite tenders for the execution of the mason, carpenter and joiner, slater, plumber and glazier, and painter's work required in erection of a sub-station at Hipperholme. Specifications, etc., from Mr. James Lord, C.E., Town Hall. Tenders to the Town Clerk by 20th inst.

Madrid.—The Government have issued an order granting an appropriation of 6,000 litres of water per second from the River Tea, in the municipal boundary of Mordariz, province of Pontevedra, for the production, by a fall of 6·40m., of electrical power for industrial uses, for which water power electric plant will be required.

Glasgow.—The Directors of the Caledonian Railway Company invite tenders for the supply of telegraph appliances, etc, and electric lighting material and fittings. Specifications, etc., may be obtained from Mr. Jas. Lorrimer, stores superintendent, Caledonian Railway, Charles-street, St. Rollox, Glasgow. Tenders by 23rd inst.

Handforth (near Manchester).—The Guardians of Chorlton-upon-Medlock Union invite tenders for an electric motor for the new laundry at Styal Cottage Homes, Handforth, near Manchester. Specifications, etc., can be obtained from the consulting electrical engineer, Mr. G. R. Peers, A.M.I.E.E., 16, John Dalton-street, Manchester.

Sydney (New South Wales).—Tenders will be received at the office of the Deputy Postmaster-General, Sydney, New South Wales, up to 2.30 p.m. on Dec. 30, for the supply and delivery at the departmental stores, Sydney, of telegraph, telephone, and electric light material. Specifications, etc., may be seen and tender forms obtained at the General Post Offices, Sydney, Melbourne, Brisbane, Adelaide, Hobart, and Perth.

Colombo (Ceylon).—The Government of Ceylon invite proposals from persons willing to enter into a contract for the supply of electrical energy to the various offices, buildings, and premises of the Government, within the Municipality of Colombo, for a term of years commencing on or about Aug. 1, 1905 Proposals must be delivered at the office of the Colonial Secretary, Colombo, by Dec. 1. The *Ceylon Government Gazette* containing above notice may be seen on application at the Commercial Intelligence Branch of the Board of Trade, 50, Parliament-street, S.W.

RESULTS OF TENDERS.

Kingston.—The Council have ordered 500 demand indicators from the Schattner Electricity Company, at an estimated cost not exceeding £800.

Preston.—The Town Council have accepted the tender of Dick, Kerr, and Co., Limited, at £80,592, for the permanent-way construction and overhead equipment of the electric tramways.

Hanley (Staffs).—The Hanley, Stoke, and Fenton Joint Hospital Board have accepted the tender of G. A. Steinthal, Cooper-street, Manchester, at £484. 15s. 6d., for additions to the electric lighting.

Sydney.—The Railway Commissioners require tenders for the supply and laying of 12 miles of electric cable. Particulars may be obtained from the Electrical Engineer, 51, Phillip-street, Sydney, N.S.W. Tenders by Jan. 11, 1904.

Walsall.—The tender of the Walsall Electrical Company, Limited, for the lighting of the Butts-road, Sandwell-street, Cross-street, and Rushall-street sub-stations, for the sum of £21. 10s., has been accepted. Instructions have been given for the economiser supplied by Messrs Green to be insured for the sum of £ 00.

Northfleet (Kent).—The contract for a complete installation of electric lighting and power arc lamps pumping plant etc., with all necessary wiring, for Messrs. Tolhurst and Son's cement works at Northfleet, Kent has been awarded to the British Westinghouse Electric and Manufacturing Company, Limited, London and Manchester

Kilmarnock.—The Electricity Committee invite tenders for work required in connection with the proposed new generating station and tramcar shed: (1) carpenter, joiner, and glazier's work; (2) slaters' work; (3) plumbers' work; (4) plasterers' work; and (5) painters' work. Specifications, etc., from Mr. Robert Blackwood, Market Bridge, Kilmarnock. Tenders by 27th inst.

Glasgow.—For the wiring of various installations, for the Scottish Office of the May-Oatway Fire Appliances, Limited, the successful contractors are the National Telephone Company and McAulay, Clark, and McLaren, for internal wiring. The brigade connections have been secured by the National Telephone Company and by the Glasgow Corporation Telephone Company respectively.

London County Council.—Amongst the accepted tenders for the supply of stores during 1904 we note, under engineers' goods and electrical stores, the names of A. Wilson and Co.; Buck and Hickman, Limited; Mosers, Limited; Jukes, Coulson, Stokes, and Co.; P. and W. Maclellan, Limited; James Gibb and Co.; M. Wilson and Co.; G. Braulik; Stewarts and Lloyds, Limited.

Johannesburg.—The Middlesbrough Chamber of Commerce have received a communication from Mr. Feethams, town clerk of Johannesburg, giving the reasons which influenced the Town Council to accept tenders for rails not of British manufacture for their tramways. Nineteen tenders were received, and of the ten lowest five were for Belgian rails, three for German and two for British. The lowest Belgian tender was £27,382, or with 2½ per cent. import duty £29,102, and the lowest English was £32,525. The Brush Electrical Engineering Company, Limited, it will be recollected, was declared the successful tenderer, some time ago, for steel grooved rails and steel Vignoles rails. The amount of their tenders was approximately £75,000. The tenders are in the market again, and the explanation given by the town clerk is in the following terms: "The reason for fresh tenders being called for is that the Brush Company have exercised their right to withdraw, the time for which their tender was open having expired prior to the acceptance by the Town Council." Further details of the plant appear in another column.

BUSINESS NOTES.

TRACTION.

Gosport.—The laying of the electric tramlines will be started in this district on March 1 next.

Bexley.—Automatic signalling is employed on the new electric tramway system in this district.

Wolverhampton.—The tramway extension up to the Fighting Cocks along Dudley-road has been commenced.

India.—We learn that the Calcutta Tramways Company are competing with Messrs. Kilburn and Co. for the tramway concession at Howrah, in India.

Slough.—The London United Tramway Company propose to apply to Parliament in the ensuing session for powers to lay tramways along certain roads and streets in Slough.

Devonport.—The Corporation Tramways Committee have referred to a sub-committee the question of the construction of a light railway from the borough boundary to Crownhill.

St. Marylebone.—By 30 votes to 29 the Borough Council at their last meeting decided to abide by their previous decision against the construction of tramways in Edgware-road.

Bradford.—During the past year the route length of the Corporation tramways has been increased from 39 miles to 45 miles, while the car mileage has increased by 1,719,898 miles.

Clay Cross.—In reference to the proposed tramway from Chesterfield to Alfreton, it was decided at the last meeting of the Urban District Council to give their general approval to the scheme.

Benwell.—The Tramways General Purposes Committee of the Newcastle Corporation have had an interview with the Urban Council regarding the proposed extension of tramways in that locality.

Baker-street and Waterloo Railway.—This Company will promote a Bill in the next session authorising them to compulsorily purchase lands to enlarge their tunnels for station purposes, etc.

Swansea.—The Board of Trade have appointed Major Druitt to hold an enquiry with reference to the proposed tramway in Oxford-street and Temple-street, when the objections of the tradesmen will be heard.

Bristol.—An electric tramway car in Bristol on Saturday dashed into another car. A driver sustained serious spinal injuries, and a cyclist who was unable to get clear had his left foot completely severed.

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Wardle.—A special meeting of the Urban District Council has decided to make application to the Board of Trade for a provisional order authorising the construction of electric tramways by the Council.

Derby.—The work of laying down the electric tramways system has commenced. The Alvaston route is the first to be converted, and every effort will be made to get the scheme now in hand completed by the end of March.

South London "Tube."—This line intends to commence the issue of monthly season tickets. It is understood that this action on the part of the company is attributable to the severe competition of the electric tram service.

City and North-East Suburban Electric Railway Bill.—The promoters of this Bill have "reluctantly come to the conclusion that it is to the best interests of all concerned to defer the redeposit of the Bill until the 1905 session of Parliament."

Finchley.—At the last meeting of the Urban District Council the surveyor reported that the contractors were making fair progress with the work of light railway construction in the district considering the extremely wet weather they had had to deal with.

Macclesfield.—The promoters of the Macclesfield and district tramways scheme intend to submit to Parliament in the ensuing session a Bill authorising the carrying out of the scheme which will be identical with the scheme submitted to Parliament last year.

Auckland (N.Z.).—The Auckland Electric Tramways Company have given an undertaking to the City Council that they will not run trams during the church hours on Sundays for the first 12 months after receiving powers, nor thereafter without a special poll of the citizens.

Woking.—The tramways scheme, as finally amended, came before the Urban District Council at their meeting last week, when it was stated that the Council's terms have been accepted by the promoters, who will at once proceed to apply for the requisite Board of Trade order.

Upholland.—A committee of the District Council has been appointed to negotiate with the Wigan Corporation for their consent to pay the cost and expenses to be incurred in connection with an application for a tramway provisional order, and to take over the order when obtained.

Crewe.—The Town Council have withdrawn their consent to a private company proceeding with a scheme of light railways for the borough, and have given notice that they intend to apply to the Light Railway Commissioners in May for sanction to an amended scheme of their own.

Paddington.—A committee of the Borough Council, to whom the matter was referred, recommend the latter to adhere to their resolution of June 9 last dissenting from the electric tramway projected by the London County Council from the Marble Arch, along Edgware-road, to Cricklewood.

Prestwich.—Salford has applied to the District Council for a formal extension of the time within which the Corporation had agreed to construct a tramway to connect the tramway in Bury Old-road with that in Bury New-road. An extension of six months from Aug. 1, 1903, has been granted accordingly.

Gloucester.—An interesting ceremony took place in Bristol-road, just beyond the Nelson Foster Memorial, on Monday, when the Mayor in the presence of a large number of the "City Fathers," ratepayers, and others, commenced the preliminary work in connection with the laying down of the new electric trams.

South Lancashire.—In the near future it will be possible to travel the entire distance between Manchester and Liverpool by tramcar. Already the necessary surveys have been completed by the South Lancashire Tramways Company, and the lines to join up all the towns *en route* will have a total length of over 80 miles.

Elsenham, Thaxted, and Bardfield Light Railway.—The Treasury will make a further grant of £2,000, in addition to the sum of £19,250 already promised towards the expenses of this scheme, on the understanding that this contribution is final, and that the balance of the amount still required will be raised by local effort.

Todmorden.—At a Local Government Board enquiry at Todmorden relative to the application by the Corporation for borrowing powers for electric lighting and power purposes and refuse destructor, it was stated that there was no intention of laying electric tramways at present, but something might be attempted in the way of electric omnibuses.

Hamilton.—At the monthly meeting of the Town Council last week a motion to approach the Lanarkshire Tramway Company for extensions of their lines down Union-street and up to Lowwaters, connecting with the existing tramway route at the Old Cross, was discussed. Eventually the committee were asked to report as to probable cost, etc.

German Rails.—The question of the use of German tramway rails by the Birmingham Corporation came up for consideration at a meeting of the St. George's Ward Conservative Association on Thursday last week, and a resolution was passed to the effect that German rails, even if purchased at a slightly reduced cost, should not be accepted in Corporation contracts.

Manchester.—The proposed new lines of tramways in respect of which powers will be sought next session, as mentioned in our last issue, are as follows: Parker-street and George-street (behind the Manchester Royal Infirmary); Victoria-avenue, between Rochdale-road and Middleton-road (when constructed); Bradford-road (the newly-formed portion); Mill-street, Ancoats.

Leamington.—Communications are passing between the Town Council and the Leamington and Warwick Tramway Company with reference to the system of traction to be adopted in the town. The company are in favour of the overhead trolley, and in the event of this being finally decided on, the Town Council are insisting on a particular form of construction being carried out.

Portsmouth.—At the last meeting of the Town Council the Tramways Committee balance-sheet for the past year was considered, and the committee recommended that the balance on the year's working be called the tramway reserve fund, and that it be left to the Finance Committee to invest. It was stated that there was a balance in the committee's favour of £6,918. The proposition was agreed to.

Greenock.—At the Corporation meeting on Tuesday an amended plan was approved of a "combination" car proposed to be used by the Greenock and Port-Glasgow Tramways Company. In this car there is accommodation for 20 passengers inside and also for five outside seats at each end, a total accommodation for 30 passengers. The cars will be in addition to and not in substitution for the present rolling-stock.

Liverpool and Manchester Electric Railway Project.—It is reported that fresh negotiations are on foot, as the result of which it is hoped to secure the whole of the capital required for the construction of the Manchester and Liverpool Electric Express Railway. It may be mentioned that the expenses in connection with the recently attempted flotation of the Mono Railway Company amounted to something like £18,000.

Newcastle.—The City Council on Wednesday approved a scheme for carrying the tramway system to Blaydon, a village in Durham, the estimated expenditure being £46,000. It was stated that it was proposed to set up a competitive system to the railway company. The Council afterwards, at a special meeting, considered the advisability of promoting a Bill in Parliament for various public improvements, including the construction of additional tramways both in Northumberland and Durham.

Bishop Auckland.—A movement is on foot to secure a system of electric trams for this district, and application is to be made for powers for the construction of lines from Bishop Auckland to Spennymoor, to Eldon-lane, to West Auckland, and to Etherley. Agreement has been given by the local authorities concerned not to oppose the application for powers, as the lines will give easy access to Bishop Auckland, the business centre of a very considerable population, and it is proposed to obtain the money by local subscription.

North-East Lancashire.—A scheme is being prepared for a light railway between Blackburn, Whalley, Burnley, and the intervening townships. Application is to be made to construct a line between Blackburn and Preston, and for a line between Preston and Lytham. If the schemes are carried out in their entirety, there will be an unbroken line of tramways and light railways from Fleetwood and Blackpool on the one hand to Rawtenstall in the Rossendale Valley on the other—a distance of over 60 miles.

Stirling.—At the Town Council meeting on Monday it was reported that Prof. Kennedy's report upon the electrification of the tramway system in the event of its being purchased by the Corporation had been received. The committee dealing with the subject was authorised to enquire as to the conditions upon which the tramway company would part with their undertaking, and also approach the Town Council of Bridge of Allan and the Central District Committee of Stirlingshire as local authorities interested.

Blaydon.—On Friday last a deputation from the Newcastle Corporation paid a visit to Blaydon, where they met a deputation from the local Council with respect to the proposal of the Corporation to extend their tramlines to Blaydon. Plans were submitted showing the suggested route, *via* Scotswood Suspension Bridge, and continuing along Church-street, Garden-terrace, returning by way of Tyne-street. The deputation expressed their intention of commencing the work immediately upon receipt of the necessary powers. The estimated cost is about £47,000.

Wallasey.—A meeting of the Town Council has been held this week, at which it was decided to promote a Bill in Parliament seeking powers for tramway extensions involving a cost of £181,000. The proposed extension is to Wallasey and Poulton. It is estimated the new tramways will cost, inclusive of electrical equipment, £65,000, the road widening and other improvements are calculated to cost £100,000, and the car-shed extensions and additional cars £16,000, the total being £31,000 more than the total expenditure on the three existing routes.

Soothill Upper.—With respect to the electric tramways scheme, it was reported at the last meeting of the Town Council that the circular system from Dewsbury, by way of Leeds-road, Hanging Heaton, and Crackenedge, back to Dewsbury, was not possible because of the enormous expenditure necessary to deal with certain property. It was suggested that trams might be run from Dewsbury, by way of Leeds-road, to Chidswell, but ultimately it was decided to refer the whole subject, including the discussion as to mode of application for an order, to a committee.

Flintshire.—At the fortnightly meeting of the Holywell Rural District Council on Friday, the Clerk stated that a meeting had been held at Mold to consider how far the Flintshire electric tramway scheme would benefit the Halkyn district. At that meeting a suggestion was made that the line, instead of following the main road from Holywell to Northop, should take the top road and go right through the heart of Halkyn district, tapping the lead mines and quarries and affording means for the conveyance of their output. It was decided that this suggestion should be thrown out to the promoters.

Torquay.—Notwithstanding their avowed intention of "abandoning the business," as mentioned in our last issue, the Dolter Electric Traction Company are taking the necessary steps for an application to Parliament for powers in the next session. A representative of the company has returned to Torquay and the posting has taken place of the necessary statutory notices in the streets. In regard to the draft

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agreement as between the company and the Corporation—some rather stringent clauses in which are believed to have led to the temporary cessation of the negotiations—this document is now under the consideration of the board of directors.

Leicester.—It was announced at the last meeting of the Leicestershire County Council that the negotiations with the Corporation of Leicester respecting the construction and leasing of the two lengths of light railway (the one to Oadby 7 furlongs 5 chains, and the one to Thurmaston 1 mile) had fallen through, as the Corporation were not now prepared to carry out the suggested arrangement which was set forth in the report presented to the Council at the May meeting. The reason for the dropping of the scheme, we understand, is that a substantial increase has been made in the estimate of cost—viz., from £16,000 to £21,000. The report was adopted.

Glasgow.—It was agreed at a meeting of the Parliamentary Bills and Tramways Committee on Monday to apply for a provisional order for several extensions of the electric tramways system. The proposals include the construction of a line from Pollokshaws West to Thornliebank, thence along the Busby-road to Giffnock, and along the Kilmarnock-road from Giffnock, joining the existing system at Pollokshaws East. Another extension is from Maryhill to Bearsden and Milngavie. The question of extending the Thornliebank line to Barrhead is also being considered. The extensions from Crookston to Paisley and the Cambuslang line will be opened for traffic within a few days.

Mid-Cheshire.—In the next session of Parliament powers are to be asked for to take over the Stockport and Hazel Grove system of electric tramways and to extend it from Hazel Grove on to Macclesfield by way of Adlington, Poynton, and Butley, skirting Prestbury. The system will run on to Broken Cross at Macclesfield. and it is proposed also to establish an electric car system in that borough. The present line from Stockport to Hazel Grove is four miles in length, and under the new scheme 14 miles will be added. If the scheme is carried out, there will be a practically continuous line of tramway from Manchester to Macclesfield, through some of the prettiest of the Cheshire country.

Bingley.—At the last meeting of the District Council it was reported that a representative of the company promoting the Mid-Yorkshire tramways scheme had been in negotiation with the Council with a view to the extension of the period during which the Bingley portion of the tramways is to be worked by the company. The Act fixes the period at 30 years, and the Council were asked to extend the time to 42 years. The Finance Committee recommended the Council to extend the lease to 35 years, on the understanding that the construction of the Bingley portion of the line should be taken in hand in the early part of next year, and the line should be laid as far as the bottom of Morton-lane. This course was agreed to.

Cardiff-Penarth Railway.—The Penarth Tramway Syndicate will apply in the next session of Parliament for a provisional order to enable them to construct a tramway line between the Grangetown Bridge and the post office, Penarth. The line will be a single one with passing places, and the cost, including the widening of the road at Cogan Hill and purchasing the whole of the thoroughfare, now vested in Lord Bute, is roughly estimated at about £100,000. Before the proposal comes under the consideration of a Parliamentary Committee, negotiations will be opened by the syndicate with the Cardiff and Penarth Councils, whose co-operation and support, it is hoped, may on certain conditions be secured.

Yarmouth.—On Tuesday a special meeting of the Town Council decided to promote a Bill in the next session of Parliament to empower the Corporation to make and maintain tramways within and without the borough, and particularly across St. Peter's-road, along Blackfriar's-road, Camden-road, across Queen's-road, along Admiralty-road, Barrack-road, South Denes-road, Caister-road, Regent-road, Hall Quay, the Haven Bridge, Bridge-road, Southtown, Southtown-road, Lowestoft-road, Feathers Plain, Baker-street, the Plain, Pier Walk, Pier-road, and the road on the north of the Gorleston Beach Gardens; to empower the Corporation to construct a transporter bridge across, and a subway beneath, the Haven, and for other purposes.

Additional Traffic Returns.—Anglo-Argentine, £1,984 increase; Barcelona Ensanche y Gracia, £136 increase; Barcelona, £7 decrease; Brisbane, £99 increase (month of August, £11,736, increase £294), British Columbia Electric (month of March), gross earnings £10,352, net income £2,659; Buenos Ayres and Belgrano Electric, £307 increase (month of October, £14,055, increase £1,002); Calcutta, £384 increase; Cape Town (month of October), receipts £16,229, expenditure £9,044; Isle of Thanet Electric, £46 decrease; Lisbon Electric (month of October), receipts 93,725 milreis, expenses 50,350 milreis; Mexico Electric (month of August), receipts £48,600, expenses £27,900; Perth Electric, £170 increase; Port Elizabeth (month of October), receipts £3,972, expenditure £2,879.

Plymouth.—The Borough Council are considering the expediency of an application to the Board of Trade for a provisional order empowering the Corporation to construct and maintain four short lines of tramway. The first three lines are in connection with the new road which is being cut from Old Town-street, through Garden-street, and into Tavistock-road. The proposed fourth line is from the boundary of the borough in the Saltash-road at Pennycomequick, up through Caprera-terrace, Torrington-place, and North road. The greater portion of this is already laid for horse traffic, but has not been used for several years. It is proposed to electrify the system, and by this means join up the Devonport and district trams at Stuart with the Corporation trams to Compton, and at the other end to the other Plymouth centres and termini.

Ipswich.—An inspector of the Board of Trade will visit the town to-day (Friday) for the purpose of inspecting the new electric tramways, and it is hoped that sanction will be given for the public opening to take place on the following day. The Electric Supply and Tramways Committee report that the by-laws made by the Council on Aug. 12 last have been allowed by the Board of Trade, and are now in force in the borough. Having regard to the trolley wires, which have now been placed in many highways in the borough, the committee are of opinion that it is advisable that the Council should take the necessary steps to adopt Part 2 of the Public Health Acts Amendment Act, and so be in a position to exercise control and supervision over any wires or apparatus which private persons or companies might desire to put up above, along, or across any street in the borough.

Preston.—The tender of Messrs. Dick, Kerr, and Co. for the permanent-way construction and overhead equipment of the new electric tramways again came up for acceptance at the meeting of the Town Council on Thursday last week. It will be remembered that at the previous meeting the matter was referred back to committee on account of some misapprehension as to who were to be the sub-contractors for points and crossings. Last week it was stated that the specification included British and American rails, but out of the total sum of £80,592 £77,500 odd would go for British material and British labour, while only £3,000 worth of material would come from America. Messrs. Dick, Kerr, and Co. have further agreed to sublet a portion of the special work included in the £3,000 to a British firm and part to the Lorain Company, the American firm. On this understanding the tender was accepted.

London United Tramways.—A new Bill is to be promoted by the London United Tramways Company in the next session of Parliament. The company propose under the Bill to secure powers to construct new tramways in Middlesex, Bucks, and Surrey, to obtain special provisions as to compensation for lands taken, and to extend the time for compulsory purchase of lands and for completion of authorised tramways. The proposed new lines are intended to form an extension of the company's system in the Brentford, Hounslow, and Ealing districts, and to continue the tramways into Bucks. The following parishes will be served by the new lines: East Bedfont with Hatton, Stanwell, Feltham, Ashford, Staines, Hardmondsworth, Slough, Farnham Royal, Burnham, Taplow, Hitcham, Colnbrook, etc. The scheme involves extensive street widenings in Richmond, Kingston, and Wimbledon particularly.

Dumbartonshire.—The Electric Supply Corporation, Limited, have a scheme for laying down a system of tramways in Dumbartonshire. The company have obtained a lease from the Corporation of Dumbarton for the electric lighting of the burgh, and last session, by consent and under agreement with the Town Council, promoted a provisional order for the purpose of laying down electric tramways within the burgh. This order was passed by the Parliamentary Commissioners at their sittings in July last, and the Bill to confirm same has also passed the committee stage of the House of Commons. In ordinary course, therefore, it will receive the Royal assent early next session. The scheme which is now proposed is of two parts. The first of these will connect the eastern terminus of the burgh tramways with the extension of the Glasgow tramways to Clydebank, and the second will extend the burgh tramways to Balloch.

The Black Country.—The work of electrically equipping the tramways which run through Oldbury to Smethwick, Birmingham, and West Bromwich is being pushed forward rapidly, and it is expected that in a short time a complete service of cars will be running. The section forms part of the circuit by which it is proposed to connect the lines of the old South Staffordshire Tramway Company, which pass through Wednesbury, West Bromwich, and Handsworth to Birmingham, and those of the Birmingham and Midland Tramway Company, which run from Dudley, through Oldbury and Smethwick, to Lionel-street, Birmingham. Already there is a service of cars on the Spon-lane and Bromford-lane routes, and when the junctions at Oldbury Market-place and Spon Croft are finished an important step towards the completion of the system of tramways by which the British Electric Traction Company intend to link together all the large towns in the Black Country with Birmingham will be accomplished.

Llandudno.—At Tuesday's meeting of the Urban District Council the Light Railway Committee reported that they had, subject to the Council's approval, agreed with the light railway company in the event of the Colwyn Bay Council obtaining an injunction restraining the Llandudno Council from supplying electricity to the company outside the Llandudno area, to accept £750 instead of £1,000 as the minimum sum to be paid by the company in any one year. The company having written to suggest that, in the event of any other authority than Colwyn Bay obtaining a similar injunction, the minimum be further reduced to £500, the committee replied that they felt they were restricted from further discussing the question whilst the supplementary agreement they were asked to vary remained unchanged, and suggested that if the company were desirous that such agreement should form the basis for further negotiation they would take immediate steps to effect an exchange. The report was confirmed.

Hammersmith.—The Borough Council have received notice from the London County Council stating that that body has decided to introduce a Bill in the next session of Parliament for powers to construct tramways (amongst others) from Shepherd's Bush-road, along Netherwood-road, Westwick-gardens, Richmond-road, Holland Park-avenue, High-street, Notting Hill, and Bayswater-road, to a point near the Marble Arch. A letter has been received from the Board of Trade, dated the 4th inst., transmitting a copy of the revised regulations it has made with respect to the use of electrical power on the London United Tramways and Light Railways, in the form in which it is proposed to issue them in the next few days. The regulations are based on those at present in force, the principal alterations being with regard to the limit of speed at which the tramcars shall be driven in certain specified streets. The Hammersmith Council are of opinion that advantage should be taken of the revision of the regulations by endeavouring to obtain an addition to No. 8, so as to provide that conspicuous notices shall be fixed on the bridges under which the tramcars pass cautioning passengers on the cars against rising from their seats or standing upright when approaching or passing under

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bridges. A representation is to be made to the Board of Trade to that effect.

Johannesburg.—Contracts are about to be awarded for the power-house, equipment, etc., for the extensive electric traction system to be constructed in Johannesburg, South Africa. There are two sets of specifications, one calling for gas-engines and the other for steam-engines to operate the road. The boiler capacity of the plant will be somewhat over 10,000 h.p. The specifications call for a gas plant capable of gasifying 7½ tons of coal per hour, with coal conveyor, cleaning and cooling plant, and accessories; four gas-engines, each to drive a 1,350-kw. dynamo; three gas-engines, each to drive a 650-kw. dynamo; three gas-engines, each to operate a 675-kw. two-phase alternating-current generator; two motor-generators, each consisting of a 250-kw. two-phase alternator; two dynamos of 150 kw. capacity each; and two 450-kw. dynamos. The specifications for the steam generating plant comprise water-tube boilers of 6,750 kw. capacity, with conveyors, automatic stokers, economisers, condensing plant, engines or turbines, electric generators, motors of before-mentioned sizes. *South African Exports* states that the contracts will be divided between the General Electric and Westinghouse interests in America.

Tottenham Court-road.—One result of the triumph of the Progressives at the recent borough elections in London will probably be the settlement of the Tottenham Court-road tramway difficulty. The County Council desire the extension of the tramway from Euston-road to the Holborn end of Tottenham Court-road, but the Moderates of the late St. Pancras Borough Council resisted this proposal. The County Council have submitted their scheme to the new Council which, the *Daily News* anticipates, being Progressive, will discuss it without any constitutional animosity to trams or to the County Council. Whether this is so or not, we are glad to be able to state that the Borough Council, at their meeting on Wednesday night, reversed the policy of the late Council, and adopted by 36 votes against 20 a resolution giving statutory consent to the construction of the tramway in question. There was an addendum to this declaring that in giving their consent the Borough Council had regard to the views repeatedly expressed by the County Council to the effect that the widening of Hampstead-road and the construction of the tramway along Tottenham Court-road must be considered in conjunction, and that the Borough Council accordingly sanctioned the tramway in the faith that the County Council would at once proceed to put in force the powers granted by the London County Council (Tramways and Improvements) Act, 1902, for the widening of Hampstead-road at the southern end, towards the net cost of which the Borough Council agreed to contribute one-eighth.

East Cheshire.—A new scheme for supplying East Cheshire with electric tramways is on foot. It is proposed to construct a line (10 miles east of Manchester Town Hall) connecting the Manchester, Ashton-under-Lyne, Oldham, Stalybridge, Mossley, Dukinfield, Denton, Hyde, and Stockport electric tramways with the Glossop and Hadfield electric tramways and with the Great Central Railway Company's main line to Sheffield, Leicester, and London at Broadbottom Station, Mottram. A syndicate has been formed for the purpose of obtaining powers under the Light Railway Act, 1896, to carry out a system with Mottram as a centre. It will have a total length of about seven miles, and will provide intercommunication between the towns of Stalybridge, Hyde, Mottram, Broadbottom, Glossop (at Woolley Bridge), Hollingworth, and Tintwistle. The system is divided into three sections—first, Stalybridge and Hyde to Mottram, Hollingworth, and Glossop (Woolley Bridge); secondly, Mottram to Broadbottom; and thirdly, Hollingworth to Tintwistle. The cost of the construction of the complete system is estimated at about £80,000, inclusive of the cost of erecting a power station for generating the electricity. It is, however, not expected that it will be necessary to erect a generating station, as it is probable that power will be obtained from one or more of the adjacent local authorities or other companies supplying power. In the latter case the estimated cost of construction would be reduced by about £10,000. The local authorities concerned have been approached, and, it is stated, are favourably disposed towards the scheme. The capital of the company will be £80,000, with power to issue debentures for £20,000.

Hayling Light Railway.—Colonel C. F. S. Boughey and Mr. Henry Alan Steward last week conducted an official enquiry at the Town Hall, Portsmouth, with reference to the proposal to construct a light railway from the existing terminus of the Portsmouth Corporation tramways to the point where the ferry now goes over to Hayling Island, and where it is proposed by a syndicate to construct a transporter bridge across the Langstone Harbour channel. Mr. Balfour Brown, K.C., on behalf of the promoters, sketched the company's proposals. He pointed out that at present Hayling either had to be reached by means of a ferry, or by rail *vid* Havant, which meant a journey of 14 miles, which occupied times varying between 53 minutes and 1½ hours. Portsmouth had a population of 200,000 people, and Hayling had a population of 1,700. The transporter bridge was similar to those which had been constructed at Rouen, at Runcorn, which would be opened in March, and at other places. It would offer no obstruction to the waterway. The cars would be worked by electricity, and the conveyor would easily be carried backwards and forwards by the same power. Most of the landed proprietors in Hayling Island were in active support of the scheme. The Portsmouth Corporation, which was an interested party, because their tramways would connect with the proposed light railway, expressed the opinion that it would be a good thing for the town, and had passed a resolution in favour of the scheme. At the same time there were one or two points to be adjusted between the Corporation and the promoters. Mr. Eady, M.I.C.E., who, with Mr Wilberforce Cobbett, of Fareham, is acting as joint engineer to the scheme, said there would be no engineering difficulties. The cost was estimated at about £63,000, including £30,000 for the bridge. Mr. Webster, C.E., gave similar evidence, and Sir William Dupree, ex-mayor of Portsmouth, stated that there was a great need for the bridge, which would provide another ready means of exit from Portsmouth and Southsea. After consultation Colonel Boughey intimated that the Commissioners considered that a public case has been made out, and they were prepared to grant the order asked for.

Rail-Welding at Glasgow.—The Corporation of Glasgow have arranged with the Lorain Steel Company, of America, to carry out the electric welding of their new lines to Paisley and Cambuslang, and also a few short extensions within the city. The distance from Crookston to Paisley is about two miles, and the Cambuslang extension is about the same length. The Lorain Company have also arranged to weld the rails on a portion of the old track. This work is being carried out when the cars are off, between 1 and 5 a.m. The total number of joints to be welded under this contract is about 2,000, the Corporation reserving the power to have up to another 1,000 joints welded. This is stated to be the first trial in Europe of electrically welding rail joints, and much interest is being taken in the process by tramway managers and engineers. On Friday the members of the Tramways Committee of Glasgow visited the scene of operations. The process consists in welding to the web of the rails two rolled-steel splice bars, the projections on which are peculiarly adapted to the purpose of securing a weld between the bars and the rail web. The joint is made in three welds—two outside welds for the purpose of tension; the central weld, which is directly at the union of the rails, for vertical stiffness. The central weld being made first, the bars are heated at the middle and elongated before the ends are welded. On cooling, the contraction of the bars exerts a powerful force to bring the abutting rail ends together. The smallest opening is thus closed, leaving practically no joint at all. The apparatus is mounted on trolley cars of convenient size. A sand blast for cleaning rails and bars precedes the welder. The welder itself consists of an alternating-current transformer, having for its secondary winding a single loop of copper of large cross section, the terminals of which engage the bars on either side of the rail. The terminals are operated by hydraulic pressure. A rotary converter takes the current from the trolley and changes it to an alternating current. Flexible cables connect with the welder transformer. At 500 volts about 250 amperes are taken. This is again transformed to the welding current of about 5 volts and 25,000 amperes. The current is on about two minutes at each weld, and it takes from 12 to 15 minutes to complete a joint. After the metal is brought to a welding heat the current is cut off and the weld, while cooling, is confined under a pressure of about 37 tons. This prevents any deterioration of the metal, and results in a remarkably tough weld, which is not equalled by any other known method of welding. After the welding is completed a surface grinder grinds the head of the rail to a true surface. So far the trials at Glasgow have proved quite satisfactory. In the same city shortly the Thermit process of welding joints will be tried. The experiments will be conducted by the Corporation staff.

London County Council.—Chief discussion at the meeting of the London County Council on Tuesday centred round the question of purchasing the London Southern Company's tramlines from Vauxhall to Camberwell-green and West Norwood. The Highways Committee brought up a supplementary report to that given in our last issue, showing that they have still further considered the matter in the light of reducing the capital cost by adopting the overhead trolley instead of the conduit system. The amount of street widenings could be reduced to a minimum in the case of the employment of the former system throughout. With the conduit system the expenditure in respect of street widenings would be extremely heavy, amounting to about £384,000, which, added to the cost of acquisition and reconstruction, would give a total gross outlay of nearly £700,000, or a total charge to the tramways account of about £430,000. The proposal of the committee now is that the trolley system should be employed on the lines between Stockwell and Camberwell-green and Norwood, and the conduit system only on the line from Stockwell to Vauxhall. This scheme would involve a total gross cost for street widenings of about £129,350, or, after deducting the value of the surplus lands, an estimated net cost of £121,350, while the cost of acquiring the undertaking and reconstructing the lines, including the provision of cars and car-sheds, sub-stations, and all incidental works, is estimated at about £254,000. It is proposed that the net cost of the street widenings should be borne, as regards one-third, by the local authority concerned, the Lambeth Metropolitan Borough Council, the remainder being charged in equal proportions to the tramways account and the account of the improvement. The total expenditure involved therefore, so far as the tramways are concerned, is about £295,000, and the whole outlay will be about £375,000. By the adoption of this plan it will be practicable to arrange for a through service of cars on the conduit system to be run between Clapham-road and Vauxhall, and ultimately over the new Vauxhall Bridge, when completed, to Victoria Station. The committee are of opinion that the lines, when reconstructed in this way, will prove to be self-supporting and there can be no question that they will add very materially to the convenience of the travelling public. The meeting discussed the above proposals at length, the main debate turning on the present depressed state of the money market. Mr. Benn, replying on the debate, stated that the Highways Committee had every expectation of the new line paying 7 per cent. on the investment. A motion to call a statutory meeting of the Council to decide for or against the purchase was ultimately agreed to, with four dissentients, and in the meantime the various local authorities interested will be invited to express their views on the scheme. The meeting afterwards voted a sum of £90,000 for the purchase of rails for the electrification of tramways north and south of the river, the steel market being now very favourable for the purchase. Details of the proposed purchase appeared in our last issue. Owing to the withholding by the local authorities interested of their consents to the construction of certain new lines of tramways, the Council

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decided not to proceed further with the following proposals: Southwark-street (London County Council tramways), at Hop Exchange corner, *via* Stamford-street, York-road, and across Westminster Bridge-road to Lambeth Palace-road; Shepherd's Bush-road, *via* Westwick-gardens, Netherwood-road, Richmond-road, Holland Park-avenue, High-street, Notting Hill, and Bayswater-road, to a point near Marble Arch; Battersea Park-road (London County Council tramways), *via* Battersea Bridge-road, Battersea Bridge, and Beaufort-street, to King's-road, Chelsea; Tooting High-street (authorised London County Council tramways), *via* that thoroughfare to the new county boundary. In connection with the construction of tramways in St. John-street and St. John-street-road, in North London, Messrs. J. G. White and Co. are to proceed at once with the laying of about 160 yards of the proposed lines at the same time as some paving works are being carried out. The estimated expenditure for which the committee asked authority is £2,650. Next week the Council will consider a proposal to spend £35,000 for the rebuilding of the car-sheds at Streatham.

LIGHTING AND GENERAL.

Walsall.—The total number of consumers supplied on Oct. 31 last was 296.

Dartmouth.—The lights on the Embankment are being increased from 50 c.p. to 100 c.p.

Kingswinford.—It is proposed to add 20 25-c.p. lamps to the public lighting in the rural district.

Walmer.—The Urban District Council of Walmer intend to apply for an electric lighting provisional order.

Mirfield.—The Yorkshire Electric Supply Company will be ready to supply electricity by the 1st of next month.

Lowestoft.—The resident electrical engineer is preparing an estimate for the lighting of Denmark-road by electricity.

Exhibition.—It is proposed to hold an exhibition of telegraphy and telegraphic apparatus in Copenhagen in February.

Islington.—Low-tension distributing mains are to be laid in Holloway-road and Hornsey-road at a cost of £118.

Pembroke (Dublin).—The Urban District Council will apply for sanction for £20,000 for electric lighting extensions.

Taunton.—Mr. Sharpe, the assistant electrical engineer, has entered upon his duties. It has been arranged to extend a cable.

Morecambe.—The Electric Light Committee have been requested to make arrangements for the more economical lighting of the borough by arc lamps.

Personal.—Mr. Sidney H. Rhodes, of Morecambe, has been appointed assistant electrical engineer at the Greenhill electricity works, Oldham.

Longford (Leinster).—The Town Council are consulting Mr. McAndrews, of Dublin, on the advisability of adopting electricity for lighting purposes.

Gravesend.—On Saturday night the supply of current failed, but was restored after 10 minutes. All the lights went out and the trams were at a standstill.

Acton.—The Urban District Council have decided on a site for the electricity works at Bradford Park, and have appointed Mr. W. H. Trentham consulting engineer.

Byrnmawr.—The Urban District Council have decided to apply for a provisional order authorising them to supply electric light throughout the urban district.

Leek.—The Electricity Committee have received 70 applications for the appointment of resident engineer, and have selected a short leet of four to attend before the committee.

Todmorden.—Major C. E. Norton has held an enquiry into the application of the Corporation to borrow £21,274 for the purposes of electricity works and £6,000 for a refuse destructor.

Wisbech.—The Town Council have asked Messrs. R. Hammond and Son to visit Wisbech to report upon the subject of electric lighting within the borough, and generally to advise the Council.

Clydebank.—The Clyde Valley Electric Power Company intend to apply for power to provide a supply of electricity for public and private purposes in certain districts, including the burgh of Clydebank.

Wimborne.—The Southern District Electrical Corporation are applying for a provisional order giving them powers to supply the district with electricity. The Council will take no action in the matter.

Morley.—Mr. J. E. Ellis, electrical engineer, in his last report states that the output of electricity during the month ending Sept 30 was 11,679 units, against 8,929 in the corresponding month of last year.

Partnership.—Mr. A. Higgins and Mr. S. Griffiths have entered into partnership to carry on the business of electrical engineers and contractors at 4, Albany-street, Regent's Park, N.W., under the name of Higgins and Griffiths.

Bristol.—Mr. Yabbicom, in his last report, refers to the extension of electric lighting in West-street, Bedminster, and St. Paul's-road and Tyndall's Park-road, Clifton, where many gas lamps will, therefore, be discontinued.

Woolwich.—The Council have informed Major-General Jelf, governor of the Royal Academy, that they are willing to render all facilities possible, and to extend the electricity mains to meet all the further requirements of the academy.

Shildon.—The Urban District Council have decided to obtain a writ claiming specific performance of the agreement and drawings, and also an injunction for restraining the local electric lighting company obtaining current from any other company.

Hammersmith.—Since the last Council meeting 37 additional consumers have been connected, representing a maximum of 1,467 8-c.p lamps; 11 consumers have been disconnected, and the present number of consumers now taking current from the mains is 1,345.

Maidenhead.—Several additions to the public electric lighting were agreed to on Monday. The area of the Council's provisional order will include the parishes of Taplow, Hitcham, Burnham, Cookham, and Bray. There are now upwards of 10,200 8-c.p. lamps applied for.

Frome.—The Urban District Council intend to apply for sanction to borrow £7,100 to carry out the suggestions contained in a report by the Council's consulting electrical engineer, Mr. F. H. Medhurst, with regard to the extensions of the cables and the alteration in the site of the cooling tower.

Finchley.—Councillor Martin has retired from the Electrical Committee owing to pressure of other duties. A mains extension, costing £350, to supply 90 houses has been agreed to. The committee are considering an application from the East Barnet Valley District Council for supply in bulk.

Oban.—The Lorne Combination Poorhouse authorities have asked the engineer to make an inspection of the wiring of the poorhouse, and to certify its completeness. The Town Council, however, do not see their way to let the engineer undertake such work. An extension of cable has been agreed to.

Worksop.—The Urban District Council are making several small extensions and have decided to obtain the following supplies: 500 yards of 30-ampere three-core cable; 50 yards of 250-ampere twin-concentric cable; 50 yards three-core pilot wire; three additional connecting boxes; two spare tubes for economiser.

Torpoint.—Mr. J. Enright's report as to the establishing an electricity supply in the district shows that the cost of an installation as suggested would be about £7,000, and would supply 1,500 8-c.p. lamps alight at one time. Up to the present time, as a result of the canvass of the town, only 500 lights have been applied for.

New Issue.—The Montreal Water and Power Company are issuing £70,000 4 per cent. prior lien gold bonds in registered bonds of £100 each, being part of the total authorised issues of such bonds, ranking *pari passu* to an agregate of £500,000. Messrs. Coates, Son, and Co. are authorised by the company to receive subscriptions.

Llandudno.—The Urban District Council on Tuesday decided to reduce the discount allowed on payment of charges for the supply of electricity from 5 per cent. to 2½ per cent. The prices for current were rearranged as follows: flat rate, 5½d. per unit; maximum demand rate, 6d. and 2d.; where minimum of 15,000 units is consumed, 4½d. per unit.

Wishaw.—In consequence of a report from a committee which recently interviewed the agents of the Clyde Valley Electrical Power Company, Limited, regarding the terms on which the latter were prepared to supply the burgh with power in bulk for lighting and motive purposes, the Council have resolved to apply to Parliament for a provisional order

Dudley.—For the six months ending September last the number of units of electricity generated at the Corporation power station was 600,040. In the corresponding period last year the number was 456,896, or an increase in the six months ending September last of 183,178. The extra monetary value compared with the six months last year amounts to £1,300.

Caerphilly.—The District Council have secured consumers for 2,720 8-c.p. electric lights in Caerphilly, Aber, Senghenydd, and Llanbradach. It would require a consumption equal to 2,000 8-c.p. lamps to ensure the electric light scheme being a financial success. It is proposed to charge 6d. per unit. On Tuesday it was decided to proceed with the order forthwith.

Sales of Plant.—Particulars of a nearly new complete electric lighting plant to be sold by tender by Mr. Ernest Pennington, auctioneer, Railway Station, Richmond, Surrey, will be found in another column, as well as details of a sale by Messrs. Weatherall and Green, 22, Chancery-lane, of plant and stock, comprising the complete equipment of an incandescent electric lamp factory.

Batley.—An enquiry has been held into an application of the Town Council for sanction to borrow £5,000 for the extension of cables for the lighting of the populous districts in the borough. The Corporation have already received sanction to loans for electric lighting purposes of £25,402, of which amount £15,007 have been actually borrowed, leaving unexhausted borrowing powers of £10,334.

Gosport.—At the last Council meeting a letter was read from the Board of Trade with reference to the electric light. It stated, as far as the Board could ascertain, no steps had been taken to carry out the works. The Clerk reported that he had written to the secretary to the Portsmouth Street Tramways Company, who have the work in hand, but no reply had been received. The letter was referred to the Roads and Works Committee.

Harrogate. Two new high-tension concentric trunk mains are to be laid, and tenders invited by advertisement for the work. Extensions to switchboard are to be carried out by Messrs. Ferranti at a cost of £250. Consumers who have electricity meters will now have the same rent free in future. The borough surveyor's plans of proposed extensions to electric light station have been approved, and tenders are to be obtained for carrying out the work.

New Addresses.—The City address of Mr. E. Kilburn Scott, M.I.E.E., A.M.I.C.E., is 13, St. Helens-place, E.C., where he is associated with Messrs. Harper Bros. and Co. in the engineering work of the North Wales Power and Traction Company, the Bath and Sunderland District Electric Tramways, etc.—J. Hopkinson and Co., Limited, Huddersfield, have extended their business, and have now offices and depôts at 41, Bothwell-street, Glasgow, and Royal-buildings, Park-place, Cardiff.

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Yorkshire Electric Power Co.—The first generating station of the Yorkshire Electric Power Company is now in course of erection at Thornhill, and we are informed that a supply of electricity to power users within a reasonable distance of that station will be available on Dec. 1, 1904. The directors have appointed Mr. W. B. Woodhouse, A.M.I.M E., A.M.I.E.E., formerly engineer to the Newcastle Electric Supply Company, Limited, as resident engineer in charge of their business in Yorkshire.

Whitby.—Mr. L. H. King, in addition to his appointment as resident electrical engineer, has been appointed the consulting electrical engineer to the Council. Application is to be made for sanction to the raising of a further loan of £2,000 for the purpose of laying a feeder and for the further extension of cables. It has also been decided to have all the public lamps in the district electrically lighted. The Hotel Metrôpole is to be supplied with current by the Corporation. The Urban District Council have agreed to light the public footpath along the West Cliff top on the overhead wire system at a cost of £81.

Stock Exchange.—The Stock Exchange Committee have ordered the undermentioned securities to be quoted in the official list: Eastern Telegraph Company, Limited, further issue of £44,435 3½ per cent. preference stock; Midland Electric Corporation for Power Distribution, Limited, £250,000 4½ per cent. first mortgage debentures, Nos. 1 to 1,750 of £100 each, and 1,751 to 1,900 of £500 each. The committee has further been asked to allow British Columbia Electric Railway Company, Limited, further issue of 1,500 5 per cent. cumulative perpetual preference shares of £10 each, fully paid, Nos. 51,001 to 52,500, to be quoted in the official list.

Greenock.—Mr. Jas. A. Robertson, burgh electrical engineer, in his last report, states that for the five weeks ended Nov. 7 82,887 units of electricity were generated for private and public supply, an increase of 23,482 when compared with the same period last year, and 77,857 units were generated for traction supply, an increase of 1,831. There are now 353 consumers, 54 more than at this period a year ago. It has been agreed to grant a supply of electricity to the Greenock Foundry Company, to be used when that company's own plant is not working, on condition that a consumption of energy equal to £11 per annum for a period of five years be guaranteed.

City of London.—At the last meeting of the Court of Common Council the Streets Committee brought up a report relative to a letter from the Board of Trade asking the views of the Corporation on an application by the undertakers under the St. Martin's Electric Lighting Order, 1899; the Strand District Electric Lighting Order, 1895; the Holborn and St. Giles's Electric Lighting Order (No. 2), 1898; and the City of London Electric Lighting Order, 1899, for consent to the transmission of energy up to 2,000 kw. in certain trunk mains in the City. It was decided that the Board of Trade should be informed that the Corporation had no observations to offer in the matter.

Steel Rolling.—The *South Wales Daily News* states that, in view of the growth of German and American competition, leading Midland steelmasters are considering the formation of a new steel bar combine, with works of its own in Staffordshire, equipped with latest electrical quick-rolling machinery. The Wolverhampton Corrugated Iron Company, which does a great foreign trade in galvanised sheets, has publicly declared its support, provided that British steel bars can be made in the Midlands as reasonably as Continental makers offer them. Several thousand tons of German steel bars continue to reach various Midland works weekly, where they are rolled into sheets and then galvanised.

Antony.—At the last meeting of the Parish Council the Lighting Committee reported that, having received Mr. Enright's report, they had distributed circulars to householders in Torpoint giving information with regard to electric lighting which had elicited responses undertaking to adopt the system up to the extent of 500 lights. This was independent of the public light. The time for taking the preliminary legal steps this year having passed, the committee recommended that the matter be deferred for further consideration until the formation of the Urban District Council, which body would have larger powers of dealing with the question of lighting than under existing circumstances. The report was adopted.

Exeter.—The Mayor, Mr. F. J. Widgery, on Monday switched on the current at the new electricity works of the Corporation at the Basin. The works will not be completed for some months, but in March the city will be supplied from the new station entirely, and all the work now done at the works at New North-road will be transferred to the Basin works. A portion of the generating plant is already in working order, and will supply current to the city and thereby relieve the heavy load on the station in New North-road. The new station has cost altogether £14,000, and comprises engine-rooms, boiler-room, coal stores, repairing shops, offices, economiser chamber, pump-rooms, etc. There are four sets, three of 550 h.p. and one of 150 h.p.

Bury.—With reference to the report in our last issue, we have received the following additional statistics for the year ended April 1, 1903. The figures in parentheses refer to the corresponding period in 1902: total capacity in kilowatts, 132 (132); maximum load, 108 (65); load factor, 16·4 (12·8); services connected, 139 (103); 8-c.p. lamps, equivalent, 8,197 (5,507); capital invested, £24,853 (£20,376); capital per unit sold, £·14 (£·27); average price obtained per unit, 3·17d. (3·92d.); public lighting price obtained per unit, 1·44d. (1·46d.); total cost, £2,574. 11s. 5d (£1,830. 14s. 4d.); coal, cost per unit sold, ·89d. (1·2d.); work cost per unit sold, 1·95d. (2 92d.); total cost per unit sold, 3 6d. (6d.); percentage of gross profit to capital, 3·81 per cent. (1·69 per cent.).

Ulster Electrical Power Distribution Co.—A company has been formed for the promotion of a scheme to obtain parliamentary powers for the supply of electrical energy upon a large scale over the province of Ulster, utilising water power where it is available, such as the Bann and the Erne rivers, and by the erection, where no water power is obtainable, of generating stations worked either with steam-engines or power-gas engines. This area contains numerous small industrial undertakings which require motive power only for two or three days a week, and to provide the same it is necessary to instal steam-boilers and engines which must necessarily lie idle a considerable time. To such industries a supply of electrical power ready for use when necessary would be productive of the greatest advantage and economy.

Edmonton.—The Works Committee of the Urban District Council reported at the last Council meeting that they had before them the reports of the electrical experts (Messrs. Hammond and Hawtayne) and also proposals from Messrs. Suter and Co., the Sir Hiram Maxim Electrical Engineering Company, the Industrial Engineering Company, and the North Metropolitan Electric Power Supply Company in respect to electric lighting, which were fully considered and discussed. The committee decided to adjourn the meeting for the engineer to obtain further information from the electrical experts, and also certain information from the Enfield District Council. The engineer was instructed to ascertain whether the Board of Trade would extend the time in which the Council are required to lay down suitable and sufficient distributing mains in Fore-street and the Green.

St. Annes.—The recent failure of the electric light has been investigated by Mr. J. H. Clothier, the town electrical engineer, who reports that the excessive rains flooded out one of the street boxes, and on another portion of mains the insulation had broken down and the cable burnt out. There are no traces left to point to the cause of the fault, but Mr. Clothier is inclined to think that the failure at this point was due to the heavy leakage current escaping from the lead covering to the earth through the wood bridge pieces, which do not appear to have been properly treated before laying, and have consequently become saturated with moisture. Mr. Clothier advocates a system whereby three districts should be formed, each to be fed by an independent feeder, so that inconvenience will be minimised should a similar event happen again. The Electric Lighting Sub-Committee have the engineer's recommendation under consideration.

Blackpool.—Mr. C. Furness in his last report states that there has been an increase during October in the works output of 4,828 units, made up as follows: lighting, 1903, 123,010 (1902, 133,631); Corporation trams, 79,074 (68,082); Lytham and St. Annes trams, 6,457—total, 206,541 (201,713). Mr. Furness points out that there is a decrease in the lighting output of 10,621 units, but the reduction in public street-lighting accounts for 4,212 units, and doubtless the autumn fêtes last year were responsible for more units being used than in the corresponding month this year. In answer to the advertisement for 450-kw. traction set, some 32 tenders were received, which were before the committee on Wednesday. The advertisement for offers for the small 50-kw. engines and alternators has only brought in two tenders, but several enquiries have been made, and Mr. Furness anticipates that at the next meeting there will probably be more offers for the plant.

Cheshire Power Scheme.—It will be remembered that last session a North-Western Electricity and Power Gas Bill passed through Parliament. Under this it was proposed to supply Cheshire and parts of Derbyshire, Staffordshire, Denbighshire, and Flint with electricity and power gas from suitable generating stations, and it is now proposed to seek power to carry out the suggestion of the Parliamentary Committee that a separate scheme should be provided for Cheshire. This will give a supply district of about 655,000 square miles, with a population of 827,000. Stations will be erected at Neston, Middlewich, Frodsham, Timperley, Bollington, and Dukinfield. The area to be served is to a large extent an industrial one, and it contains several districts which are essentially manufacturing. In the original scheme some of the stations in Cheshire would have served the contiguous parts of the surrounding counties, but as there will now be two systems it is proposed to enlarge the number of stations in Staffordshire, Derbyshire, and the two Welsh counties.

Burgess Hill Telephones.—On Saturday afternoon the union of Brighton and Burgess Hill in telephonic communication was officially inaugurated at the Burgess Hill Urban Council offices by means of an exchange of greetings between Mr. A. P. Scrase, J.P., chairman of the Urban Council, and Councillor Beryl, at Brighton Theatre Royal. The Mayor of Brighton, the chairman of the Telephone Committee, Mr. D. J. Barnes, engineer and manager, followed suit. The Corporation telephones have over 1,300 customers already, and have received 52 new orders within the last fortnight. They have a large number of orders at Burgess Hill, which they hope to execute within the next few days. The success of the Corporation in getting through to Burgess Hill has been entirely due to the support of the county and urban councils throughout the whole area. Burgess Hill would not have had telephones so cheaply but for the Corporation, and has been extremely lucky in getting such low terms, and they can communicate with National subscribers in any town except Brighton.

Macclesfield.—The following details of the electricity proposals appear in the *Macclesfield Courier*:—Messrs. Crompton: site, Mill-street and Derby-street; total plant capacity, 165 kw. or 2,760 16 c p., or equivalent; gas producers, Crossley's burning anthracite about 27s. per ton; guarantee, 1lb. of above coal per brake horse-power per hour; engines and dynamo, Crossley Crompton, belt driving from horizontal engine; mains, within compulsory area and few streets outside—cables laid and solid; approximate price, £16 000; buildings, no buildings included in above figure. The British Westinghouse Company: site, gasworks yard, fronting Commercial-road; total plant capacity, 600 kw. or 10,000 16-c.p. lamps, or equivalent; gas producers, one of several well-known local makes burning cheap slack about 7s. 6d. per ton; guarantee, 1½lb. of above coal per brake horse-power per hour; engines and dynamos, Westinghouse throughout, vertical engine direct coupled to generator; mains, within compulsory area, and outside where necessary—distributors solid, feeders in pipes; approximate price, £32,000: buildings, all buildings and foundations included in above figure.

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Loughborough.—At a meeting of the Town Council, sitting as the General Purposes Committee, on Monday, the Gas Committee presented a report recommending the adoption of a scheme for the establishment of an electricity undertaking submitted by the engineer, Mr. Charles H. Gadsby. It is proposed to put down a plant of 500 kw. capacity only at first, comprising two sets of 250 kw. each, leaving the 100-kw. set out for the present, but so arranging the buildings as to allow of the 100-kw. set being added when required. The estimate is £28,408. The Council also reported that the plant on the Moor-lane baths site for providing a temporary supply of current to the works of Messrs. Herbert Morris and Bastert, Limited, was in working order by the time stipulated in the agreement with that firm, and is now running and supplying them with the current they require for lighting the whole of their works. The plant was at first worked by men provided by the Brush Company, but an engineer (Mr. G. H. Saunders) recommended by the Brush Company has now been engaged, and has taken charge of the works, and is, with a stoker who has been engaged to assist him, now running the plant, and the men supplied from the Brush Works have been withdrawn. The committee have decided to recommend that the charge to private consumers be—for lighting, 5d. per unit, and for power 2½d. per unit, with a provision for making special terms by agreement with large consumers.

London Gazette.—A receiving order has been made out in the estate of George Neale, electrician, 2, Fulham Palace-road, London, lately trading with another as South-Western Electrical Contracting and Maintenance Company. A general meeting of members of the Imperial Tramways (Old) Company will be held at Clare-street House, Bristol, on Dec. 19, at 12 noon, for the purpose of receiving the liquidator's statement and account. The partnership subsisting between Edward Thacker Mackrill, Edward Samuel Mackrill, and William Henry Mackrill, carrying on business at Aylesbury, Buckingham, as electrical engineers, under the style and firm of E. T. Mackrill and Sons, has been dissolved. All debts due and owing will be received and paid by Edward Samuel Mackrill and William Henry Mackrill, by whom the business will in future be carried on. A general meeting of the Electric Royalties Syndicate, Limited, will be held at 82, Victoria-street, Westminster, on Dec. 18, at 2 p.m., for the purpose of receiving the liquidator's accounts. The partnership subsisting between Albert Lester Taylor, Archie Kelly, and Walter James Hide, carrying on business as consulting electrical engineers at 36, Dale-street, Liverpool, under the style or firm of Lester Taylor, Kelly, and Hide, has been dissolved. All debts due and owing will be received and paid by Archie Kelly and Walter James Hide, who will carry on the business under the style of Kelly and Hide. The partnership subsisting between Haydn Thies Harrison, Frederick Startin Pilleau, and Philip Jefferson Brewer, carrying on business as electrical engineers at 11, Victoria-street, Westminster, S.W., under the style or firm of Haydn, Harrison, and Co., has been dissolved. All debts due to and owing will be received and paid by Haydn Thies Harrison and Philip Jefferson Brewer, who will continue the business.

Dundee.—At Monday's meeting of the Town Council the question of the condition of the electrical supply system was raised, and it was stated that they were about to take steps to borrow a sum of £74,000 to spend upon the electrical system, and they had it on the authority of the engineer that the greatest part of that expenditure was due to the old mains giving way, although these had been laid only 13 years. After discussion, it was decided to ask the engineer to report on any defects in the electrical system needing urgent attention. The *Dundee Advertiser* refers to the proposed formation of a company in the district for the provision of electric energy for the mills and factories of the city. This scheme apparently is still in the initial stage, but it is understood that a considerable amount of necessary data has already been obtained, and should the manufacturers show a disposition to discard their present power machinery, the promoters of the new scheme are confident of success. The intention is to construct a large generating station well to the north of the city, and supply electric energy as required to the public works. It will be necessary to obtain not only parliamentary sanction, but also an arrangement with the Town Council of Dundee for entering the Corporation territory. No approach has as yet been made to the Town Council. There is also some talk about using the water from Lintrathen for power purposes. In an interview, Mr. George Baxter, the water engineer, said, as reported in the same paper: "When I looked into the subject many years ago, I saw there was one scheme whereby Dundee might get about 5,000 h.p. from Lintrathen—namely, by increasing the storage capacity of the loch 12 times, putting a huge stone embankment across the bridge end of the bank, up the south side of the loch, bringing in the River Isla through the Horne of Needs, and laying steel flumes from the loch down to the bottom of the Den of Airlie, which is within a short distance. In that way you could utilise a fall of 250ft., and produce by that means 5,000 h.p. Or other resources could be built in the glens on the Isla, and on the Melgam above Lintrathen."

COLONIAL NOTES.

Bloemfontein.—The electric lighting scheme is now complete.

Durban.—An 800-h.p. engine has just been erected at the electric lighting station, and, with the 900 h.p. now on order, the Corporation will have 5,000 h.p. available for electric light and trams.

Mysore Goldfields (India).—A company has been registered under the title of the Kolar Mines Power Station, Limited, with a capital of £230,000, the object being to establish a central electric station in the district which contains the Mysore, the Champion Reef, Ooregum, and Nundydroog mines. We understand that Sir Chas. Tennant and Lord Ribblesdale are interested in the concern.

Madras.—*Indian Engineering* says: "We see that the Marshall-Crompton combine are exploiting Madras, and as this is almost an untilled field success should soon attend their energetic methods. There is a great need for a general supply undertaking in the southern capital, both for the purposes of lights and fans. Government and a few of the important leading firms have already put down some installations, but they have been beyond the reach of the general public, who would be quite as eager as the people of Calcutta to avail themselves of these necessities of modern life in India if they could be easily and cheaply procured."

Cape Town.—The ss. "Highland Corrie" was the first vessel to be discharged at Cape Town by the new installation of electric cranes for working cargoes. The ship's officers were well satisfied with the cranes, which worked without a hitch, and they think that the knowledge that Cape Town now possesses this improved means of discharge will attract shipping. The cranes are somewhat on the principle of ordinary cranes, and are unconnected with any system of cargo transporters. They are, therefore, not on the most approved principle, but with Delagoa Bay on the one hand and Cape Town on the other having adopted electrical appliances for working their cargoes, Durban should see the folly of clinging any longer to the ancient traditions of steam.—*South African Exports.*

Calcutta Jute Mills.—A large order has recently been awarded to the British Westinghouse Electric and Manufacturing Company, Limited, for two turbo generators and auxiliary plant, which will, it is believed, mark not only the first introduction of the large modern steam-turbine, but also one of the first extensive applications of electric power for factory driving in India. The plant in question will supply electric power to drive the large jute mill of Messrs. Birkmyre Bros. on the River Hugli, near Calcutta. The turbo-generators will each be of 1,300 kw. capacity, furnishing three-phase current at 440 volts and 25 periods. Each turbine will exhaust into a vertical surface condenser, having 4,800 square feet of cooling surface; and the exciter generators, of 20 kw. each, will be mounted direct on extensions of the turbine shaft. The turbines are to be of the multiple-expansion parallel flow type, running at 1,500 revolutions per minute. With steam at 1,175lb per square inch, 27½in. vacuum, and 200deg. F. superheat, a low steam consumption will be attained. The boilers will be eight in number, of the "Economic" type, supplied by Messrs. Davey, Paxman, and Co. The various departments of the mill will be driven throughout by Westinghouse polyphase induction motors, type C, of sizes varying up to 700 h.p. The 700-h.p. motors, three in all, will run at 290 revolutions per minute, and will be direct-coupled by solid flange couplings at each end of the spindle to 350ft. lengths of shafting. A large number of other motors will also be of the slow-speed type for direct coupling to the shafting without the intervention of belts or gearing. The contract includes, in addition to the above, the necessary switchboard and auxiliary apparatus, various transformers, and two jib cranes.

King William's Town (S.A.).—On Oct. 23 the electric lighting scheme of the King Electric Company, Limited, was successfully inaugurated by Mrs. George Whitaker, wife of the managing director of the company. The *Cape Mercury* says: "In the matter of the electric lighting of King William's Town the local Borough Council was first approached by Mr. E. G. Jones, the East London representative of Messrs. Reunert and Lenz, the contractors for the East London electric lighting and tramway scheme, but after considerable negotiations the above-mentioned firm declined the concession offered by the Borough Council, and for the time being the matter was dropped. The advantages which would accrue to the town if electric light was installed had made a great impression on some of the leading men of the town, and subsequently this important matter was taken in hand by Mr. George Whitaker, and very soon a limited liability company was formed on philanthropic lines, as follows: the shareholders not to receive more than 6 per cent., the overplus to be used for the improvement of the scheme for assisting the Town Council to buy the scheme out, thus enabling King William's Town to be lit by electricity some considerable time earlier than the finances of the Town Council would allow it to be done. The movement was very enthusiastically taken up, and in a very short time the whole of the capital and guarantees required were subscribed by local people. A board of directors was elected, Mr. E. G. Clifford Jones, M.I.E.E., was appointed consulting engineer, and the plans and specifications for the scheme were drawn up by him. The carrying out of the scheme was done on rather new principles. Plans and specifications were prepared for the individual apparatus and plant required, and tenders were called for both in South Africa and England. This enabled the company to deal directly with the manufacturers of the plant. The tenders were duly received, and the following firms were entrusted with the orders for the various items of plant: boilers, Messrs. Davey, Paxman, and Co., Limited, Colchester, England; engines, Messrs. Belliss and Morcom, Limited, Birmingham; dynamos and alternators, Electric Construction Company, Limited, Wolverhampton; condenser and feed pumps, Wheeler Condenser Company, Limited; steam-pipes, Babcock and Wilcox, Limited, Glasgow; underground high-tension cables, Glovers Limited, Manchester; poles, Messrs. Spends and Co., Limited, England; cross-arms and insulators, International Electric Engineering Company, Limited, London; bare copper wire, Messrs. Geipel and Lange, London; street brackets and stay-rods, Messrs. Reunert and Lenz, Johannesburg; and transformers, Ferranti Limited, London. The lighting is carried out on the single-phase high-tension alternating-current system. The current is generated at a potential of 2,100 volts, and is transformed down in nine transformer stations situated in different parts of the town to a potential of 220 volts for purposes of street-lighting and private supply. The power station is equipped with two Paxman Economic boilers, capable of generating 6,000lb. of steam per hour at a pressure of 140lb. to the square inch. These boilers are fed by two feed pumps, provided with a special arrangement for duplicate suction and feed mains and two independent water supplies. This arrangement was specially designed by the consulting engineer so as to give immunity from breakdown. The steam

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is conveyed from the boilers through a specially arranged system of solid-drawn steel steam-pipes to the alternator and exciter engines, and the arrangements here are such as to give immunity from breakdown. The engine-room is equipped with two 50-kw. alternators and two direct-driving exciters. The exhaust steam from these is carried into a surface condenser situated in a pit in the engine room. The current from these generators is carried by underground cable situated in trenches to a specially-designed switchboard. At present only one alternator is required to meet the demand of street-lighting and private supply, but so many consumers have applied for private supply that arrangements are being made for the installation in the near future of another large steam alternator and another boiler. The engine-room is equipped with an overhead travelling crane capable of lifting any of the plant. The current is conveyed from the power station to the transformer houses by underground concentric, armoured, paper-insulated cables, and the secondary supply is conveyed from the transformer houses to the street lights and private consumers by bare copper overhead mains. The switchboard at the power station was specially designed by the consulting engineer to avoid accidents through the use of high-tension current, and specially designed cable terminal boxes and high-tension switch fuses have been installed in the transformer houses, so that it is utterly impossible for anyone entering a transformer house or the power station to receive a dangerous electric shock. The streets of the town are lit by 225 25-c.p. incandescent lamps, the switching of which is controlled from the power station. Up to date, applications have been received from about 100 private consumers for supply of electric current, and there is not the least doubt that in the near future this number will be very greatly augmented. The power station, as is generally known, is situated on the bank of the Buffalo River at Ninow's Dam, where there is an unfailing supply of water for condensing purposes. The building is of brick with concrete floor under iron roof, and was specially designed to give immunity from damage through fire. Messrs. Sharpe and Kenmuir were the building contractors. The cost of the scheme to date is £18,000. Current for street-lighting will be supplied at 7d. per unit, and to private consumers at 1s. 3d. per unit. It is the intention of the directorate to reduce these rates as soon as the scheme is on a favourable footing. Great attention has been given to the installation of an economical system, and the whole of the works will be run by a staff consisting of the resident engineer (Mr. G. E. Saunders, formerly of the Hampstead Corporation electricity works), five white men, and eight natives. Mr. A. Scott has had charge of the power station since the work commenced, and will continue in that position. The whole scheme has been designed and carried out under the personal superintendence of Mr. E. G. Clifford Jones, M.I.M.E., late city electrical engineer, Cape Town; resident engineer, Cape Town; tramways and town electric engineer, East London."

PROVISIONAL PATENTS, 1903.

Nov. 9.

24244. An improved method of supporting trolley wires on electric tramways, railways, canals, and the electric operation of road vehicles. Percy Sewell Sheardown, Danum, Pembroke-park, Clyde-road, Dublin.

24248. Improvements in and connected with collectors of electricity for railways and tramways. Robert Cumming, 249, West George-street, Glasgow.

24282. Improvements in electric switches. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

24283. An improved electric switch with indicator. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

24284. Improvements in third-rail insulators for electric railways. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

24285. Improvements in electric switches. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

24285. Improvements in a double-throw electric switch with indicator. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

24302. Improvements in magneto-electric induction apparatus. Arthur George Bloxam, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Alfred Schoeller, Germany.) (Complete specification.)

24305. Improvements relating to the electrical deposition of smoke, fume, mist, fog, and the like. Oliver Joseph Lodge, Kt., 18, Southampton-buildings, Chancery-lane, London.

24310. Improvements in magnetic inductors. The Aktien Gesellschaft "Magneta" (Electrische Uhren ohne Batterie und ohne Contacte), 46, Lincoln's-inn-fields, London. (Date applied for under Patents Act, 1901, Jan. 20, 1903, being date of application in Switzerland.) (Complete specification.)

Nov. 10.

24333. Sparking plug, or device for electrical ignition of oil-engines, gas-engines, and the like. Malcolm Cooper, Dell's Farm, Beresford-road, Highbury, London.

24366. Improvements in magnetic compasses. George Charles Lilley, Billiter House, Billiter-street, London.

24396. Improvements in and relating to galvanic batteries. Elizabeth Marie Risac, 323, High Holborn, London. (Complete specification.)

24413. Improvements relating to electric current meters. Edward Jesse Piper, 24, Southampton-buildings, Chancery-lane, London.

Nov. 11.

24444. An improvement in ships' telegraphs. George Green and Francis E. Prior, 298, Old Chester-road, Rock Ferry.

24445. Improvements in electricity meters. George Hookham, 18, Southampton-buildings, Chancery-lane, London.

24449. An improved sparking plug or electrical ignition device. Graham Francis Henry Satow, 10, St. George's-crescent, Liverpool.

24465. Positive electrode for a galvanic battery. Gustav Heinrich Carl Kolosche, 81, High Holborn, London.

24469. A new or improved suspending chain for electric lamps and the like. James Hinks and Son, Limited, and Arthur Henry Wright, 7, Staple-inn, London.

24472. Improvements in electric furnaces. Ernst Ruhstrat and Walther Eugen Grimmer, 10, Reinhauser-chausse, Gottingen, Germany. (Complete specification.)

24474. Improved apparatus for automatically controlling the speed of Wheatstone telegraphic transmitters and the like. John Gell, 21, Finsbury-pavement, London.

24483. An improved electrical switch. Edwin Liddle and Guy Emanuel Druiff, 47, Hatton-garden, London.

24500. Transmitting alternating current through a vapour. Ezechiel Weintraub, 111, Hatton-garden, London. (Date applied for under Patents Act, 1901, March 23, 1903, being date of application in United States.) (Complete specification.)

24501. Rectifying alternating current. Ezechiel Weintraub, 111, Hatton-garden, London. (Date applied for under Patents Act, 1901, March 23, 1903, being date of application in United States.) (Complete specification.)

24502. Improvements in transmitting alternating current through a vaporous conducting medium. Ezechiel Weintraub, 111, Hatton-garden, London. (Date applied for under Patents Act, 1901, May 9, 1903, being date of application in United States. (Complete specification).

24515. Improvements in and relating to automatic transmitting apparatus for telegraphic and analogous purposes. James Tarbotton Armstrong and Axel Orling, 323, High Holborn, London.

24516. Improvements in and relating to receiving or detecting and recording apparatus for telegraphic and other electrical purposes. James Tarbotton Armstrong and Axel Orling, 323, High Holborn, London.

Nov. 12.

24581. An improved portable electric fan. Max Margowski, 72, Cannon-street, London.

24621. An improved automatic guide for engaging trolley heads of electric cars with overhead wires. John Edwin Hopthrow, sen., and John Edwin Hopthrow, jun., 5, Hatton-garden, London.

24623. Improvements in controlling an electric generator dynamo, or booster and battery for constant or variable pressure. Arthur George Bird, 18, Buckingham-street, Strand, London.

24626. Improvements in or relating to plates for secondary batteries. William Phillips Thompson, 322, High Holborn, London. (Pfluger Accumulatoren-Werke Actiengesellschaft, Germany.)

24630. Improvements in current-collecting devices for electric railway vehicles. Joshua Shaw, 6, Lord-street, Liverpool.

Nov. 13.

24680. An electrograph or apparatus for the electrical transmission, reception, recording, and reproduction of sound. Ernest George Craven, Devereux House, Campbell-road, Twickenham, London.

24693 Improvements in telephone apparatus Jules Cerpaux, 65, Chancery-lane, London.

24695. Improvements in or connected with means for electrically igniting miners' safety lamps. John Charles Best, 33, Chancery-lane, London.

24701. Improvements in and relating to electric motion in conjunction with the creation and multiplication of electricity applicable to machinery of all kinds requiring power. Thomas James Howell, 93, King's Cross-road, London. (Complete specification.)

24706. Improvements in rails for electric trams, railways, and for other similar suitable purposes. Thomas Lister Patchett and William Buck, 8, Quality-court, Chancery-lane, London.

24730. Improvements in dynamo-electric machines. John Herbert St. Hill Mawdsley, Norfolk House, Norfolk-street, Strand, London.

Nov. 14.

24755. Improvements in or relating to electrical fuse holders, fuse boxes, and the like. Francis Gibson Baily, 11 Ramsay-garden, Edinburgh.

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24770. Improvements in and relating to devices for making electrical contact in cables, armatures, and other electrical appliances. Henry Morrison Bremner, 96, Buchanan-street, Glasgow.

24791. Improved means for synchronising dynamo-electric machines. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

24792. Improvements in electric cut-outs. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

24793. Improvements in fluid pressure regulators. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

24794. Improvements in arc-extinguishing devices. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

24795. Improvements in electric cut-outs or fuses. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

24796. Improvements in emergency brakes for railway and tramway vehicles or trains. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

24797. Improvements in dynamo-electric machines. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

24798. Improvements in electrically-driven vehicles. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

24799. Improvements in electric motor systems. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

24800. Improvements in braking systems. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

24806. Process for the electrolytic manufacture of peroxides of magnesium and zinc. Friedrich Hinz, 37, Essex-street, Strand, London.

24833. Spark intensifier for electric igniters for explosion motors. Alfred Wydts and Joseph Klopfenstein, 53, Chancery-lane, London.

COMPLETE SPECIFICATIONS ACCEPTED.

To be published Dec. 3, 1903.

1902.

19647. Electric elevators or lifts. Bremner.

21969. Electric meter. Halsey. (Date applied for under International Convention, March 13, 1902.)

22024. Lifeguards or fenders for electric cars and other road vehicles. Munro, Brecknell, and Rogers.

22135. Electrolytic decomposition of alkaline chlorides. Gilmour.

24325. Apparatus for use in testing electric lamps. Wilson and Hardingham.

24744. Lightning guards, specially applicable for submarine telegraphy. Lodge and Saunders.

24772. Electrical transformers. Berry and British Electric Transformer Manufacturing Company, Limited.

25085. Switches for use in electric lighting. Quaney and Kirwan.

25216. Electrical cut-outs and regulators and their application. Leitner and Lucas.

26039. Electric train-control systems. Carolan. (General Electric Company.)

26647. Electric recording instruments. Carolan. (General Electric Company.)

26818. Incandescent electric lamps and collars for the same. Cleminson.

26906. Junction frog plates for use on the overhead system of electric tramways. Foster.

26917. Switching mechanism applicable for intercommunication telephone systems. Byng and Anders.

27133. Enclosed electric arc lamps. Reclus, Petitdidier, Schmitt.

27272. Method of selective electric signalling. Lake. (Stone.)

27373. Galvanic cell. Pearson and Fiedler.

27374. Electrode for galvanic cells, and a method or process for producing same. Pearson and Fiedler.

27476. Electric railway or tramway traction on a surface-contact or like systems. Boult and Boult.

25574. Reversible boosters. Peebles and Pickstone.

27755. Electric furnaces or muffles. Carolan. (General Electric Company.)

27758. Machines for cutting micanite and the like. Carolan. (General Electric Company.)

27765. Electric phase-indicating instruments. Carolan. (General Electric Company.)

27769. Electric rheostat switches. Carolan. (General Electric Company.)

27771. Electromagnetic locks for automatic electric circuit breakers. Carolan. (General Electric Company.)

28510. Trolley poles of electric tramcars and the like. Hommel and Hommel.

28643. Supporting devices for trolleys for overhead electric traction. Kennington and Fawcett.

1903.

10. Automatic suspension and contact appliance for electric arc lamps and other apparatus requiring to be raised or lowered. Stevenson.

273. Manufacture of electrodes for secondary batteries. Müller.

517. Miners' lamps that are ignited by means of electricity. Naylor.

518. Back gearing appliances for electric motors and dynamos and for steam and water-driven turbines. Davidson.

778. Device for indicating the condition of the electric circuit controlling the air brake valves on a train. Siemens Bros. and Co., Limited. (Siemens und Halske Actiengesellschaft.)

1088. Manufacture of positive electrodes for secondary batteries. Roderbourg.

2874. Switches for controlling an electric circuit from several points. Terry.

19524. Manhole terminals for electrical conduit sections. Gest.

20061. Receivers for wireless communication. Morin.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.		Last price
Commercial and Industrial.—	£		£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1	..	½-¾
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1	..	1/16-3/16
British Insulated and Helsby Cables, Ord., 1-100,000	5	..	6-6¼
—— 6 per cent. Cum. Pref., 1-100,000	5	..	5¼-5⅜
—— 4½ per cent. Mortgage Debentures	100	..	102-105
British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red.	100	..	103-105
British Westinghouse Elec. and Manuf., 6 per cent. Pref., 275,001-375,000	5	..	5¼-5⅜
—— 4 per cent. Mortgage Debenture Stock	100	..	100-102
Brush Electrical Engineering, Ordinary, Nos. 1-105,751	2	..	¾-1
—— Non. Cum., 6 per cent. Pref.	2	..	1-1¼
—— 4½ per cent. 1st Debenture Stock	100	..	97-100
—— 4½ per cent. 2nd Debenture Stock	100	..	85-90
Callender's Cable, Debentures	100	..	106-110
—— Ordinary	5	..	11-12
—— 5 per cent. Pref.	5	..	5¼-5⅜
Crompton and Co.	3	..	1¾-2¼
—— 5 per cent. Debentures	100	..	100-104
Edison and Swan United, "A" Shares, 1-99,261	3	..	¼
—— "A" Shares, 01-017,139	5	..	1-2
—— 5 per cent. Debentures	100	..	76-81
—— 4 per cent. Deb. Stock, Red.	100	..	72-77
Electric Construction, Limited, Nos. 1 to 112,100	2	..	1¼-1⅜
—— 7 per cent. Cumulative Pref.	2	..	2¼-3
—— 4 per cent. Perp. 1st Mort. Deb.	100	..	97-100
Ferranti Limited, 5 per cent. 1st Mort. Deb. Stock, Red.	100	..	90-95
General Electric Company (1900), 5 per cent. Cum. Pref.	10	..	9⅜-10¼
—— 4 per cent. 1st Mort. Deb. Stock	100	..	96-99
W. T. Henley's Telegraph Works, Ordinary	5	..	14-15
—— 4½ per cent. Preference	5	..	5-5¼
—— 4½ per cent. Debentures	100	..	108-112
India Rubber, Gutta Percha, and Telegraph Works	10	..	18¼-19¼
—— 4 per cent. Debentures	100	..	100-103
Parker, Thos., Limited, Ordinary	10	..	14¼-15¼
Telegraph Construction and Maintenance	12	..	34-37
—— 5 per cent. Bonds	100	..	101-104
Electric Lighting and Supply.—			
Blackheath & Greenwich District Ordinary 1,201-101,200	1	..	⅝-¾
—— 4½ per cent. Deb. Stk. Certs., Red. and Conv.	100	..	116-119
Bournemouth and Poole, Ordinary	10	..	12½-13½
—— 4½ per cent. Cum. Pref., 7,501-15,000	10	..	10-11
—— 6 per sent. Cum. Second Pref., 15,001-22,500	10	..	11-12
—— 4½ per cent. Debenture Stock, Red.	100	..	103-106
Bromley (Kent) Electric Light and Power Co., 4½ per cent. 1st Debenture Stock, Red.	100	..	100-103
Brompton and Kensington, Ordinary	5	..	10¼-10⅜
—— 7 per cent. Preference	5	..	10-10¼
Calcutta Electric Supply Corp., Ordinary, Nos. 1-40,000	5	..	6¼-7¼
—— Nos. 20,001-30,000	5	..	7-8
Cambridge Electric Supply Company, Ltd., £10 Ord.	8	..	14½
—— " " £10 Ord.	6	..	10⅜
Central Electric Supply, Ld., 4 per cent. Guar Deb. Stock	100	..	107-110
Charing Cross and Strand, Nos. 1-70,000	5	..	9-9¼
—— 4½ per cent. Cum. Pref.	5	..	5¼-5⅜
—— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000	5	..	4⅜-5
—— 4 per cent. Debenture Stock, Red. (Prov. Certs.)	100	..	104-106
Chelsea Electricity Supply	5	..	5¼-6
—— 4½ per cent. Debentures	100	..	108-111
City of London, Ordinary	10	..	10-10¼
—— 6 per cent. Cumulative Pref.	10	..	13-14
—— 5 per cent. Debenture Stock	100	..	122-127
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100	..	102-105
County of London and Brush Provincial, Ordinary	10	..	7¼-8¼
—— 6 per cent. Cum. Pref.	10	..	11¼-12¼
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	100	..	107-110
Edmundsons' Electricity Corporation, Ordinary, 1-50,000	5	..	6¼-6⅜
—— 6 per cent. Cum. Pref.	5	..	6-6¼
—— 4½ per cent. First Mort. Deb.	100	..	104-107
Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-30,000	5	..	3¼-4¼
—— 5 per cent. Debenture Stock, Red	100	..	95-98
Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000	5	..	5¼-6
—— 4½ per cent. First Deb. Stock, Red.	100	..	100-103
Hove Electric Lighting, Limited, Ord., 1-13,000	5	..	7¼-8¼
Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000	5	..	10¼-11¼
—— per cent. Debenture Stock Red.	100	..	106-108

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Name.	Amount paid.	Last price.
	£	£
Kensington and Knightsbridge and Notting Hill	100 ..	101-104
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10 ..	9½-10½
London Electric, Ordinary	3 ..	1½-2½
—— 6 per cent. Pref.	5 ..	4½-5½
—— 4 per cent. 1st Mortgage Debenture Stock, Red..	100 ..	98-101
Metropolitan, Ordinary	10 ..	17-18
——½ per cent. First Mortgage Debenture Stock	100 ..	110-114
——3½ per cent. Mortgage Debenture, Red.	100 ..	96 99
Newcastle-upon-Tyne Electric Supply, Ordinary.....	5 ..	28-101
—— Preference.....	4 ..	100 103
Notting Hill Electric Lighting	10 ..	12½-13½
—— 4 per cent. First Mort. Debs., Nos. 1-500 (Reg.) ..	100 ..	98-101
Oxford Electric, Ordinary, 1-96 and 407-14,310	5	5½-6½
—— 4 per cent. Debenture Stock	100	98-101
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	10 ..	98-100
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000 ..	5 ..	3-3½
—— 4 per cent. Debenture Stock	100 ..	85-90
South London, Ordinary	5 ..	3½-4
St. James's and Pall Mall, Ordinary, 101-20,080	5 ..	14½-15½
—— 7 per cent. Pref.	5 ..	8-9
—— 3½ per cent. Deb.....	100 ..	97-100
Urban Electric Supply Co., Ordinary, 8-30,007	5 ..	4½-5½
—— 5 per cent. Cumulative Preference, 50,001-80,000	5 ..	4½-5½
Westminster, Ordinary	5 ..	12-13
—— 5 per cent. Cum. Pref., 110,101-138,251	5 ..	6-6½

Electric Railways.—

Central London, Ordinary.....	100 ..	93-96
—— 4 per cent. Pref.	100 ..	99-102
—— ,, ,, deferred	100 ..	99-102
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)..	100 ..	115-118
City and South London, Consolidated Ordinary	100 ..	50-52
—— 4 per cent. Debenture Stock	100 ..	110-113
—— 5 per cent. Pref. Stock '91	100 ..	127-130
—— ,, ,, ,, '96	100 ..	125-128
—— ,, ,, ,, '01	100 ..	122-127
Liverpool Overhead, 5 per cent. Pref.	— ..	13-13½
—— Ordinary, 1-50,000	— ..	7½-8
—— 4 per cent. Mortgage Debentures, Red., 1-1,700 ..	— ..	102-104
Waterloo and City, Ordinary	100 ..	91-94

Electric Tramways.—

Anglo-Argentine, 1-260,007	5 ..	4¼-4¾
—— Permanent 6 per cent. Debenture Stock, 1888....	100 ..	125-130
Blackpool and Fleetwood Tramroad.....	10 ..	13½-14½
Brisbane Tramway Invest., Lim., Ord., 1-75,000	5 ..	2-3
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5 ..	3¾-4¼
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100 ..	98-102
British Columbia Electric Railway Co., Ord., Nos. 1-20,000	100 ..	81-84 xd
—— Non-Cum. 5 per cent. Pref., Nos. 25,001-38,600 ..	100 ..	93-96
—— 4½ per cent. 1st Mt. Debs., Nos. 1-6,250, of £40 each	40 ..	102-104 p.c

Name.	Amount paid.	Last price
	£	£
British Electric Traction, Ord. 1-300,000 & 60,001-80,000..	10 —	11¼-12
—— 6 per cent. Cm. Pf., 30,001-60,000	10 —	11-11½
—— 5 per cent. Perpetual Debenture Stock	100 —	120-123
Buenos Ayres and Belgrano Tram., Ord., 1-100,000	5 —	2¾-2¾
—— "A" 6 per cent. Cm. Pf., 1-40,000	5 —	5-5½
—— "B" 6 per cent. Cm. Pf., 1-27,500	5 —	4½-5½
—— 5 per cent. Deb. Stock, Red.	100 —	107-110
—— Prov. Cert., all paid	100 —	99-102
Cape Electric Tramways, Nos. 1-480,000	1 —	1½-2½
City of Birmingham Tramways, 5 per cent. Cum. Pref.....	10 ..	5-5½
—— 4 per cent. 1st Mortgage Deb., 1-3,000 (1917)	100 ..	98-101
Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red.	100 ..	100 103
Cork Electric Tramways and Lighting Co., Ordinary	10 —	13-14
—— 5 per cent. Cum. Pref.	10 —	11-12
—— Debentures	100 —	96-99
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10 —	12-13
—— 6 per cent. Pref., Nos. within 1-60,000	10 ..	15-16
—— 3½ per cent. Mort. Debs., 1-3,000, Red.	100 —	94-97
Imperial Tramways Ordinary.....	all —	22-22½
—— 6 per cent. Cum. Pref.	all —	14½-15½
—— 4½ per cent. Deb Stock	100 —	112-114
Isle of Thanet Electric Tramways and Lighting, 5 per cent. Cum. Pref., Nos. 30,001-60,000	5 ..	3¾-4½
—— 4 per cent. Debenture Stock	100 ..	92-95
Kidderminster and District Lighting and Traction, Pref...	5 —	3¾-4
London United Trys.(1901), 5 per cent. Cum. Pref.	10 —	11½-12
—— 4 per cent. 1st Mt. Db. Stock, Red	100 ..	104-106
Metropolitan Electric Trams., Deferred, 1 000 001-1,314,016	1 ..	3/16-5/16
—— 5 per cent. Cum. Pref., 500,001-814,016..	1 ..	⅞-1⅛
New General Traction, Ordinary	5 —	¼
—— 6 per cent. Cum. Pref.	5 —	1½-2½
—— 5 per cent. Mortgage Debentures, 1-1,713 (Regd.).	100 ..	88-93
Oldham, Aston, and Hyde Tramway, Ordinary.....	10 —	10½-10¾
—— 5 per cent. Cum. Pref.	10 ..	11½-12½
Perth Elec. Tramways (W.A.) 5 per cent. 1 Mort. Deb. Stk.	100 ..	99-102
Potteries Electric Traction, Ordinary, 20,001-40,000	10 —	8¼-9½
—— 5 per cent. Cum. Pref., 1-20,000	10 —	8¼-9½
—— 4½ per cent. Debenture Stock.....	100 —	102-105 xd
South Lancashire Electric Traction and Power Company—		
—— £250,000 Ordinary	1 —	1
—— £101,132 6 per cent. Preference.....	1 —	1
—— £528,093 4½ per cent. Debenture Stock	100 p.c. —	100 p.c.

Telephones.—

National Telephone, Preferred	100 —	100-102
—— Deferred Stock	100 —	74-76
—— 6 per cent. Cum. First Pref.	10 —	13-14
—— 6 per cent. Cum. Second Pref.	10 —	13-14
—— 5 per cent. Non. Cum. Third Pref.	5 —	5-5½
—— 3½ per cent. Deb. Stock, Red.	100 —	93-96
—— 4 per cent. Deb. Stock, Red.	100 —	102-104
Oriental Telephone and Electric Company	1 —	13/16-15/16

TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line	Traffic Returns for week			Increase or decrease.		Miles of single track open.		Accounts for past year.				Receipts per			Cost per car mile.
	Ending	1903.	1902.	Week.	Current year.	1903.	1902.	Ending	Total receipts	Passengers carried.	Car miles run.	Pas-s'nger	Car mile.	Mile of track.	
		£	£	£	£				£			d.	d.	£	d.
Aberdeen Corporation.....	Nov. 7	1,108	815	+ 293	+ 4,789	19¼	17¼	May 31	37,931	9,099,715	794,641	0·98	13·02	1,970	6·1
Ayr Corporation.....	,, 7	180	174	+ 6	+ 42	8	6	Sept. 25	12,503	2,979,276	290,099	1·00	10·34	1,560	4·7
Birmingham Tramways	,, 14	5,221	5,102	+ 119	+ 9,238	6½	6½	—	—	—	—	—	—	—	—
Blackburn Corporation	,, 13	750	712	+ 38	+ 864	24	24	March 25*a*	40,964	7,234,106	826,558	1·36	11·87	1,705	7·44
Blackpool Corporation.....	,, 12	307	305	+ 2	— 209	17½	16½	,, 31	211,168	6,169,121	784,443	1·52	10·8	—	—
Blackpool-Fleetwood Tramways	,, 14	292	208	+ 14	— 111	16½	16½	Dec. 31	30,923	2,049,677	584,989	3·62	12·68	1,932	6·99
Bolton Corporation	,, 15	1,686	1,619	+ 67	+ 7,525	38	25	March 31	85,704	17,761,605	1,896,247	1·15	10·75	3,430	5·87
Bournemouth Corporation.....	,, 11	736	—	—	—	10½	—	—	—	—	—	—	—	—	—
Bradford Corporation	,, 15	3,645	3,292	+ 353	+15,001	41	—	—	—	—	—	—	—	—	—
Brighton Corporation	,, 16	824	761	+ 63	+ 6,311	6½	—	,, 31	—	10,432,508	1,031,928	1·00	10·10	—	—
Bristol Tramways Company	,, 13	4,720	4,301	+ 419	—	51½	51½	Dec. 31	223,480	41,192,899	5,724,114	1·30	9·38	4,348	—
Burnley Corporation	,, 14	791	688	+ 103	—	—	—	—	—	—	—	—	—	—	—
Burton Corporation	,, 15	331	—	—	—	—	—	—	—	—	—	—	—	—	—
Cardiff Corporation	,, 7	1,853	1,521	+ 332	+18,098	—	—	—	—	—	—	—	—	—	—
Carlisle Tramways Company....	,, 14	189	147	+ 42	+ 686	—	—	,, 31	—	2,216,583	320,129*h*	—	—	—	—
Central London Railway.....	,, 14	6,9·6	7,358	— 362	— 6,624*h*	6	—	,, 31	367,225	45,305,110	1,276,971*a*	1·87	66·6*a*	59,076	35·6*a*
City and South London Railway	,, 15	2,894	3,429	— 535	— 8,197	6⅝	—	,, 31	165,003*a*	19,069,319*a*	—	—	—	—	—
Cork E. T. and L. Company	,, 12	437	420	+ 17	— 3,420	—	—	—	—	—	—	—	—	—	—
Darwen Corporation.....	,, 13	210	219	— 9	— 204	7·23	—	March 31*g*	12,341	2,360,735	254,279	1·25	11·65	1,707	9·36
Dover Corporation	,, 14	165	181	— 16	+ 51	3	—	—	—	—	—	—	—	—	—
Dublin & Lucan Electric Railway	,, 15	101	91	+ 10	+ 165*h*	—	—	Dec. 31	5,796	364,796	102,087	3·81	13·62	359	7·68
Dublin U. T., electric cars.....	,, 13	3,725	3,594	+ 131	—	46	46	March 31	126,121	24,553,133	3,429,356	1·23	8·82	2,741	5·06*h*
Dublin S. District, Electric	,, 13	776	707	+ 69											
Dundee City Tramways	,, 11	799	776	+ 23	—	22	22	May 15	35,874	9,084,522	752,814	0·93	11·276	1,630	—
East Ham Corporation	,, 14	612	452	+ 160	—	10·75	7·52	March 31	25,341	9,971,337	650,224	0·61	9·35	2,357	—
Farnworth U.D.C.....	Oct. 21	150	143	+ 7	—	—	—	—	—	—	—	—	—	—	—
Glasgow Corporation	Nov. 14	13,723	12,673	+1,050	+35,004	124	101	May 31*g*	656,572	177,179,549	14,008,750	0·88	11·25	5,489 *b*	7·40*d*
Halifax Corporation.....	,, 4	2,546	2,169	+ 377	+ 5,122	30¼	27½	—	—	—	—	—	—	—	—
Huddersfield Corporation	,, 14	1,173	1,000	+ 173	—	34	35	March 31	56,631*h*	9,738,213	1,218,539	1·4	11·14	1,618	6·38
Hull Corporation, E. S.....	,, 14	1,895	1,712	+ 183	+ 3,362	19	19	,, 31	87,707*h*	21,065,999	2,218,696	1·00	9·49	5,004	5·07
Ilkeston Corporation	,, 11	106	—	—	—	—	—	—	—	—	—	—	—	—	—
Kirkcaldy Corporation	,, 11	147	—	—	—	—	—	—	—	—	—	—	—	—	—
Leeds Corporation	,, 14	5,105	4,855	+ 250	+11,079	77	—	March 25	262,656	57,239,779	5,773,651	1·11	10·91	3,283	—
Liverpool Corporation.....	,, 7	9,900	9,902	— 2	+14,525	101	95	Dec. 31	504,304	108,906,472	11,705,425	1·11	10·34	5,000	6·88
Liverpool Overhead Railway....	,, 15	1,536	1,552	+ 84	+ 2,209	15½	15½	June 30	79,252	10,466,726	986,185*a*	1·82	19·30*a*	5,110	— *a*
Lowestoft Corporation	,, 7	161	—	—	—	—	—	—	—	—	—	—	—	—	—
Nelson Corporation	,, 14	87	—	—	—	3	—	—	—	—	—	—	—	—	—
Newcastle-on-Tyne Corporation	,, 14	3,569	3,082	+ 487	—	38½	36	March 25*g*	150,334	33,474,122	3,379,119	1·08	10·93	4,175	6·17
Portsmouth Corporation.....	,, 7	1,531	1,282	+ 249	—	29	29	Sept. 30	47,651	9,168,137	868,157	1·24	13·17	1,643	—
Rochdale Corporation	,, 2	117	121	— 4	—	4½	—	March 31	5,416	925,281	127,456	1·38	10·27	—	7·66
Rotherham Corporation	,, 12	398	—	—	—	—	—	—	—	—	—	—	—	—	—
Salford Corporation	,, 16	3,813	2,873	+ 940	+38,109	—	—	—	—	—	—	—	—	—	—
Sheffield Corporation	,, 15	4,450	—	—	—	53½	46¼	Mar. 25*g*	216,709	56,812,049	4,926,083	0·904	10·428	7,510	7·0
Southampton Corporation	,, 12	905	928	— 23	—	11	11	,, 31	35,874	9,084,522	752,814	0·946	11·436	3,760	—
Sunderland Corporation	,, 15	1,035	1,062	— 27	+ 2,007	18·48	17·18	,, 31	59,930	13,987,121	1,270,957	1·03	11·3	3,243	6·43
Wallasey U.D.C.	,, 14	595	531	+ 63	+ 3,015	10·5	10·5	,, 31*g*	31,307	5,690,378	654,550	1·32	11·47	2,981	6·97

* Includes maintenance of permanent way and proportion of profits paid to the tramway companies for term of unexpired lease. *a* Train mile.
b Per mile of single track. *c* Include rail and tram. *d* Including depreciation. *f* Including one section of horse traction. *g* 1903. *h* Half-year's figures.

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NOTES.

Engineering Standards Committee.—This committee have appointed Messrs. Crosby Lockwood and Son, of 7, Stationers' Hall-court, E.C., as their official publishers. All the reports and specifications published by the committee may be had either from that firm or direct from the offices of the committee, 28, Victoria-street, Westminster.

Royal Meteorological Society. — The opening meeting of this society for the present session was held on the 18th inst., at which Dr. H. R. Mill and Mr. R. G. K. Lempfert contributed an elaborate and interesting paper on "The Great Dustfall of February, 1903, and its Origin." The authors came to the conclusion that the dust originated on the West Coast of Africa, taking two days to reach this country.

Trials of Electric Automobiles.—In May next year it is proposed by the Automobile Club to hold a series of trials of electrical vehicles. Draft conditions have been prepared and the makers and agents of electrical vehicles in this country have been asked whether they would be prepared to make a definite entry now, as the club have decided that in the event of fewer than 10 entries being received from this country no trials will be held.

American Institute.—The October number of the *Transactions* of the American Institute of Electrical Engineers has just reached us. It continues the reprint of the papers and the discussions thereon at the Niagara Falls convention for the two last days of the meeting—viz., July 2 and July 3—and also reports the proceedings at the September meeting in New York, when President Arnold delivered his inaugural address. Two papers were read at this meeting—*i.e.*, "An Efficient High-Pressure Water-Power Plant," by Mr. Geo. J. Henry, jun., and Mr. Jos. N. Le Comte; and "Electric Motors for Centrifugal Pumps and Fans," by Mr. A. J. Bowie, jun.

Electricity Supply Areas in London.—Our readers must by now be familiar with that hardy perennial, the Bill promoted by the Board of Trade for altering and readjusting the electricity supply areas in London. Twice has it been presented to Parliament in two consecutive sessions and twice withdrawn, for reasons unexplained. The Board of Trade will again bring the Bill forward in the new session, but as to its ultimate fate we decline to anticipate. The matter with which the measure deals may not be of first importance in these days of educational and fiscal reform, but it strikes us that it is quite time the areas of electricity supply in the Metropolis as affected by the passing of the London Government Act in 1899 should be definitely defined.

Soldering of Aluminium.—A method of perfectly soldering and brazing aluminium is reported to have been achieved by a young French savant after four years' experiments. He is also stated to have discovered a process for hardening the metal, and greatly increasing its powers of resistance without adding to its weight. Should the invention prove to be successful in practice, it will undoubtedly lead to the more extended use of aluminium for electrical transmission. Perhaps the greatest obstacle in the way of the successful employment of aluminium for electrical conductors has been the soldering difficulty. Although many methods have been devised for improving these conditions, no one, so far as we know, has been completely satisfactory.

British Electrical Instruments at St. Louis.—There is every reason to believe that the British electrical industry in its various spheres will be well represented at the World's Fair to be held at St. Louis next year. In this connection the value of the Royal Commission appointed to assist in arranging for English exhibits is fittingly illustrated. Under the guidance of this Commission the electrical instrument makers of Great Britain are arranging a collective exhibit of great variety, which, in its complete form, will be forwarded to St. Louis in one consignment, thus enormously reducing the expenses of the individual exhibitors. We may mention that among the exhibits will be a platinum resistance thermometer capable of measuring temperatures from that of liquid air up to 1,400deg. C.

Cable Telegraph Record.—The cricket season in Australia has afforded an excellent opportunity for testing the possibilities of the cable lines between the Commonwealth and this country on the point of speed of transmission. On Saturday both the Eastern Telegraph Company and the new Pacific line made a determined bid for the supremacy, and the result was that a record was established in cable telegraphy from Australia. Identical messages were handed in at the two offices in Sydney at the same hour, giving the close-of-play score in the cricket match then in progress. The Eastern Telegraph Company delivered the message in London 13 minutes later, while the message sent by the Pacific route came through hardly a minute behind the other—the former making an absolute record for a public telegram from Australia to this country.

Post Office Telephone Rights.—We congratulate the Post Office on its victory in the case heard at Kingston-upon-Thames County Court on Friday, the point at issue being whether it was entitled to erect wooden poles at Wimbledon in connection with the extension of the Post Office telephone system in that district. The local authority objected to the erection of wooden poles on the ground that the æsthetic aspect of the roads would be spoiled in consequence, and attempted to force the Post Office to put the wires underground in some cases and to use ornamental iron poles in others, by withholding their consent to the work being carried out. This would mean a large increased expenditure, and the Post Office accordingly took county court proceedings to test the point. The judge held that painted wooden poles would not much interfere with the æsthetic character of the neighbourhood, and gave his decision in favour of the Post Office.

Telegraph Facilities in Rural Districts.—A very useful extension of the present system of delivery by hand, or by "express" or ordinary post, of telephonic messages received at central postal offices is about to be made in Lancashire. In certain part of that county the old A B C instruments are still in use, and instead of replacing them with the latest form of telegraph instrument, a substitute will be found in the telephone. It is thought that this instrument will prove more efficacious than the telegraph for the transmission of outlying messages, because of the scarcity of trained operators in the rural districts. Under this system the message will simply be telephoned through to the nearest telegraph office, and redispatched by hand or by post, as required. We understand that the new arrangement will presently be extended to every post office in the kingdom which is also a telegraph office, and telephonic and telegraphic communication with outlying districts should thus be greatly facilitated.

Embankment Tramways.—Among the important legislative proposals which the London County Council will bring before Parliament next session is one for a series of new tramways, including the oft-rejected line along the Victoria-embankment. Since its first introduction in the House of Commons this scheme has met with strong

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opposition, for reasons more æsthetic than practical, the opinion being that an electric tramway along the embankment would spoil the present picturesque aspect of that thoroughfare. However, the opponents of the schome only succeeded in obtaining its defeat last session by a single vote. Now it is hoped that the opening up of the new highway between Holborn and the Strand will help to influence Parliament in favour of the proposed tramway, which, as in its original form, aims at providing the connecting link between the Council's system south of the water and the North London lines by means of the shallow underground tramways now under construction from Theobalds-road, Holborn, beneath the new Kingsway, to the Strand.

Municipal Telephony.—A new objection has been raised by Mr. W. Gaine, of the Telephone Company, against the methods of municipal telephony. He takes the view that the practice adopted by most municipal corporations in this country owning a telephone exchange of making no charge to their subscribers until they can guarantee them connection with a certain number of others, is a breach of the provisions of the licenses granted by the Postmaster-General. The case in point is the Brighton municipal undertaking, and Mr. Gaine declares the view of his company to be that the first subscribers to the system are obtaining an undue preference as against subsequent subscribers. This, however, is not the case, for the Corporation could not fairly ask their subscribers to pay for a service which is not in full working order. There is no question of "favour" or "preference" here as guarded against in the Corporation license; it is the usual practice adopted in the early stages of a municipal undertaking, which is dependent for its success on the amount of support it can get at the beginning.

Junior Institution of Engineers.—At the meeting of this institution held at the Westminster Palace Hotel on 20th inst., a paper on "Fires on Shipboard: Their Causes and the Methods for Prevention and Extinction," was read by Mr. George Canning. The author dealt with the losses sustained through fire casualties amongst shipping, and urged the adoption of gas systems, which he maintained were the only feasible methods extant, not only for the prevention, but also for the extinction of fires on shipboard. On the following day, by invitation of the Clayton Company, the institution witnessed a demonstration of fire-extinguishing at Orchard-place, Blackwall. The apparatus shown in operation consisted of a sulphur chamber or generator, in combination with a blower and engine, and a cooler. Ordinary rolled sulphur is placed in the generator and set alight by means of a piece of waste. Two pipes are fitted to the generator, one for delivering the gas to where the combustion is taking place, and the other as a return or suction pipe. Air taken from the compartment to be treated enters the generator, and the oxygen combining with the sulphur vapours produces sulphur polyoxide gas. The demonstration was attended by successful results.

New Books.—"Report on the Influence of Gauge Length and Section of Test Bar on the Percentage of Elongation," by Prof. W. C. Unwin (Messrs. Crosby Lockwood and Son. 2s. 6d.). This report deals with the variation of percentage of elongation with different gauge lengths and sections of test bar, and is issued in connection with the excellent work which is being carried on by the Engineering Standards Committee. It is based almost entirely on tests of steel-plate test bars supplied by the Dalzell Steelworks, Motherwell, and the Parkgate Steelworks. These tests cover a wide range of conditions, and no such complete information as to variation of elongation with the form of test bar has been previously available. As the results are, it is believed, valuable whatever decision may be arrived at as to standard forms of test bars, they have been very fully and critically discussed by the author. "The Practical Electrician's Pocket-Book and Diary, 1904" (Messrs. S. Rentell and Co., Limited, Strand, W.C. 1s.). This admirable little book has now reached its sixth year, and is no exception to the previous issues, in that it succeeds in keeping pace with the most recent developments of electrical practice Many alterations and additions have been made to the matter, so that the electrician and fitter will find it quite trustworthy. With the growth of the industry the tabulated list of central stations with particulars of current and rates has now grown to considerable dimensions, and this represents not the least interesting section of the book.

The Speed of Tramcars.—It was hardly to be expected that the energetic managing director of the London United Tramways, Mr. J. Clifton Robinson, would be content to take an inactive part in the campaign which Mr. Moffat Ford has commenced against the speed of electric tramcars as reflected in the recent proceedings at the West London Police Court. As we showed in our last issue, Mr. Ford has attempted to establish that he is working for the public good, but at the same time he urges that even more stringent regulations should be imposed on electric tramcars than on motorcars, his argument being that the motorcar weighs considerably less, has at least two sets of efficient brakes, and can steer clear of danger, while the heavier tramcar can avoid danger only by use of its brakes. Mr. Clifton Robinson, in a letter to the *Times*, completely disposes of these points when he says that, to the average man in the street, an electric tramcar is a known quantity, while the motorcar is not. Hence the latter constitutes a greater source of danger than the tramcar pursuing its rigid and defined course. The fundamental differences between motorcars and tramcars offer no real basis of comparison, and if Mr. Ford thinks he is going to achieve his avowed object by prosecuting individual tram-drivers, we fancy he is mistaken. As Mr. Clifton Robinson truly says, the prosecution of the driver of a private motorcar for excessive speed does not justify retaliation on the part of that individual by seeking "to hamper the operations of a public tramway system, to the inconvenience of the 50 millions of passengers who travel yearly on its electric cars."

The Metric System.—It may be within the knowledge of some of our readers that last August a congress of chambers of commerce of Great Britain and the Empire was held at Montreal, at which a decision was come to in favour of the adoption of the metric system of weights and measures. Details of this decision, however, are only now available. It seems that at the meeting there were present delegates from 75 British chambers of commerce, and from the chambers of the principal cities of India, Ceylon, Egypt, South and Central Africa, Canada, the West Indies, Australasia, Hong Kong, and Malta. In the discussion of the question it was urged that the matter should be so forced upon the Government that it would be bound to take action. The resolution, which was adopted with but few dissentients, reads as follows: "That this congress, having had under its consideration the following resolution, adopted at the conference held in London during the months of June, July, and August, 1902, between his Majesty's Principal Secretary of State for the Colonies and the Prime Ministers of the self-governing colonies of the British Empire—namely, 'That it is advisable to adopt the metric system of weights and measures for use within the Empire, and the Prime Ministers urge the Governments

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represented at this conference to give consideration to the question of its early adoption'—hereby expresses its hearty concurrence therewith, and urges upon the Government of the United Kingdom the necessity for legislative measures being taken in the interests of British trade and commerce to make the use of metric weights and measures compulsory."

Electricity in Ladysmith.—So enthusiastically is the electric light being taken up in the South African town of Ladysmith, of famous memory, that we learn further extensions of plant are already decided upon. The present installation gives supply on the three-wire, direct-current system, with 400 volts between the outer wires, the middle wire being earthed. All the supply mains are carried overhead on iron poles, the two outer wires being supported on porcelain insulators fixed on wooden cross arms, while the middle wire is bound to a special clamp on the pole itself, and is thus earthed at every pole on the line. This is one of the main features of the distributing system, the possibility of danger being reduced to a minimum. In the generating station there are two sets of engines and dynamos, each consisting of a compound two-crank Willans and Robinson engine, to which are coupled two continuous-current compound-wound generators. Each set has a capacity of about 65 kw. as a maximum, and the two generators of each set are arranged to be connected on opposite sides of the three-wire system, so that each engine with its two generators supplies current to both sides of the mains to the extent of its capacity. Steam is supplied by three Robey boilers. The main switchboard consists of two generator panels and six feeder panels, with room for additions. The panels are of polished marble, and, in addition to the measuring and regulating apparatus, they only carry switches and fuses connected to the outer 'bus bars, the middle 'bus bar being earthed and having all connections joined to it. A subsidiary switchboard controls the street-lighting circuits. We understand that the performance of the plant so far gives every reason for satisfaction, and it is anticipated that the undertaking will be on a paying basis in the second or third year of its existence.

Possibilities of Electric Traction.—Mr. G. H. Sheffield, the new president of the Newcastle Association of Students of the Institution of Civil Engineers, made some noteworthy remarks on the possibilities of electric traction in the course of his address at the opening meeting of the association a few days ago. If the railway companies, he said, were to retain their suburban traffic, they had no alternative but to electrify their local lines, and he mentioned 50 millions sterling as a "conservative estimate" of the cost of doing this. The adoption of electric traction on such lines would lead to greater progress in 10 years than had been seen in 30 years with steam traction. As regards the main lines, there was a possibility of matters being precipitated by the establishment of independent express lines in competition with the existing railways, but at the present the problem was surrounded by difficulties. Discussing the better system of working to adopt—the third rail or the overhead—Mr. Sheffield threw out the hint that as the latter was the cheaper it should be tried for suburban traffic, using the bow trolley as in Germany. He then referred to the advantage of electric tramways or light railways for the carriage of merchandise, remarking that if the railways took a common-sense business view of the matter they would accept the inevitable, and encourage goods traffic on electric tramways by making connections with their goods yards and warehouses. In this way the tramways would act as valuable feeders to the railways, which would be able to reduce their costly cartage departments. He saw no reason either why specially-constructed tramway wagons should not be allowed to run over the railway systems, thus enabling them to work colliery sidings and factories. In conclusion, he advocated the standardisation of all tramway rolling-stock to permit of free interchange of traffic on adjacent systems.

Electrolysis of Fused Lead Chloride.—The *Journal* of the Chemical Society for November contains an abstract of a paper by Mr. A. Appelberg describing some experiments he has made regarding the electrolysis of fused lead chloride with reference to its connection with current density and current yield. The author has determined the current yield and studied the phenomena which occur at the cathode and at the anode in the electrolysis of fused lead chloride. The arrangement was similar to that used by Helfenstein in previous work, and the fused lead chloride was contained in a V-tube. The results (exhibited in tables and graphically) which are obtained with varying current density show that as the density decreases the yield of lead diminishes regularly. If the current yield curve be extrapolated, it meets the current strength axis at about 0·05 ampere; therefore, if the current strength is reduced below this, no lead is separated. The minimum current intensity corresponding with this point is about 0·6 volt, but these values are not absolute, since they vary with the conditions of the experiment—such as temperature and distance between the electrodes. With high-current densities the polarisation is almost constant at 1·25 volts, and is independent of the density. The chlorine yield was determined by Auerbach's method, using varying current density. With high densities the yield agrees with the lead yield, but with low densities the agreement is not good, and this is to be attributed to variation of the experimental conditions. The electrolysis takes place in a cylindrical vessel standing either vertically or obliquely, just as in the V-tube; in all cases the current yield is independent of the duration of the electrolysis. When a cylindrical cell was used, a cloud of lead was always produced in the lead chloride; in order to avoid this a current of chlorine was passed throug the fused mass, but this was not successful and it lowered the current yield.

Railway Electrification.—"A Correspondent" contributes a three-column article to the *Times* of Tuesday under this title, but he does not enter into any especially controversial points. For instance, experts are agreed that a certain part of the traffic abstracted from railways can be better handled by trams and tubes than by steam trains, but that if the railway companies were to electrify their local lines they would succeed up to a certain point in stemming the present severe competition of the newer forms of locomotion. The real solution of the problem is to be found in a more rapid acceleration of the trains, and this can only be effected by adopting electric traction. The writer thinks that, under certain conditions in this country, the reduction in the cost of working by electricity would be sufficient to meet the interest upon the capital outlay. This cost of working, however, is largely dependent upon the price at which electric current can be obtained, and the writer regards the ideal arrangement as being that existing in the case of the North-Eastern Railway, where the company is obtaining its supply from a power company which, owing to the variety and extent of its load, can produce and sell at a far lower figure than any independent station. It is to be hoped that the railway companies in the neighbourhood of London, when the time should arrive, will co-operate as far as possible in obtaining their supply of electricity. Now that many of the large electrical companies are moving their stations into the outskirts of London in order that they may generate current

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under more favourable and economical conditions than hitherto, it should be possible for some of the suburban railways to arrange with them for the supply of current at a reasonable figure. The writer concludes that a carefully designed scheme of electrification could be carried out at a much lower cost than is generally supposed to be the case.

Telephones in Paris.—A report has been issued by Mr. Marcel Lembat, a member of the Chamber of Deputies, on the postal telegraph and telephone services in France during 1903, a very interesting portion of which deals with what is called the telephone crisis in Paris. Mr. Lembat notes that the subscription rate in that city is £16 per annum, and although the administration promised to reduce this rate to £12, nothing has been done in the matter. For the present rate an unlimited number of conversations is allowed within the Paris area proper, which embraces 48 exchanges. There were in the city on Oct. 31, 1902, total connections to the number of 40,555, or only 1·49 connections for every 100 inhabitants, this being much lower than the average for other European cities or in America. The apparatus, with the exception of the batteries, has to be supplied by the subscribers at their own cost, but the maintenance is at the cost of the State. The patronage of the system is not extensive, as it appears that the daily use of the instrument does not reach above five conversations on the part of 53 per cent. of the subscribers, while less than 9 per cent. use the telephone more than 15 times a day. Under these circumstances, Mr. Lembat advocates the message-rate system, which is working well in many countries at the present time, and has resulted in a remarkable increase of subscribers. He insists that a reform of this kind ought to be made, although considerable change in mechanism and apparatus would be necessary. The telephone service provided in Paris at the present time is described as inferior, and great difficulty is often experienced in getting com munication. Mr. Lembat closes with the satirical enquiry, What would happen if a private company dared to do that which the State is at present doing, and strongly recommends the Government to lower the flat rate and institute the message-rate system.

Industrial Decentralisation.—At the Surveyors' Institution on Monday night a paper was read by Mr. Herbert T. Scoble on "Industrial Decentralisation an Important Factor in the Solution of the Housing Problem." The author state that a comparison of the advantages and disadvantages of town and country with regard to factories and labour showed a substantial balance in favour of the latter, though exceptional cases would occur from time to time, and must be taken into account. Descriptions given of two recently erected factories, one rural and one suburban, lent weight to the author's contention that decentralisation pays, and it was stated that most substantial economies are made in the handling of goods, in rent, rates, insurance against fire, etc. The model villages of Port Sunlight and Bournville were dealt with, and the design and accommodation of the cottages received special attention. The effects of decentralisation were considered as regards manufacturers, workers, and the community; and a case was quoted where, by removal to the country, manufacturers of machinery were enabled to reduce the price of their goods by no less than 20 per cent. Mr. Scoble's view is that by migration to rural or semi-rural districts the manufacturer will be in a position to produce more cheaply; that if he studies the interests of his workpeople, comfortable houses will be erected for them; and that, by virtue of the lessened cost of manufacture, more successful competition in the home, colonial, and foreign markets may be expected. The establishment of factories in the country and the housing of labour in the immediate vicinity will do more to solve one of the most pressing problems that have to be dealt with—viz., the housing of the working classes—than the erection by municipal or philanthropic effort of tenement buildings in towns near our industrial centres, or the provision of transit facilities which must inevitably lead to greater congestion.

Indian Telegraphs.—The chief point that strikes one in looking through the report of the Indian Telegraph Department for the year 1902-3, which has just reached this country, is the proportionately small loss incurred through the reduction in the rates of cable messages between India and Europe from 4s. to 2s. 6d. a word. This favourable result can only be traced to the increased business which the lowering of the rates brought in its wake. Thus, the foreign private message revenue only fell off by 3½ lakhs, and this was due not so much to the reduction in the rates as to the diversion of the Australian traffic with Europe, formerly transmitted *viâ* India, to the direct cable route *viâ* South Africa. The total receipts for the year amounted to 112½ lakhs of rupees, showing a slight advance on those of the previous year, and the net profit gave a return of 4·15 per cent. on the aggregate capital expenditure of over 795 lakhs. With regard to the present position of the department, there were at the end of the year under review 5,652 telegraph offices, 56,830 miles of lines, and over 200,000 miles of wire. The report states that the Wheatstone automatic apparatus has proved invaluable in disposing of the traffic in times of pressure and prolonged interruptions of communication, and was of great assistance in connection with the work entailed on the department by the Delhi Durbar. Coincident with the issue of this report, the Indian Government announces a revised inland tariff, reducing the charges for all three classes of messages known as urgent, ordinary, and deferred, and also for Press messages. For the first class of messages the new rate is two rupees for 16 words, and is double that for ordinary telegrams. The minimum charge for deferred messages has been correspondingly decreased from eight annas to four annas. Under the system prevailing in India the address of six words is sent free of charge, and four words of message can be sent for four annas, each additional word being charged one anna.

Dublin Local Section.—The address delivered at the inaugural meeting of the Dublin Local Section of the Institution of Electrical Engineers on the 12th inst. by its chairman, Prof. W. E. Thrift, may be described as a general review of present-day progress in matters electrical, which embraced many of the latest and more important inventions of electrical science. From the Nernst lamp—for which the professor predicted a great future—to the steam-turbine, the gas-engine, the three-phase induction motor, the single-phase motor, and the Cooper-Hewitt mercury vapour lamp, the author passed in quick succession, describing the principal features of each and offering some comments. Particular reference was made to the Curtis steam-turbine, and in passing it was noted that the claim is made for it that the efficiency at light loads is nearly as high as that at full load. The gas-engine he regarded as likely to prove a formidable competitor of the steam-engine in driving large-type generators, whether for power or lighting purposes. On the other hand, attempts are being made to increase the efficiency of the steam-engine by combining with it a vapour-pressure engine, but it yet remains to be seen whether in practice the increased economy in working makes up for the increased initial expenditure. On the subject of electric traction,

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it was noted that the present year has witnessed the first conversion in the United Kingdom of a steam railway into an electric railway, the reference, of course, being to the Mersey Railway. The author passed on to refer to local affairs, particularly to the completion of the new city lighting scheme, by which Dublin is provided with three-phase current generated at the Pigeon House. A long treatise on polyphase motors followed, special reference being made to the successful work of Mr. Heyland in this field, and of M. Latour. The next section of the address was devoted to the recent discoveries of radio-active bodies, which have opened up a new sphere of analysis and investigation, and the author expressed the belief that in radium there may be found the long-sought-for cure for cancer and consumption. The electron theory is little more than in the initial stage of its mathematical development, but it presents problems to the mathematician to solve of almost infinite variety and complexity, whether with regard to its own nature and properties, the explanation of gravitation and the proportionality of mass and weight, or in reference to the part which it plays in the structure of the atom.

Electricity in Railway Workshops.—The Government of Queensland, Australia, has recently completely reconstructed its large railway workshops at Ipswich, and as a natural consequence, perhaps, the electric drive has been adopted for all the large machine tools. The decision to equip the new works for electrical working was only come to after exhaustive enquiry, which showed that the electric drive was most economical and the most suitable for the conditions to be encountered. The works comprise 14 different shops, covering an area of five acres; and the distribution of the electric power is carried out by underground conductors. The power plant which has been laid down consists of three generating sets, each set being made up of a 200-kw. Westinghouse two-phase generator, directly connected to a Westinghouse compound engine, and controlled from a white marble switchboard. The generators are of the rotating armature type, delivering two-phase alternating current at 60 cycles and 220 volts. These generators carry full load continuous at 90 per cent. power factor, with a rise in temperature in any part not exceeding 40deg. C.; with a 25 per cent. overload the rise under the same conditions does not exceed 50deg. C. The machines have an efficiency of 93 per cent. under full non-inductive load. The exciting plant consists of a 17½-kw. Westinghouse engine type generator, directly connected to a Westinghouse 8½ by 8 standard engine, running at 350 revolutions per minute. The switchboard is of the Westinghouse standard type, and consists of seven polished white Italian marble panels. The general arrangement of the board is of the double-throw type. The engines are vertical single-acting, compound condensing machines. The cylinders are 18in. and 30in. in diameter and the stroke is 16in., taking steam at 150lb. pressure. The speed of these engines is 250 revolutions per minute. The boiler-room contains four Babcock and Wilcox boilers, each having a heating surface of 2,823 square feet and capable of evaporating under normal conditions 7,380lb. of water per hour at 150lb. pressure. The stoking is done automatically. The plant was installed by Messrs. Noyes Bros, of Melbourne and Sydney. The main shops which are supplied with electric power are the boiler, machine, and erecting shops, where the greater portion of the electricity is required for driving the metal-working tools. It is also used, but not to so great an extent, in the carriage and wagon shops, paint shop, ironfoundry, smithy, wheel shop, two sawmills, and the patternmakers' and forge shops.

The Italian Royal Visit.—The Council of the Institution took advantage of the presence of King Victor Emmanuel of Italy and Queen Elena in this country last week to present an address to his Majesty expressing recognition of the courteous and generous hospitality accorded to the members of the Institution during the visit to Italy in the summer. The deputation, which went down to Windsor by special train on Friday afternoon to present the address, consisted of Mr. Robert Kaye Gray (president), Lieut.-Colonel R. E. Crompton, C.E, R.E., Sir H. Mance, C.I.E., Dr. J. W. Swan, F.R.S., and Prof. Silvanus P. Thompson, F.R.S., accompanied by Mr. W. G. McMillan (secretary). The party was received in the Vandyck Room of the Castle, being introduced by Lord Kenyon (Lord-in-Waiting). The King, who wore Italian uniform, having shaken hands with the members forming the deputation, received the address graciously, and afterwards entered into general conversation, in course of which he disclosed an intimate knowledge of the progress of electrical and telegraphic science and engineering within his dominions. The address was in the following felicitous terms: "The Institution of Electrical Engineers in Great Britain having in the spring of the present year rendered homage at the tomb of the illustrious physicist, Alessandro Volta, and having visited the electrical railways, power stations, and works which form so noble a monument to Italian enterprise to-day, humbly beg permission to avail themselves of the present opportunity and to lay before your Majesty an expression of their recognition of the courteous and generous hospitality accorded to the members of this Institution, not only by their sister society, the Associazione Elettrotecnica Italiana, and by electrical engineers generally, but also by the various municipalities and corporations of the districts visited by them. The members of the Institution who were fortunate enough to visit your Majesty's dominions will never forget the genial kindness of their reception by the distinguished engineers and others whom it was their privilege to meet. During your Majesty's presence in England the President, Council, and members of this Institution respectfully tender an assurance of their devotion to the sovereign of a nation for whom they entertain feelings of the highest respect, admiration, and affection. We ever pray that the friendship and good feeling between the two countries, of which the warmth of our reception in Italy gave convincing proof, may continually grow in intensity, and that your Majesty may long be spared to guide the destinies of a nation to whom the people of this country are united by the bonds of an inalienable sympathy." Telegrams were dispatched the same evening to the Associazione Elettrotecnia Italiana and to the Milan Section of the Associazione, and the following replies have been received: "Most sensible to the feelings that inspired your kind telegram. I thank the Institution of Electrical Engineers for the new proof of sympathy, and return most hearty greetings in the name of the Associazione Elettrotecnica Italiana. (Signed) Ascoli." "Homage added by Institution of Electrical Engineers to enthusiastic reception to our king by all England was learned with grateful feelings by Milan Section Associazione Elettrotecnica Italiana as a new token of friendship binding scientific bodies of the two countries. (Signed) Bertini." Many of our readers, and more particularly their lady friends, will doubtless be interested to hear that amongst the Italian ladies who were presented to H.M. the Queen of Italy at the Italian Embassy last week was Mrs. W. B. Esson. Mrs. Esson's father bore the illustrious name of Giustiniani, and fought with Garibaldi in the cause of independence. The lady was born in Rome, and her mother was a Venetian.

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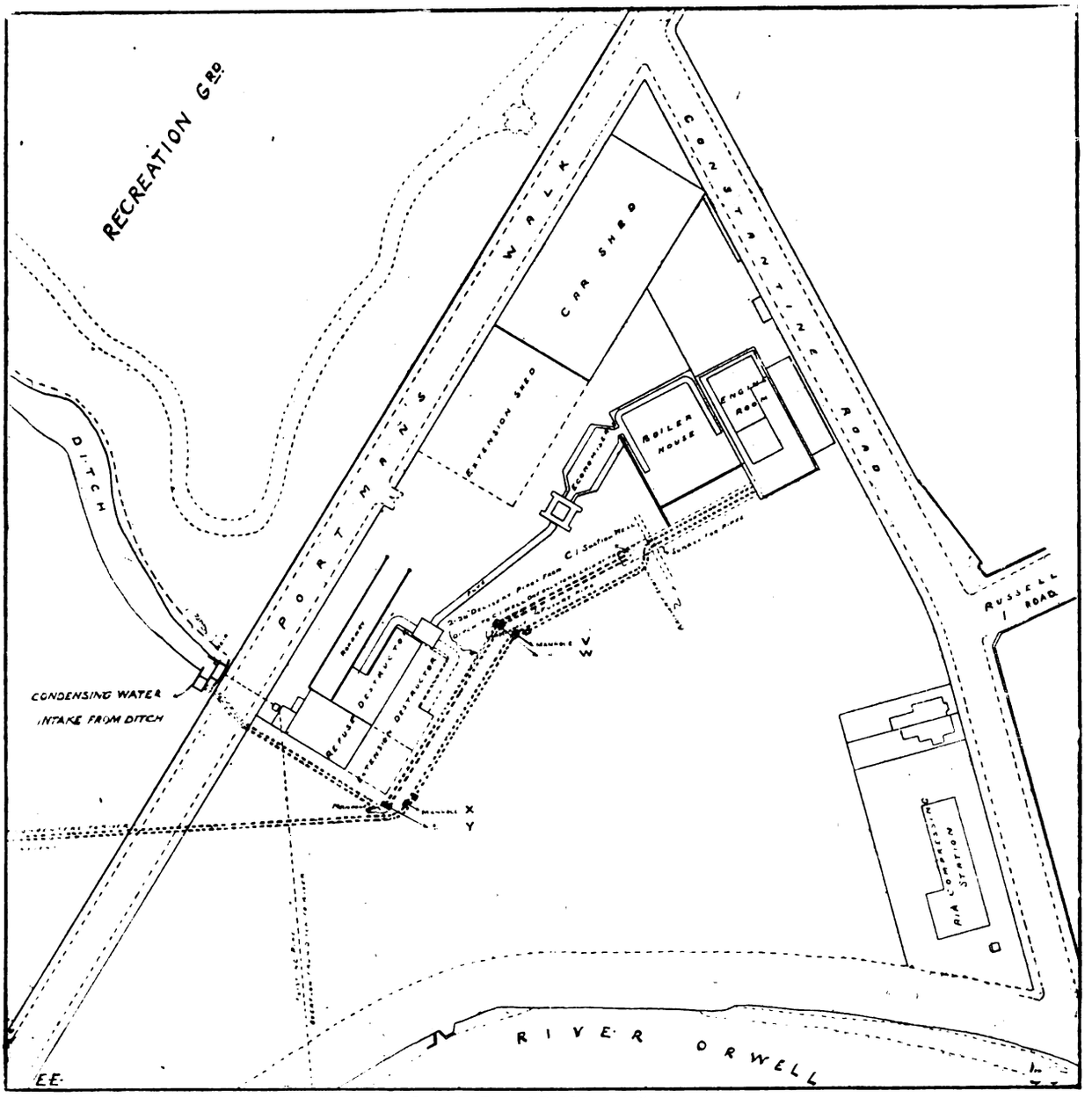
IPSWICH TRAMWAYS.

The formal opening of this system took place on Saturday, Nov. 21. We have taken part in many a function, but never in one so badly managed as this. The good people of Ipswich seem to think the representatives of technical papers are so badly off for a lunch that they will upon urgent invitation travel many miles to get one, and upon arrival find they must hunt through a large room to find if a chair is provided for them, like a hungry dog after a bone. The citizens of Ipswich will, in our opinion, long rue the day when this particular scheme was determined upon. Tramways are excellent things under certain conditions, but if the shopkeepers of Ipswich are not up in arms ere long they will prove more than human. The conditions in certain streets at Ipswich are altogether against the success of the scheme as carried out. These streets are narrow, so narrow that between tramrail and kerb there is not room for a cart or carriage or even a barrow. How the ordinary business of all these shops is to be carried on without interminable friction will puzzle the authorities. Probably the shopkeepers during the inception and early discussion of the scheme never realised what the end would be, and when their opposition might have been effective did not oppose—hence, we presume, will have to bear their loss as best they can.

In connection with this part of the question, however, the following report may have some importance. A case came before Mr. Justice Jelf at Manchester relating to the driving of a tramcar, and the judge is reported to have said: "Tramcars have no more right to the highway than I have, and the drivers must exercise reasonable and proper care. They had not the slightest right," he added, "to say to people, 'At all risks get out of the way,' but they must get out of the way themselves if the necessity arose." It is the general notion that under all circumstances other traffic must give place to tram traffic, but we believe the judge is right and general opinion wrong. The general conditions are that other traffic can, without loss or inconvenience, give place to the tram traffic; but we have yet to see tested the case where other conditions prevail.

It has been our good fortune to visit Ipswich several times recently and thus to examine the works during progress. The genial and energetic engineer (Mr. Ayton) was good enough on one of these occasions to visit with and describe to us the works, and there is no doubt but that the contracts have been carried out under his constant superintendence in an excellent manner. The detail drawings given herewith explain themselves, and will give a better idea of the works than any amount of words. It is sufficient to say that Messrs. Kennedy and Jenkin are the engineers and Mr. Peach the architect, in order to know that from the engineering point of view the greatest care has been taken to obtain an installation as perfect as knowledge and experience can make it.



Ipswich—Plan of Buildings on Site.

Our illustrations show (Fig. 1) the plan of buildings on

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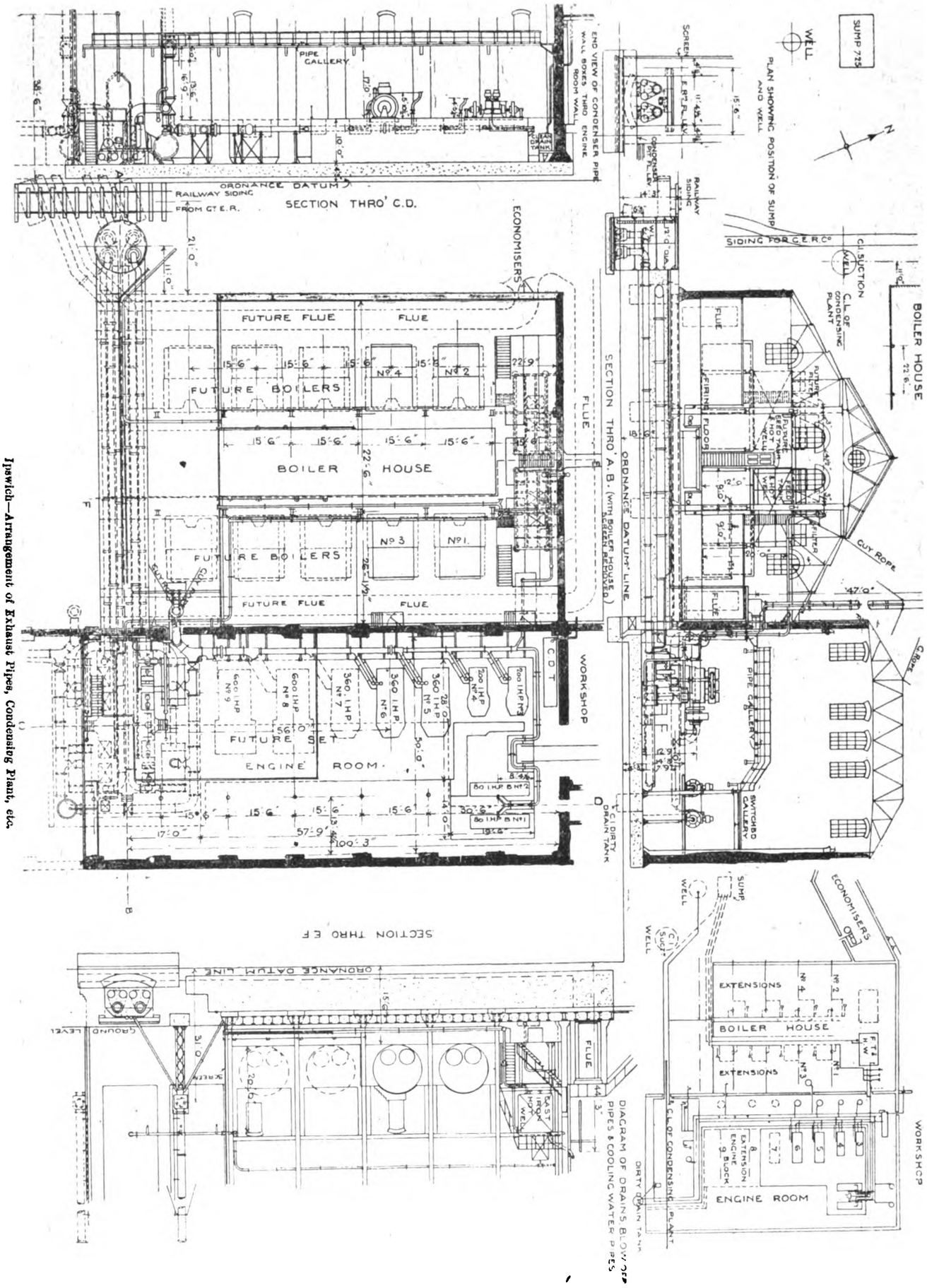
the site. The contractor for the buildings was Mr. S. A. Kennay, of Ipswich, the amount of the contract being £26,948 for the generating station and £6,704 for the car-shed. In the latter are eight sets of rails for 40 cars, of which 26 are now in use. Figs. 2, 3, and 4 show details of arrangement of plant and lighting. It will be seen that the station is combined with a destructor, which is of the Meldrum Simplex type. The destructor and

shaft were built by Messrs. Shillitoe, of Bury St. Edmunds, who had a good deal of trouble with the foundation of the shaft. This is on a concrete base 46ft. square and 12ft. deep, with three layers of expanded metal embedded in the concrete. The shaft at the bottom outside is 21ft. 6in. across, and the walls are 3ft. thick. It is 178½ft. high, and is 12ft. square inside at the top, the wall at the top being 1ft. thick. The shaft is lined with firebricks



Ipswich—Arrangement of Exhaust Pipes, Condensing Plant, etc.

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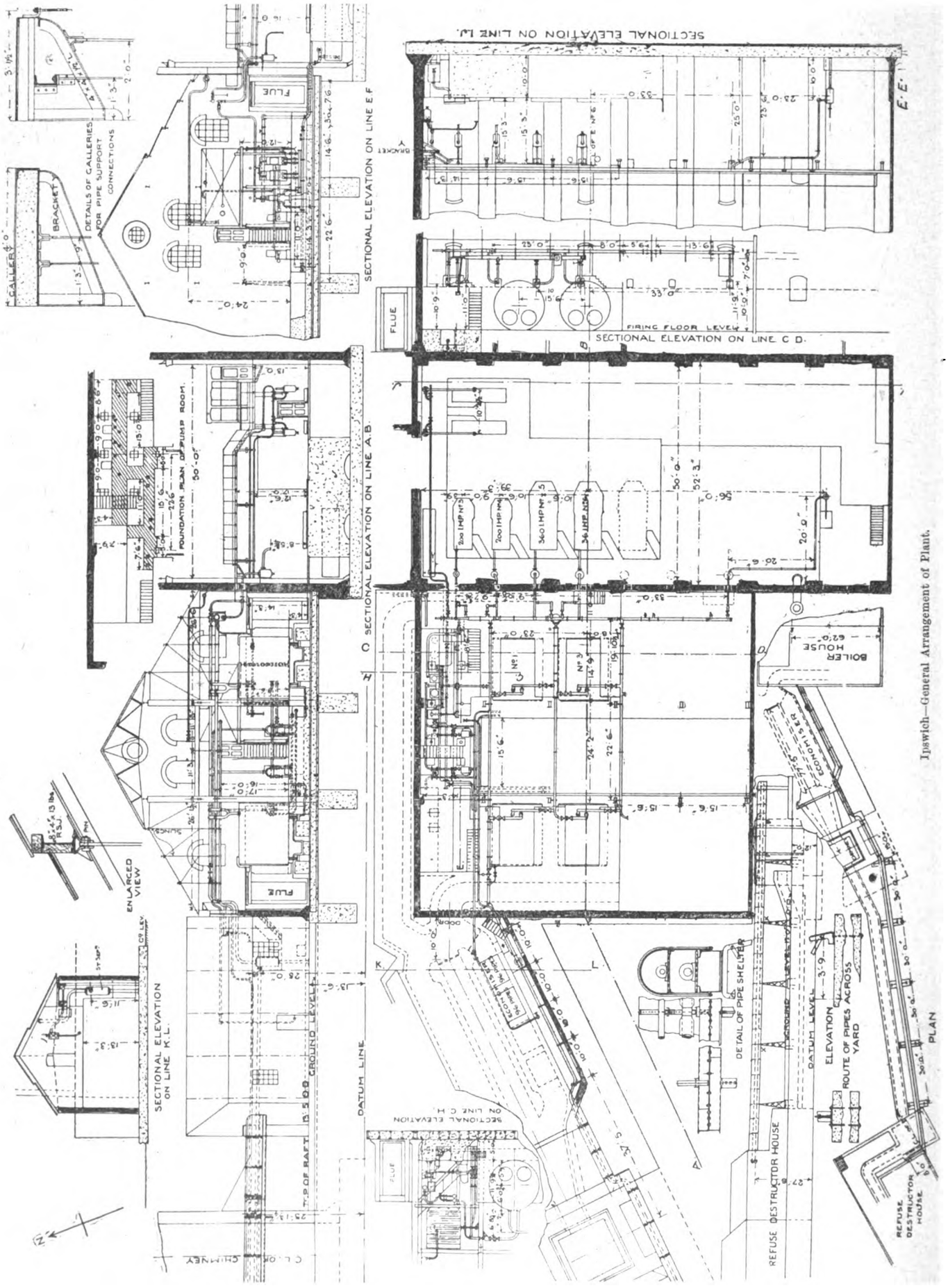
to a height of 97ft. above the top of the footings. The destructor buildings are of brick and corrugated iron. The tipping platform is approached by an inclined road-way from Portman's-walk. The refuse is shot down into a pit, from which it is shovelled into the destructor by hand. The destructor is worked by forced draught, and is connected with the shaft by a long flue on the opposite side to the flue from the generating station.

The boilers, by Messrs. Danks and Co., of Oldbury, are of the marine tubular type, 14ft. 9in. long and 11ft. in diameter. The combined engine and dynamo sets have Reavell engines combined with dynamos of the Allgemeine



Ipswich—General Arrangement of Plant.

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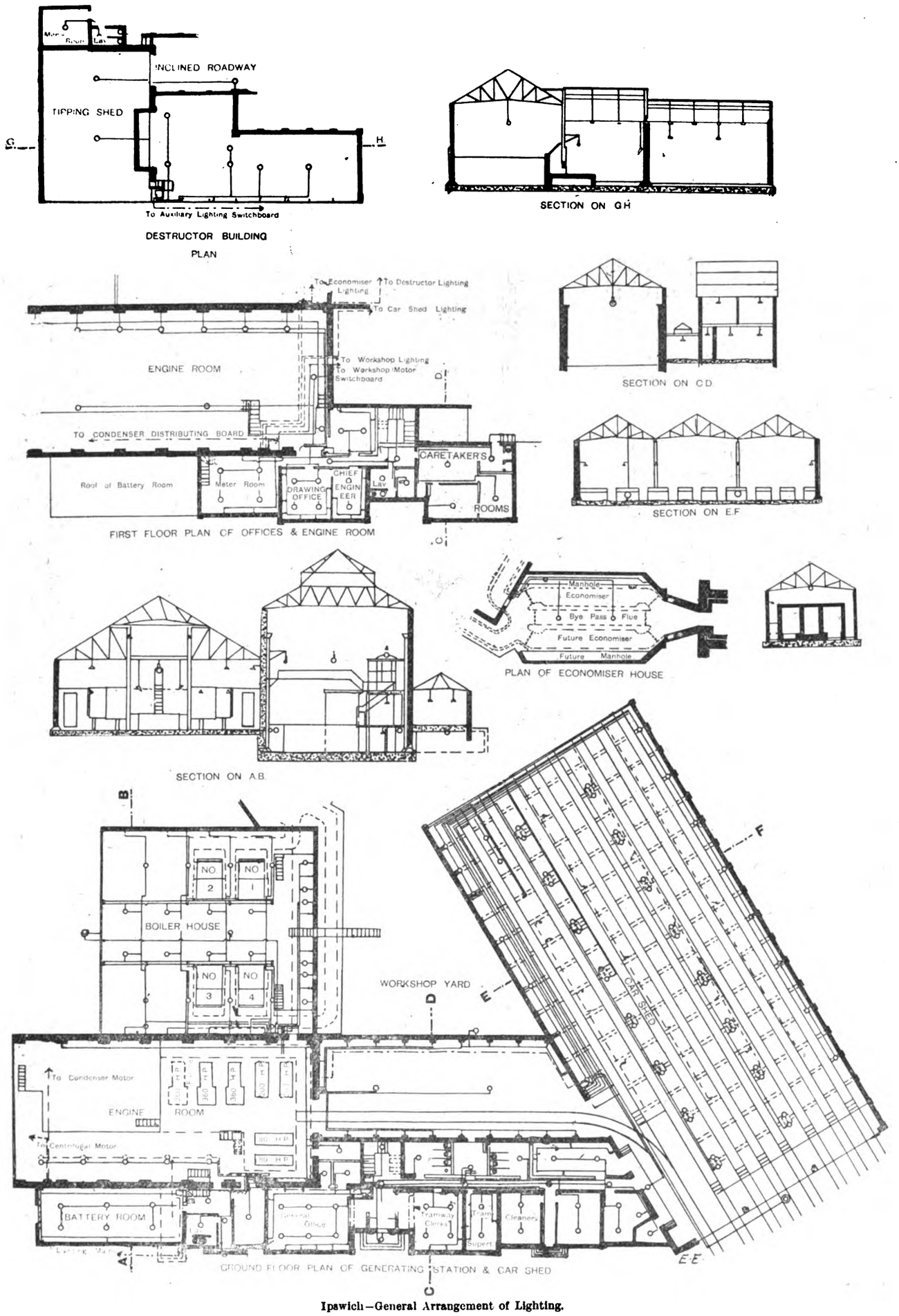
Company's type, supplied by the Electrical Company. Messrs. Reavell and Co. have supplied in all six high-speed engines, the two largest capable of an output of 240 kw., two sets capable of 120 kw., and two balancing sets. The engines are all of the three-crank compound type, and can give 360 h.p., 200 h.p., and 80 h.p. respectively. The dynamos are for generating continuous currents. The two largest dynamos, for the tram work, are compound wound; whereas all the smaller ones, for lighting, are shunt wound.



Ipswich—General Arrangement of Lighting.

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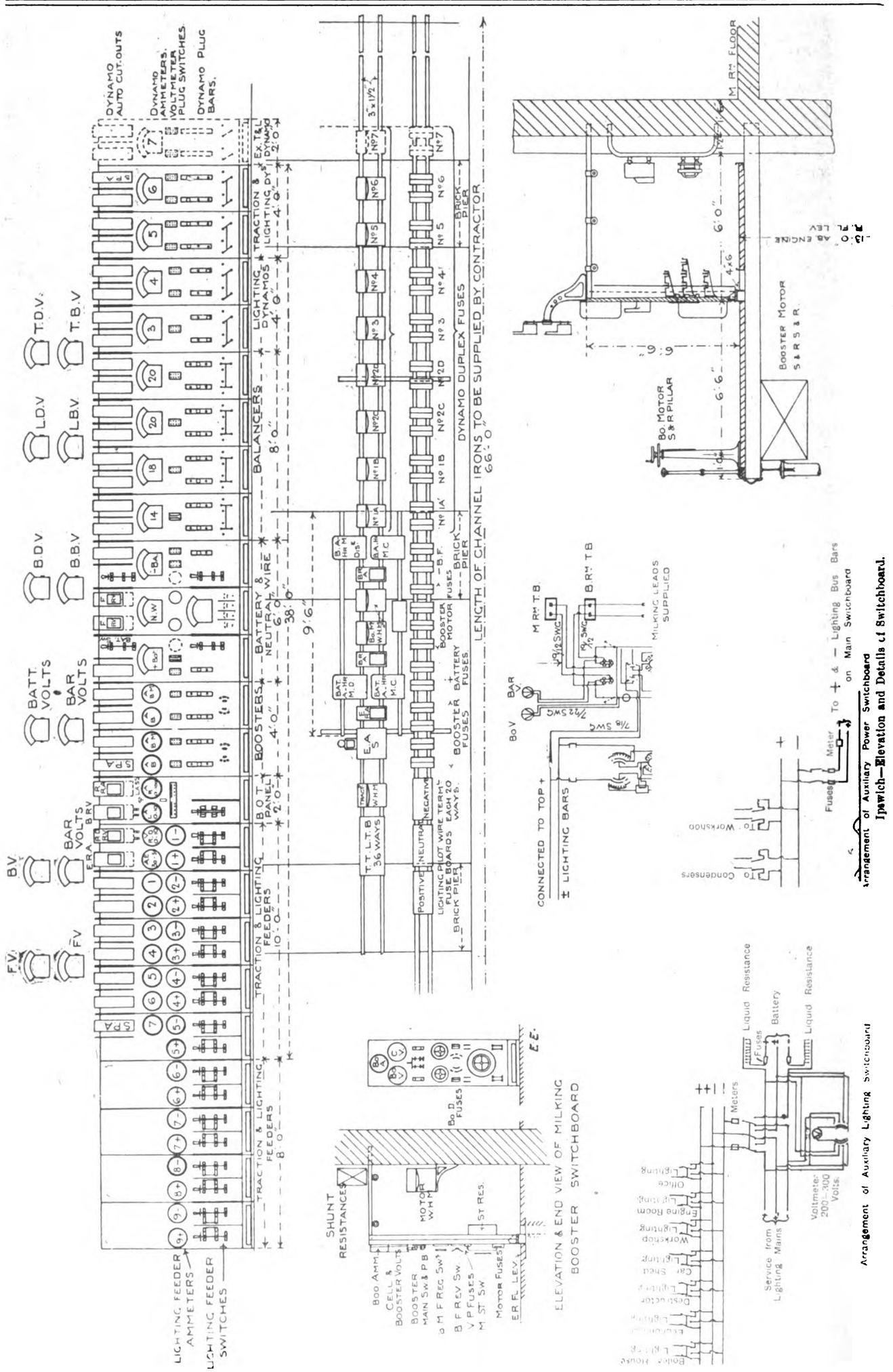

Arrangement of Auxiliary Power Switchboard Ipswich—Elevation and Details of Switchboard.

The switchboard, the details of which are shown in Fig. 5, has been designed by Messrs. Kennedy and Jenkin, and supplied by the Electrical Company. It is divided into 21 panels of polished marble, on which the instruments are

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mounted as shown in the drawing. The whole of the copper work on the switchboard is coated with tin. A battery of 124 cells, each cell with a capacity of 400 ampere-hours, has been supplied by the Tudor Accumulator Company. The steam pipes, exhaust pipes, etc., have been supplied by the Sir Hiram Maxim Electrical Company, who also supplied the surface condenser and pumps. Messrs. Johnson and Phillips have carried out the cable work both for the tramways and electric light. Messrs. Dick, Kerr, and Co. laid the permanent way, and this extends to something over 10 miles. In fact, the total length of single track is over 25,000 yards. The cars are of the single-truck double-deck type, capable of seating 50 passengers—24 inside and 26 out—and are supplied by the British Westinghouse Company, with the Brush Company as sub-contractors. The overhead equipment is by the British Electrical Equipment Company. There are 500 street poles 25ft. high above ground and 6ft. below, the buried part fixed in concrete. Section boxes are provided about each half mile of line.

INDEPENDENT TELEPHONY IN GREAT BRITAIN.

BY GARDNER AND HOLME.

(Continued from page 765.)

(6) Overhead Construction.

In the past and even present day, few engineers have realised the importance of good substantial overhead construction. An article appeared in a South of England newspaper only about a year ago stating that anyone could string up telephone wires, as they were as easily done as clothes lines. Such a statement confirms exactly what has been the general idea and practice of some for years, and which telephone users have found to their cost. There is no part of the whole undertaking requiring more care and attention and skilled workmanship than the overhead equipment, and if done well and good material used in the first installation, it will save constant interruption, repairs, and expense in maintenance. Bad overhead construction in a telephone undertaking shows up more than in any other electrical work, as the circuits are numerous, and when once put up necessitate very often the whole of the work being done over again, and at a much greater cost than if done well in the first instance.

Within large towns lately underground cables have done away with much of the overhead work, but being limited to the main, sub-main, and distributing cables, still necessitate the use of overhead circuits for distribution, in the form of No. 18 bronze wire upon insulators from distribution poles to the subscriber's premises. Entire underground distribution has been carried out in Glasgow and London within the central area, but this only to a limited extent, as the enormous expense involved in the laying-out of a system to provide for all business and private houses entirely underground makes it prohibitive, and there is no system yet designed that solves the question or commends itself. Overhead distribution from poles placed in the most convenient and accessible positions will be taken as the present everyday practice. These positions being obtained from private owners or placed on the local authorities' property, should be chosen as central and as near each group of subscribers' premises as possible, in order that the distribution of the wires will be equal from all directions, and the length of each circuit as short as possible.

In selecting poles for distributing purposes, the probable ultimate cable capacity should be allowed for in height, as the erection of a larger pole afterwards to accommodate more lines is a very expensive matter. The position should also allow of staying in three directions, but where this cannot be obtained the pole should be set deeper and surrounded with concrete and bracket stays fixed. Distributing wooden poles should invariably be of stout specification. Methods of staying will be described in junction construction. Very often great difficulty is experienced in the handling of these poles in erecting, owing to the crowded state and height of the buildings adjacent to where they are to be placed. In such cases it might be cheaper to distribute from an iron standard or pole, placed on one of the tallest buildings, or to carry the underground cable up to the side of the buildings, and distribute them from a pothead or junction box fixed to the building. In many instances where a number of subscribers are located in the same building, this is the best and most practical way of reaching them and least costly. Iron standards placed on roofs are not commendable, as it means (if extensively used) the opening up of trouble and expense in maintaining the roofs. Roofs upon which it is proposed to erect a standard ought to be carefully examined by a thoroughly practical workman, and even if sound ought to be braced and propped inside to prevent straining. In selecting and settling the positions for distributing poles great judgment should be used. It has been found from experience that to get the positions as near to one another and as near to the main cable as possible, in order to equally distribute the subscribers' overhead lines, is the best plan.

Schedule of Prices to be allowed for carrying out the Erecting of Distributing Poles, Wires, Brackets, Insulators, and the Running of Overhead Wires on Poles and Roofs.

Description of Work to be Done.

Number or quantity of poles.	—	Rate each.	Total amount allowed for.
	75 feet set 8ft. 0in. in ground..... at	£	
	70 feet set 7ft. 6in. in ground..... .. at	£	
	65 feet set 7ft. 3in. in ground..... at	£	
	60 feet set 7ft. 0in. in ground..... at	£	
	55 feet set 6ft. 6in. in ground..... at	£	
	50 feet set 6ft. 0in. in ground..... at	£	
	45 feet set 5ft. 9in. in ground..... at	£	
	40 feet set 5ft. 3in. in ground..... at	£	
	36 feet set 5ft. 0in. in ground..... at	£	
	30 feet set 4ft. 6in. in ground..... at	£	
	28 feet set 4ft. 3in. in ground..... at	£	
		£	
Number or quantity of roof standards.	—		
	18 feet .....at	£	
	20 feet .....at	£	
	30 feet .....at	£	
	Pole roofs.....at	£	
	Pole finials .....at	£	
	Oak arms.....at	£	
	Stays and stay rods .....at	£	
	Stays outriggers .....at	£	
	Chimney brackets .....at	£	
	Wall eye spikes .....at	£	
	Insulators, long bolt .....at	£	
	Insulators, short bolt .....at	£	
	Insulators, coach screw.....at	£	
	Insulators, special pattern .....at	£	
	Soldering joints on distributing poles from cables to overhead wires .....at	£	
	Running —— miles lead-in wire to subscribers' premises .....at per yard	£	
	Running miles —— 100 copper wire on poles .....at per mile single	£	
	Running earth wire on poles, at per pole	£	
	Fitting pole steps .....at	£	
		£	
	Distributing poles at stations, including cartage, handling to positions, at per pole	£	
	Travelling expenses and out-allowances to workmen..... .....at per	£	
		£	
	Summary.		
	Erecting distributing poles .....at	£	
	Fitting and mounting ditto .....at	£	
	Fitting brackets, insulators .....at	£	
	Running overhead wires and lead-in wire at	£	
	Travelling allowances .....at	£	
	Cartage of poles and materials..... .....at	£	
	Total	£	

Fig. 27.

The sizes of the distributing poles and positions and wayleaves settled, the ordering forward and assembling of the stores, tools, and the general organisation of the work

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can now be arranged. From the plan and schedule of the quantity of work to be carried out, the amount of stores necessary to order forward and the number of tools and

FIG. 28.

tackle to be provided will be obtained. As it is understood that the work is to be carried out to a price as arranged from the estimate and schedule of quantities, the workmen each day, this amount of work in calculation equalling the amount of wages paid as shown in Fig. 27.

The superintendent in charge of the gangs and who arranges the work each day should make it his special duty to examine and pass same and see that each gang of men are provided with all the necessary tools, tackle, and stores, and that precautions are taken to prevent accidents. He should also be acquainted with the condition of all plant necessary for carrying out the work, and be held responsible that ropes, blocks, ladders, and other tools, any failure of which might result in an accident, are maintained in good condition. He should make a periodic inspection and, when necessary, condemn and break up at once any plant or ladders showing signs of fracture. He should observe that all men placed under his charge are qualified for the work required of them. This will prevent many accidents, and ensure a better class of work being done. The qualifications necessary for ordinary wiremen are to understand perfectly the mounting and arming of wood and iron poles, fixing combiners, preparing soldering irons for use, seeing that firepots, poles, wires, tackle, and ladders are not left in any position in which accidents might be caused by them, and that open holes are never left unprotected, to be able to bind in and make off wires on insulators, solder same, and to have a thorough knowledge of all stores and material, and see that no work of a temporary character is done. First and second class wiremen should be well up in the preparing of tackle and understand the selection of positions for the erection, staying, and setting of ground poles and standards, running of wire, fixing of brackets and spikes to buildings, running and stapling of leading-in wires, testing and numbering out cables, making of potheads on distributing poles, testing out with battery and galvanometer, making off and soldering overhead wires to underground cables, examining and fixing earth wires to poles for lightning discharge, and be able to test out and repair faults. The foreman in charge of these men should be able to organise the work and see

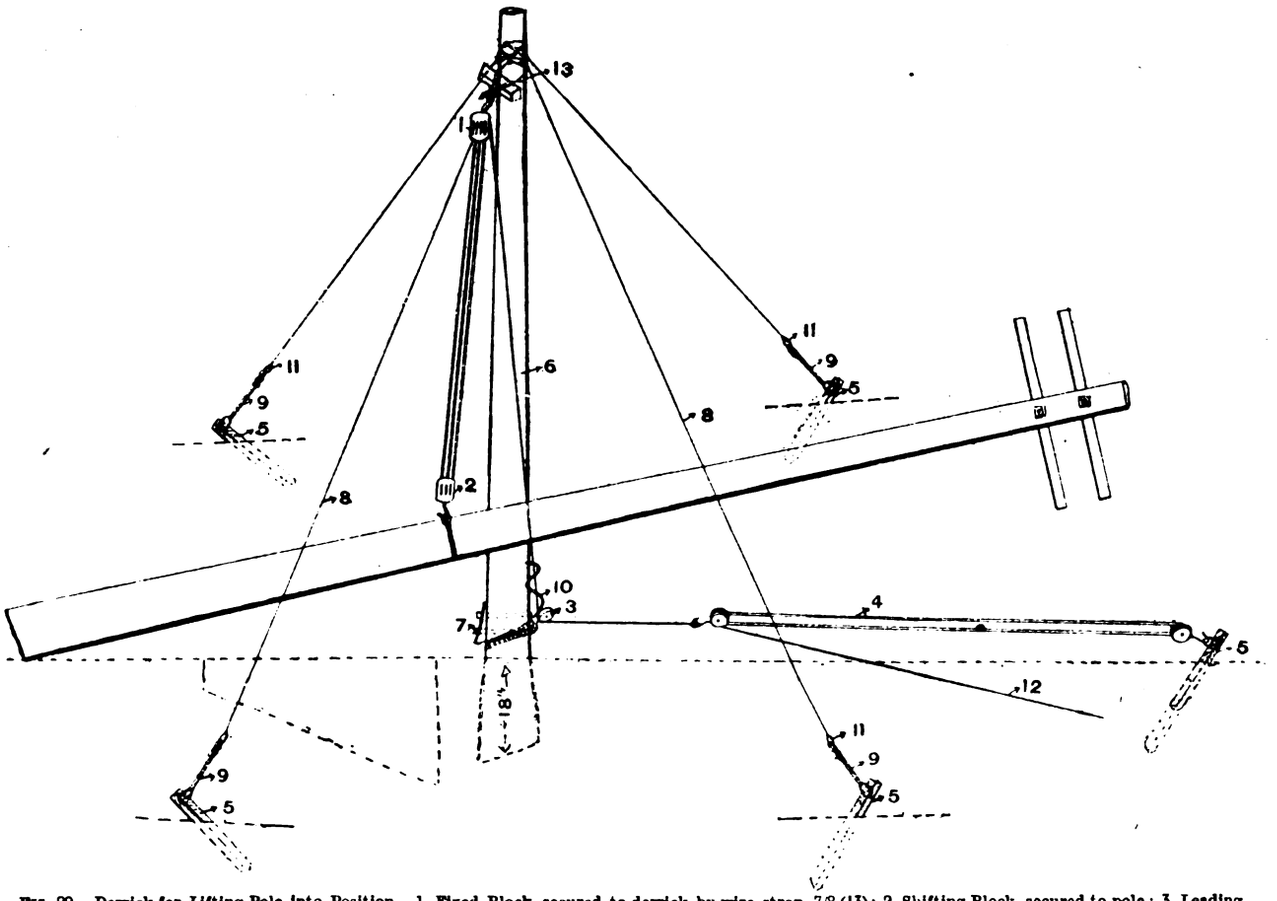

FIG. 29.—Derrick for Lifting Pole into Position.—1, Fixed Block, secured to derrick by wire strop, 7/8 (13); 2, Shifting Block, secured to pole; 3, Leading Block; 4, Luff Tackle; 5, 4ft. Holdfast. 2½in. by 2½in. T-iron with ring; 6, Derrick; 7, Chock; 8, Guys or Stays, ⅜in. flexible steel, fitted with eye for securing to holdfast; 9, 1in. Hempen Tail or Lanyard; 10, Stopper, for taking strain on fall of main tackle; 11 Eye; 12. Hauling Rope.

can be organised accordingly—that is, a number of gangs can be engaged and should consist of a first-class foreman, four wiremen, and two labourers to each gang. They should be organised to execute a stated amount of work same carried out thoroughly, be able to keep all records of work done, time-sheets and stores slips, understand all orders in reference to the receipt and issuing of stores and tools, prevent waste of material, and see all tools and

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materials safely under lock and key and not left lying about, and keep his superintendent well posted up in the progress of the work under his charge.

Poles up to 50ft. can safely be erected by ladders and guys, as shown in Fig. 28, but for large distributing poles a derrick should be used. A diagram of the tackle is shown in Fig. 29. In preparing the tackle for erecting a large pole, the following method should be adopted. The derrick should be erected by ladders, and stayed temporarily with light lines of sufficient strength to bear the fitting up of the guys, stays, and tackle. This being done, the mounting and arming of the large pole can be going on as well as the digging of the hole. The derrick should be planted about 1ft. or 18in. from the deep end of the pole hole and about 18in. in the ground, being held in position by guys and stays. These stays are best made of flexible steel stranded wire rope, and made off with a spliced eye or thimble to receive the lanyard tackle, which in turn is fixed or made off on the ring of the T-iron bars driven into the ground. These bars are best made up of angle T-iron 2½in. by 2½in. by 4ft. long, provided with a ring of substantial make for attaching the lanyard. The stays can be made of permanent length to suit the raising of all sizes of poles, as the idea of having a lanyard is to take up or let out the spread of the stay. These lanyards should be of 3in. hemp rope, and able to take the strain of the whole pressure at any time likely to be put upon them. The heavy tackle is next fixed to a small arm, which should be permanently bolted to the derrick, about 12in. from the top, and the heavy tackle should consist of a two and a three way block for a rope, and fitted with a hook to take the chain sling, by means of which the heavy pole is lifted.

The tackle being in position and ready for lifting, the next step is to fit the leading block in position. This is done by means of a sling or chain round the base of the derrick and under the chock, the chock being used to prevent the sling slipping in an upward direction when the strain is taken on the tackle. The leading block should be what is termed a snatch-block—that is, a block with a movable outer strap—the bite of the running end of the main tackle being placed in this ready for hitching on to the luff tackle. The luff tackle consists of a similar make to that already described, but of lighter design, and is for the purpose of increasing the lifting power, as will be seen from the diagram. The usual method of securing the tail end of the main tackle to the luff tackle is by a Blackwall hitch. A relief guy or stay should always be at hand ready to take the place of one of the fixed guys, as often the fixed stays prevent the pole as it is raised from being brought to a vertical position; this additional stay can then be used to free the obstructing stay.

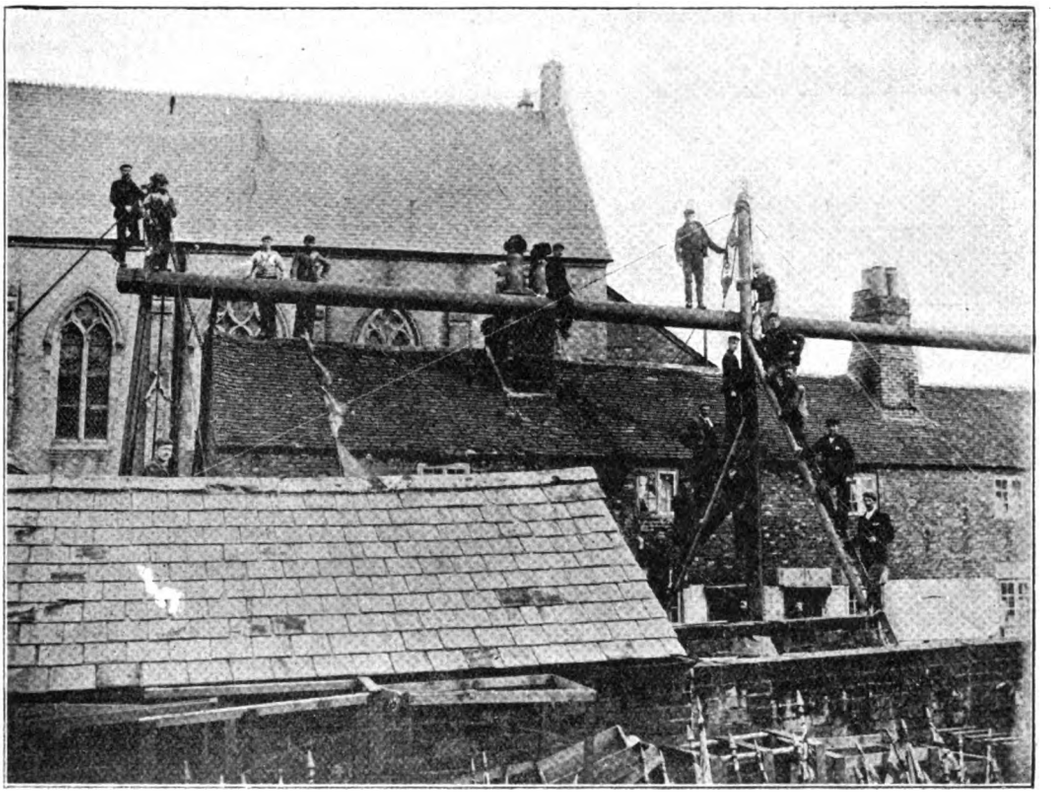

FIG. 29A.

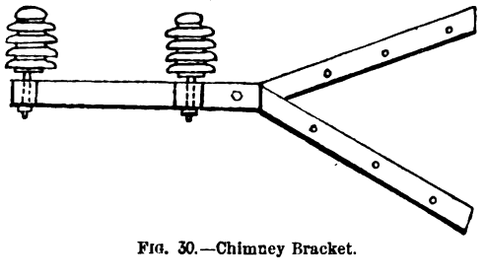

FIG. 30.—Chimney Bracket.

The poles being planted to the required depth, as a check upon this being honestly performed they are usually branded about 10ft. from the butt with a distinguishing mark, generally the local authorities' initials, and the dates of the month and year. Poles should always be set well against their work, for it is generally found when the ground sets the severe tension of the wires has pulled the poles upright, whereas if this precaution is not observed and the poles are set upright in their erecting the wires are almost certain to pull them over, and no amount of staying will bring them to the perpendicular. Arming and mounting poles should be placed in the hands of good men who are fitted for such, as, apart from the

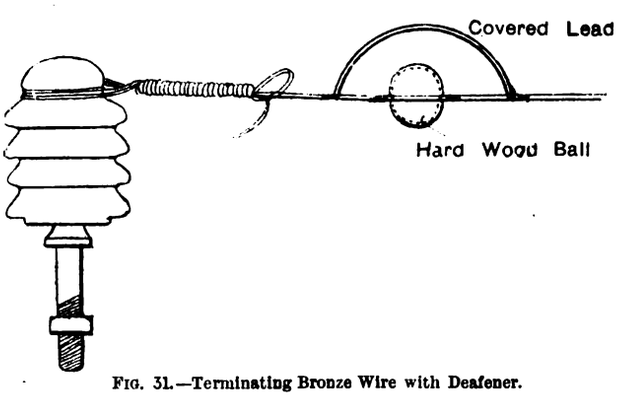

FIG. 31.—Terminating Bronze Wire with Deafener.

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irregularity in regulating the wires, if the arms are fitted badly their appearance is most objectionable.

Staying.—The power of a line of wires to resist wind storms, and to maintain immunity from faults or irregularities, depends upon its strength and rigidity. It is not possible to provide poles of sufficient strength to withstand unaided all the stresses to which they are exposed without resorting to a method of staying or strutting. In order to obtain this, stranded wires of galvanised iron are used, or in the case of struts a creosoted pole. The upper end of the stay is fitted after the manner which will be described under the heading of junction lines, and the lower end attached to a stay rod fitted with an adjustable stay tightener in the ground, the rod in the ground being fixed to a large wood block of timber fixed firmly and rigidly so that a wind storm shall not affect the structure.

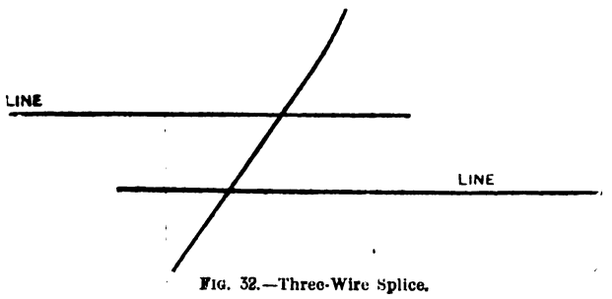

FIG. 32.—Three-Wire Splice.

Overhead Wires.—From the distributing poles to the subscribers' premises the overhead wires are run, and fixed to the chimneys or corners of the buildings by means of wrought-iron brackets or spikes, as shown in Fig. 30. To these brackets are fitted white porcelain insulators, preferably the pattern designed by Mr. A. R. Bennett, as they are in all ways more suited for telephone work than any other insulator, giving higher insulation and handier for making off wires. These insulators are for the purpose of preventing leakage and also supporting the wires. In attaching brackets to chimneys, the bracket should be fixed to the brickwork inside with the pull of the wires; if fixed away from the pull, an iron band should be placed around the structure or chimney. Roofs of old buildings should not be made use of for supports or brackets, as they form a source of endless expense. The foreman should in all

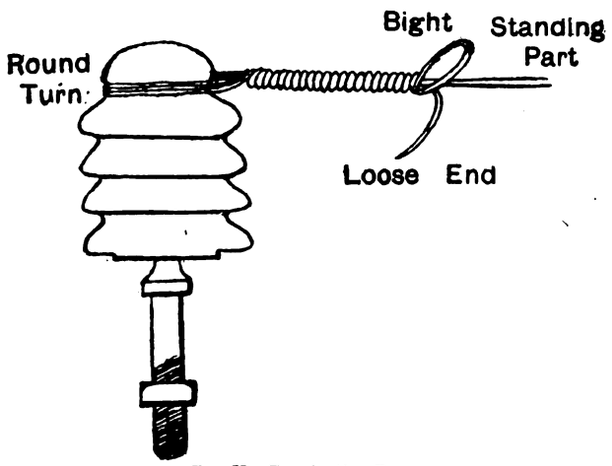

FIG. 33.—Terminating Bronze.

cases notify the owner or tenant, before commencing operations to fix his line, if the roof or structure shows any signs of damage. Wires should be kept absolutely clear of chimneys, lead roofs, or any such obstacles when first erected. One or two brackets will be found sufficient for each distributing line in a good underground system, and each insulator should carry its own wire, and each wire should be properly made off and soldered with bolt and resin to the insulated leading-in wire, which in turn is fixed by means of galvanised iron staples on the face of the building and run to the nearest inlet or window, the frame of the window being bored for the purpose of passing the insulated leading-in-wire through ready for connecting up to the inside apparatus. In the fixing of wires to buildings trouble is sometimes experienced through the humming noise, and several more or less effective methods of overcoming the difficulty exist. One plan is to bind in the bronze wires with strips of lead about ½in. wide, and twist the lead round the wires for a distance of about 12in. from the insulator. A better and more excellent method is to break the wires about 18in. from the insulators, and insert hard wooden balls doubly grooved for making off and terminating the wires, the continuity of the wires being made by bridging over the wooden balls with a piece of insulated wire. Fig. 31 gives a general idea of the method. It is inadvisable to cross power circuits or electric traction wires with open wires. These should be crossed at right angles and with special insulated wire, provided with a stranded steel core for attachment to the fixtures and the suspension and support of the insulated wires. In the running of bronze wires great care should be exercised in the handling. The wiremen should not be permitted to pay off with the hand, but should be instructed and made to use drums for the purpose, as if the wire receives the slightest abrasion or the skin becomes damaged it is sure to give way at the

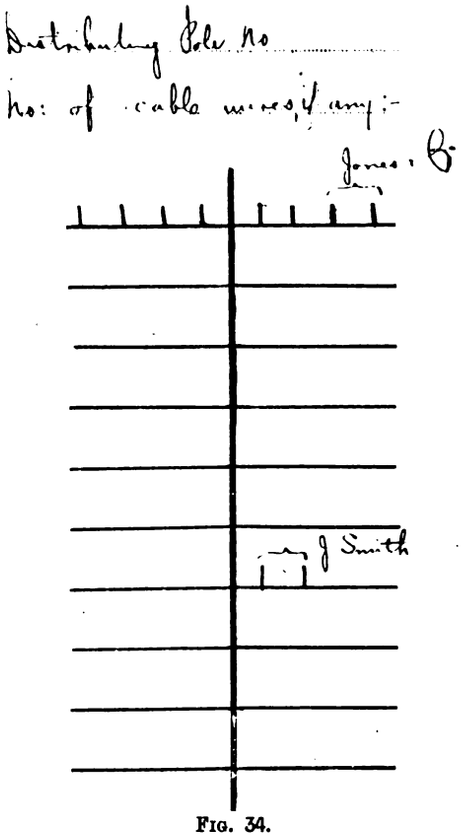

FIG. 34.

damaged part. The jointing of bronze wires should be done in the following manner: the two ends are laid together, overlapping each other, for a distance of about 9in., then twisted together in the centre position with a lay of about ½in. for a distance of 1¾in.; each end is then wrapped round the other wire for a distance of about ½in. The joint should be carefully soldered in the middle only. Soldering is most essential in all telephone joints, but many American engineers in place of solder make a joint which they consider it is not necessary to solder, and is known as the "three-wire splice." This is made by splicing in an extra piece of wire, as shown in Fig 32, after which it is finished the same as any other twist joint. It is much stronger, and is in our opinion better than the ordinary joint. In terminating or making off bronze wire, a length of about 30in. is allowed beyond the insulator, and at a point 12in. beyond the centre of the insulator the wire is doubled back on itself, the bite or loop thus formed being taken twice round the top groove of the insulator, and then bound tightly and closely round the main wire, as shown in Fig. 33. In running wires over roadways or across thoroughfares, watchmen should be stationed in commanding positions to warn drivers and passengers.

Numbering of Wires.—For the convenience of identifying working wires on distributing poles a diagram book should be kept (as shown in Fig. 34) giving all necessary informa-

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tion. Too much care cannot be exercised by telephone men in the erecting of overhead wires, and the damage done to buildings over which the wire has been drawn should in every instance be repaired the moment it is discovered.

(To be continued.)

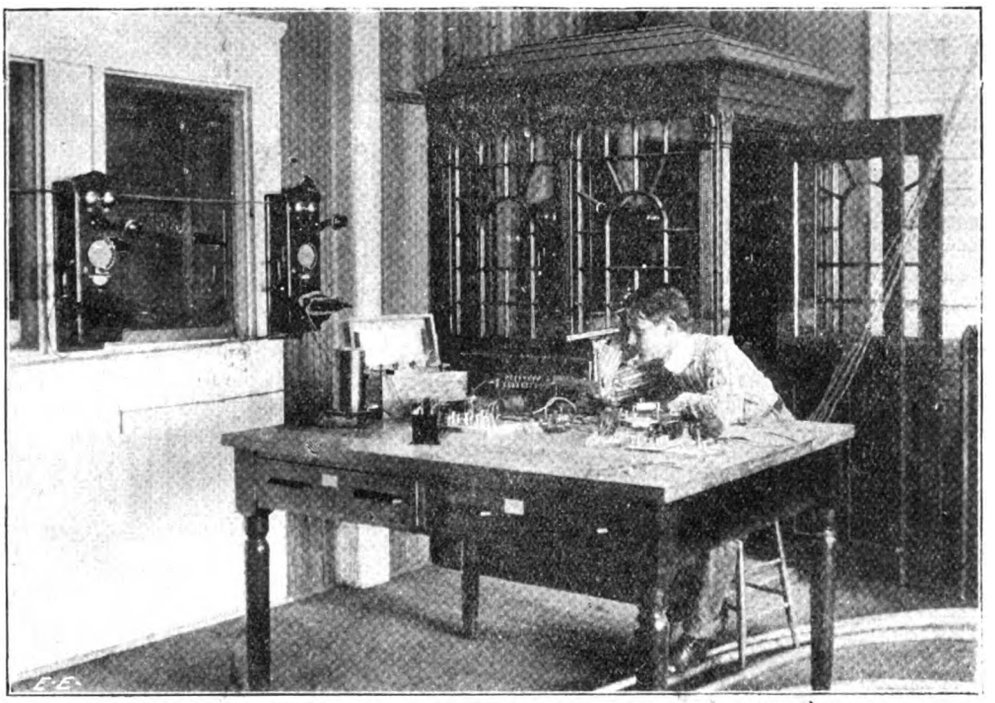

FIG. 1.—Sound-Proof Telephone Box with Cable-Testing Apparatus in Foreground.

TELEPHONE ENGINEERING AT PURDUE UNIVERSITY.

BY F. WELZ.

The great success which the American industry has shown in the last decade is largely due to the pronounced method of specialising which has taken place in the United States in all fields of business life. But not only that, the engineer and workman are exclusively specialists in their business, for the early education of the student is also more or less along special lines, this having been carried to a farther degree than is the case in Europe. The education which is given to an American student in his college differs very essentially from that which is given in England. The American high schools generally include large, prodigiously equipped laboratories, and a more practical education is given to the student than in England. These assertions are strikingly demonstrated by the fact that at Purdue University for more than two years a special school of telephone engineering has been created, and this is at present the only college in the United States where a special course for telephone engineers is given.

For the study of electrical engineering, generally four years are provided for. The future telephone engineers take the first two years together with the general electrical engineers, but in the third year the lectures on thermo-dynamics, mechanics, and steam engineering are omitted and are supplanted by special studies in the rudiments of telephone engineering. These special lines comprise lectures on telephone circuits, beginning with the old earth series system, continuing with the metallic self-restoring drop system and the now generally employed multiple common battery

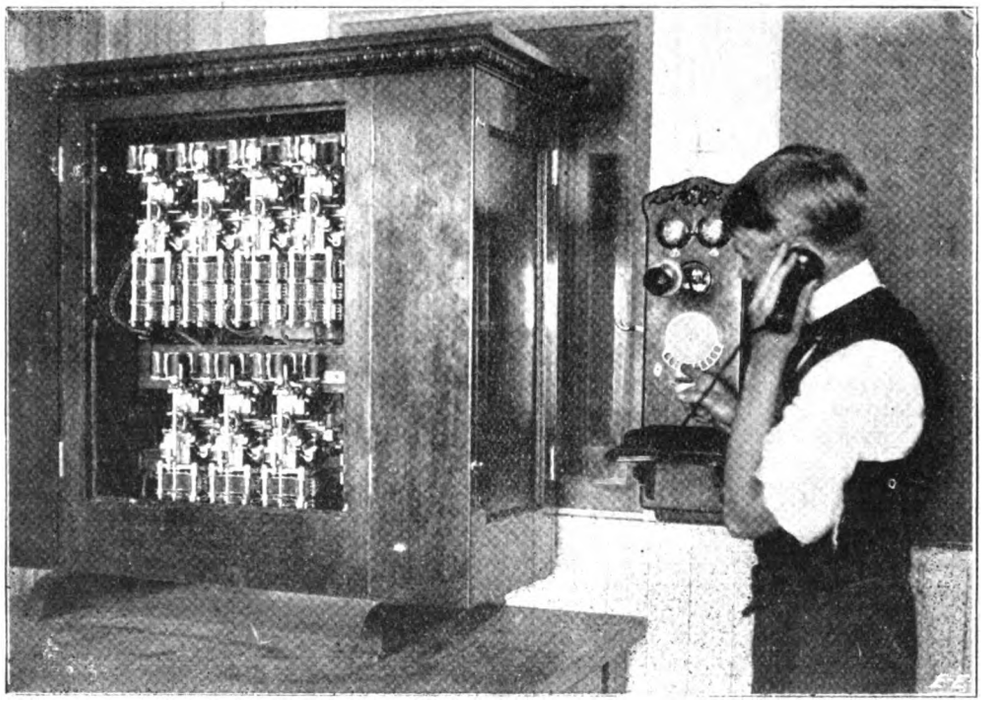

FIG. 2.—Strowger Automatic Telephone Exchange.

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system. All metallic battery systems in use at the present time are elaborately discussed, and for six to ten hours a week the student has the best opportunity to take up in the laboratory the construction and the installing of telephone apparatus, testing telephone lines for grounds, resistance to earth, current and voltage conditions, and the locating of faults. Following this course of study, lectures are given on exchanges, apparatus for protection, signalling systems, and automatic exchanges. These lectures are also accompanied by well-selected work in the laboratory, dealing especially with the construction and manufacture of these apparatus. In the same year special lectures are given on acoustics, in which line special work is also done in the laboratory. In the last year follow studies of the different telephone systems, accompanied by the designing and laying-out of complete exchanges and telephone systems. The work in the laboratory comprises the more exact tests of cables, working relays, investigations on the variation of induction from one, two, and three phase alternating current of 104 to 9,000 volts, and effect of direct current of 110 to 500 volts, etc., upon telephone lines, etc.

The accompanying illustrations show the great importance which is given in the United States to the strictly practical side of the education of telephone engineers. The illustrations show (Fig. 1) the sound-proof telephone booth and a student testing cables, and (Fig. 2) the complete outfit of a four-party exchange of 1,000 lines ultimate capacity, system Strowger of the Automatic Electric Company. This system has been recently introduced on a very large scale in Berlin by the German Post Office Department. It is operated by a storage battery of 50 volts, and is subject to special investigations by advanced students.

The telephone laboratory of Purdue University also contains a 100-pair Roebling cable, 300ft. long, so arranged that it represents six miles of line capacity, and affords excellent facilities for measuring capacity and localising faults; a 20-pair switchboard cable, 500ft. long, used for ringing and transmission tests; and a complete installation of the Clarke automatic system; a Kelvin astatic galvanometer of 13,000 ohms resistance; Anthony 100,000-ohm box, different galvanometers, of d'Arsonval, Nalder, Rowland, Edelman, and a whole series of other laboratory instruments; a storage battery equipment, consisting of 10 cells of the Juilien type and 75 Chloride cells; a special 50-kw. 60-cyle generator, giving either monocyclic, two-phase, or three-phase alternating currents; a special high-tension switchboard, equipped with instruments and apparatus of the most modern type; a combined switchboard, having a total capacity of 920 double-connection plug terminals; a lamp board of 200 lamps, each lamp having separate terminals so that any range in the resistance from 1 ohm to 40,000 ohms can be obtained; a bank of 52 microfarad condensers; a high-voltage lamp board of 50 lamps and testing transformer of 10,000 volts; different apparatus for recording alternating curves, and a number of different machines and instruments. This shows without any doubt that great efforts are made to give the student not only a theoretical knowledge, but to make him a practical engineer. The necessity of creating such a special school for telephone engineers has been denied from different sides, but the success at Purdue University in the first two years does not leave any doubt in this direction.

There are at present 10 students in the fourth-year class who will receive their diplomas next June, 12 in the third-year class, and 43 in the two lower classes. The director of the department of electrical engineering at Purdue University is Prof. W. E. Goldsborough, at present also chief of the department of electricity at the World's Fair, St. Louis, 1904. The telephone section stands under Prof. T. R. Kelsey. It must be remembered that the telephone has found far more extensive use in the United States than in Europe, and not only all cities of any importance are connected by long telephone lines, but also large business houses and factories have their own private exchanges, and in the country we hardly find a farmer to whom a telephone is not an absolute necessity for his private and business life.

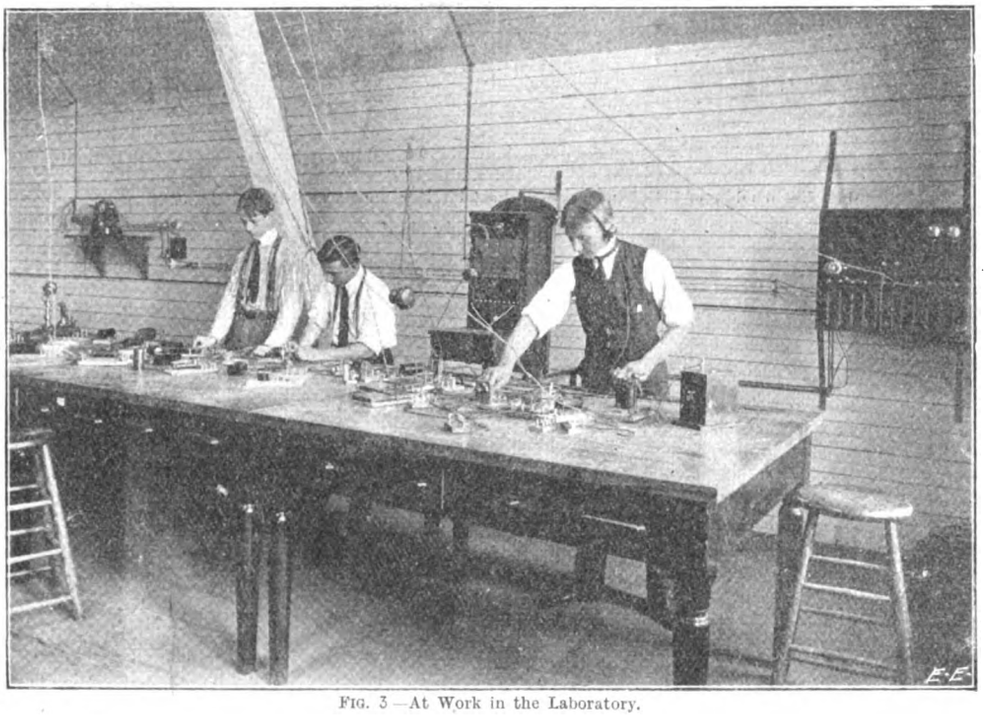

FIG. 3.—At Work in the Laboratory.

TRADE NOTICES AND NOVELTIES.

Litholite.

Messrs. Hunt and Hess, who manufacture this insulating material at 3, The Grove, Hackney, N.E., recently had a sample tested at the Westminster Electrical Testing Laboratory for insulation resistance and dielectric strength. Mr. L. W. Wild, the chief electrician at this laboratory, describes the results of the test as follows: "The sample consisted of a disc of 8½in. in diameter and 0·327in. thick. On receipt of the sample our first step was to paste on to each side a disc of tinfoil of 4in. diameter. A guard ring also of tinfoil was pasted round the edge of the disc to intercept leakage. We next measured the insulation resistance between the two discs, and obtained a figure of 67,000 megohms with a testing pressure of 1,500 volts taken from a battery. On disconnecting the guard ring the same figure was obtained, showing that surface leakage is negligible under normal conditions. The sample was next immersed in salt water for 24 hours, and after wiping off the surface moisture, but not otherwise drying it, we tested it again, and obtained 60,000 megohms with the guard ring connected and 600 megohms with it disconnected. In this case the surface leakage was some 100 times the leakage through the material, as might, of course, be expected. Next the sample was

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left standing in a free current of air for three hours to dry, but was not baked. We then tested again and obtained 67,000 megohms with the guard ring, and 60,000 without it, the surface leakage being thus about 10 per cent. of the leakage through the material. The above tests show that the material is practically non-absorbive of water, has a high specific resistivity, which is well maintained after immersion in water, and although there is a certain amount of surface leakage when first removed from the water, yet this is soon stopped as the surface dries by natural means. The specific resistivity of the sample, from the above figures, works out to 6,550,000 megohms per centimetre cube at a temperature of 58 deg. F., and when subjected to a testing pressure of 1,500 volts. The dielectric strength was measured by applying an alternating pressure of 120 periods between the two tinfoil discs. The sample broke down with a pressure of 36,000 volts, having withstood 35,000 for a period of five minutes previously.

Rhodes Motors.

We have received a well-prepared list of the continuous-current R.E. type of electric motors made by the Rhodes Electrical Manufacturing Company, of Bradford. This company has its London office at 70 and 71, Bishopsgate-street.

We illustrate herewith one of these motors arranged with a back gear, so as to get a comparatively slow speed on the pulley. These gear wheels are stocked by the firm in a large number of sizes, so that they can give a great variety of speeds at short notice. The motors themselves, as illustrated in detail in the list, show evidence of careful design, and they are in conformity with the latest practice in continuous-current work. The motors are rated conservatively, so that they can stand a 25 per cent. overload for an hour without undue heating, and a 50 per cent. overload temporarily without sparking or injurious heating. The design of the motor is such that the one frame serves for the open and enclosed types, with, of course, variations in the possible output. The firm give at the end of the list prices both for the slow-speed and moderate-speed types, and we gather that they are stocked for several different voltages. No doubt, in this respect the firm will conform to the standards fixed by the Engineering Standards Committee, which were referred to recently in our columns. The firm would not be able to give the prompt deliveries which they guarantee were there not some limit to the range of voltages on which the motors have to work.

Portable Ammeter and Voltmeter.

The illustration herewith is of a combined instrument put on the market by the Union Electric Company, of 151, Queen Victoria-street. The instrument consists of a moving-coil ammeter and a moving-coil voltmeter mounted in the same case for convenience of transport, in order that tests may be made on installations so as to ascertain various electrical quantities. The voltmeter, for instance, can be used on three different ranges. In the first the whole of the scale corresponds to three volts, which is serviceable for measuring the

voltages on primary and secondary batteries. Under the second connection voltages from 0 to 150 volts can be measured, which is most useful when dealing with private plants and battery installations. With the third system of connection the extreme range is from 0 to 600 volts, which is intended for central-station work and for testing power distribution mains. The ammeter scale is divided into 60 equal divisions. The ampere-meter acts as a shunt across standard resistances, of which two are provided. With the first the meter reads from 0 to 30 amperes, and the second from 0 to 150. This instrument, if used direct on circuit of low voltages, can measure down to one-thousandth of a volt. With the two instruments and a six-cell battery, insulation resistances up to 500,000 ohms can easily be measured. The price of the whole set is exceedingly moderate, and should command for it a ready sale amongst contracting engineers.

Pamphlets, Catalogues, etc., Received.

INDUCTION MOTORS, enclosed arc lamps, oil switches, overhead trolleys, electrical measuring instruments, type K single-phase integrating induction wattmeters. The British Thomson-Houston Company, Limited.—Additions 155-158, 160, and 161 to general catalogue; illustrated and descriptive.

IMPROVED WALL PLUG. Illustrated. The Improved Plug Company, 45, Upper Jackson-street, Manchester.—Describes a patented wall plug which provides a ready and efficient means, mechanically correct, for an unskilled hand to plug a wall in a sound and neat workmanlike manner, at a price considerably less than the old-fashioned method. Serviceable to electricians, telephone and bell fitters, plumbers, gasfitters, furnishers, etc., and for household requisites.

PATENT PHŒNIX ELECTRIC HEATING APPARATUS. Illustrated. The Electric Heating Corporation, 34, Leadenhall-street, London.—The corporation state that they are prepared to arrange with central supply stations for the supply of patent Phœnix heaters on special terms. They have in preparation a list of cooking apparatus, hot-plates, and flat and curling irons, foot warmers, etc.

PERSONAL.

We have to congratulate Mr. Bertram Hopkinson on his appointment to succeed Prof. Ewing in the chair of Mechanism and Applied Mechanics at Cambridge.

Mr. Alfred Rosling Bennett, who has acted as general manager and engineer of the Glasgow Corporation telephone department since its establishment, has intimated to the committee that, owing to the many claims upon his time entailed by his outside duties, he wishes to retire from the general managership. The Telephone Committee recommend that Mr. Bennett continue in his present position until the close of the financial year, and that thereafter he be retained as consulting engineer; that Mr. John Macfee, who has been throughout the assistant manager, be appointed general manager; and that Mr. John MacCallum, who has hitherto held the office of cashier, be appointed assistant manager as well as cashier.

Mr. W. H. Grimsdale, the chief engineer of the Warrington electricity department, and manager of the electric tramways, has resigned upon being appointed to superintend the electrical equipment of the Government dockyard at Portsmouth.

Mr. R. C. Coxon, of Sunderland, has been appointed general clerk at the electricity works, Bermondsey, at a salary of £104 per annum, and Mr. H. Atkinson, of York, has been appointed as switchboard attendant.

Mr. H. T. Strugnell, who has been employed temporarily as storekeeper at the central electric generating station, Battersea, has been placed upon the staff at a salary of £91 per annum.

With reference to the appointment of assistant electrical engineer at Oldham, we are informed that, Mr. S. H. Rhodes having withdrawn, Mr. H. A. Brimelow, of Bolton, has been appointed.

NEW COMMITTEES.

BARNSTAPLE.—*Electric Lighting*—Aldermen Aston and Young; Councillors Richards, Lindsley, Youings, Hopper, Cooke, and Andrew; the Mayor (Councillor H. Barrett), chairman.

BATTERSEA.—*Electricity*—Mr. W. Rines, chairman.

DONCASTER.—*Electricity*—Alderman Abbott; Councillors Bennett, Clark, Dowson, Halmshaw, Kay, Manwaring, Smith, Steel, Tuby, Wightman, and Windle.

GRAVESEND.—*Electric*—Aldermen Russell and Wood; Councillors Byrne, Enfield, Rhodes, Archer, Davis, Prevost, Schultz, Cosh, Smith, Sandford, and Berkowitz.

GRIMSBY.—*Electric Lighting Sub-Committee*—Alderman Dobson, chairman; Councillor Alward, vice-chirman; the Mayor (Councillor Colonel Bannister); Aldermen Brocklesby and Evison; Councillors Brown, T. King, Maddison, F. Moss, T. C. Moss, Riggall, Simons, Tickler, Wharton, G. A. White, Jackson, and Pickwell.

OXFORD.—*Tramways*—Alderman Salter; Councillors Cannan, Carter, Dodd, English, Higgins, Jackson, H. S. Kingerlee, Le Mesurier, Maunsell, Salter, Taylor, Twining, Underhill, and Sherwood.

RAWTENSTALL.—*Electricity and Tramways*—Alderman Trickett, chairman; Councillor Compston, vice-chairman.

ST. MARYLEBONE.—*Electricity*—Councillor E. R. Debenham, chairman.

SWANSEA.—*Tramways and Electric Lighting*—Mr. A. Sinclair, chairman; Mr. David Davies, vice-chairman.

WEYMOUTH.—*Electric Lighting*—The Mayor; Aldermen Whettam, Lovell, Bagg, and Morris; Councillors Honebon, Bridle, and Bennett.

WOOLWICH.—*Electricity*—Aldermen Macnamara, Robson, and Tynemouth; Councillors Adshead, Baglow, Calderwood, Elms, Fennell, Ledger, Merritt, Mitchell, Sheppard, J. Turnbull, J. A. Turnbull, W. Turner, and Widger.

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THE

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TO CORRESPONDENTS.

All Rights Reserved. Secretaries and Managers of Companies are invited to furnish Notices of Meetings, Issues of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration.

All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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BAD BUYERS.

Amongst the many interesting questions which have been raised in Mr. Joseph Chamberlain's speeches on the fiscal policy of this country, is that of the real advantage to the country of importing foreign goods in order to save comparatively small amounts in first cost. Any such argument in the abstract is much enhanced by quoting special instances, but in so doing the figures given are often open to criticism in detail quite apart from their general bearings. It will be remembered that, speaking in Newcastle, Mr. Chamberlain referred to the purchase of Belgian tramrails by the London County Council. His argument was that the saving made was small as compared with the larger amount of remunerative labour which would have been employed if these rails had been manufactured in this country. The actual figures given as to the saving in first cost on the total expenditure of forty-one thousand pounds were incorrect, as has been shown by Mr. J. W. Benn, the chairman of the London County Council Highways Committee. This disagreement over the figures raises a side issue with which we now propose to deal. Thus, referring to the subject in his speech last Friday at Cardiff, Mr. Chamberlain says that if there was the large difference of eight thousand pounds between the English and foreign tenders, the County Council "must have been very bad buyers, because I was buying rails at the same time in very large quantities for one of our great Colonies. I had to give an order for about one hundred thousand tons. The difference between the lowest price at which Germans and Americans would put the rails and the price which I obtained in tender from English railmakers was only something like five shilling per ton, and that certainly would not make a difference of eight thousand pounds on a purchase of thirty thousand pounds' worth of rails. I have come to the conclusion, therefore, that if the County Council buy all their goods without taking a little more pains to give the opportunity to English firms to tender, probably their undertaking will be less profitable than it might." In reply to this speech, Mr. Benn has stated in a letter that English firms had every opportunity to tender, because the matter was fully advertised in the leading trade journals and newspapers, and that three or four of the leading British railmakers tendered. The fact that only three or four British firms took the trouble to send in their prices for these rails is evidence that the London County Council is not highly esteemed in this country as a buyer of materials. A few months ago the same thing was in evidence when the Council were advertising for structural steelwork. In that case complaint was made that English firms either refused to tender or required too long a time to complete the work. The conclusion to be drawn is not one which is complimentary to the Council, but it is the natural outcome of the trading policy which they have pursued. This subject of the relations between the buyer and the seller is one which is intimately connected with the economical carrying out of work. It is in few cases that the actual cost of materials supplied is so closely connected with the contract sum as in the supply of steel rails. In the majority of cases with which our electrical contracting firms have to deal, there arise in fixing the contract sums questions of sub-letting of portions of the work, the erection of the plant, etc. These items introduce risks which are intensified by the standard clauses of the London County Council, which often would, if adhered to, call for the disorganisation of the working arrangement of a firm when carrying out the contract. Another point is that the lowest tender is usually accepted, as

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it requires an extremely strong technical man to carry through not only his departmental committee, but also through the Finance Committee and the whole Council a recommendation to accept a tender high up in the list on grounds which may not be appreciated by the individual councillors. The result is that contractors are not keen to take work at extremely low competition rates accompanied with the many risks entailed by the standard labour clauses of the Council. These clauses are practically inoperative abroad, with the result that while framed to assist the English working-man, they have the effect of sending work on which he depends for a livelihood out of the country. We are not in any way blaming the Council for accepting a foreign tender which shows a large saving in first cost, as the reasons for and against this are yet to be thoroughly investigated. We do blame them, however, for their short-sighted business policy, which prevents their being able to buy on even as favourable terms as a Government department. The opposite extreme, as far as buying is concerned, we take to be that of our great railway companies, who have not yet found it advantageous to go abroad for their supply of steel rails.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

THE AIM OF A SCIENTIFIC INSTITUTION.

SIR,—It appears to me that Mr. Gray's remarks regarding the proper scope of the Institution of Electrical Engineers have been, to some extent, misunderstood by the electrical Press.

I would, at any rate, venture to express my own view on the subject with every deference to those who differ with me. In my opinion, an Institution of Electrical Engineers should, in accordance with the terms of its charter, be all-sufficiently concerned with the technical work of an electrical engineer, leaving the business side of all questions in the hands of those who are responsible for the administrative and commercial working of their respective electrical undertakings. I am quite ready to admit that more often than not the successful engineer is successful because he possesses a business mind, or has had a commercial training. That, however, is no argument against a separate association for dealing with the business aspect of things electrical, and anyone who is serving in the double capacity of director (or manager) on the one hand, and engineer on the other, would naturally seek attachment with both headquarters.

I venture to suggest that a great deal of the work that certain prominent members of the Institution are engaged over in connection with pressing claims for revising legislation and suchlike, is far more connected with their interests as business men than as engineers, and that as there is an abundance of such work ahead, it would be as well if a separate body were formed to attend to it.

The very constitution of the Institution shows that its work is really strictly technical. Thus, those who are only associated with electrical work from a commercial point of view are classed as associates; yet obviously these, rather than those who have attained academic or technical distinction, are the most suited for urging legislative reforms. Again, it has been suggested that the proposed tariff reforms should be discussed in their relation to electrical work, but here, again, surely those who would be best adapted to represent the Institution are the "men of affairs" rather than those who, as distinguished engineers or electrical *savants*, are prominent members of Council or vice-presidents.

Tariff reform on an Imperial basis is a subject I myself have been very deeply interested in for a number of years, but not as an electrical engineer, any more than as a mere consumer of bread, and I should certainly not look to an Institution of Electrical Engineers for taking the matter up. On the other hand, I should expect an association concerned with the commercial aspect of electrical undertakings to enquire into the matter in connection with their interests, and with useful results.

We might surely do worse than note the way such institutions as the Institution of Civil Engineers regard the difference between technical (or scientific) work on the one hand and business on the other.

Certainly, if a "temple of engineering" were ever to be realised, that, as a sort of enormous trades union (of the right type) to guard and agitate the interests of all the trades concerned in any form of civil engineering—mechanical, railway, electrical, etc.—would be the most suitable channel for dealing with reforms associated with the business, as opposed to the technical side of electrical work. Meanwhile, there would appear to be ample scope for an association to take up the interest of "commercial electricity" as distinct from the interest of those who, as engineers, *render* electricity a subject of commerce. I am aware, however, that a new body such as I speak of would, at first, be open to the objection of carrying less weight in mass, but it would be more in accordance with reason.—Yours, etc.,

CHARLES BRIGHT.

31, Old Queen-street, Westminster, Nov. 24.

STEAM TURBO GENERATING PLANTS.

SIR,—While I am quite able to defend and maintain my position on the above matter, provided the controversy is carried out on fair and legitimate lines, I beg to protest strongly against the tactics resorted to by Messrs. Belliss and Morcom, Limited.

In the first place, although at the outset of my last reply I frankly accepted the correction they made as to the steam consumption of their Leeds engine as given to me by the city electrical engineer (trivial though that correction was), and also expressly declared that the figures given in my paper were, to the best of my knowledge, correct, Messrs. Belliss calmly ignore these facts, and insert the following inaccurate statement in their letter: "We called the statements extracted from his paper misleading because these incorrect statements were largely used in his argument. As he does not in his reply dispute the inaccuracies (*sic*), the previous letter still applies to the facts." After this apparently wilful or careless neglect of facts, I trust Messrs. Belliss will cease to make reference in general terms to alleged inaccuracies on my part unless they point out exactly where the inaccuracies are.

The difficulties which Messrs. Belliss suggest with regard to working turbines with steam superheated within practical and economical limits are purely imaginary, and appear to indicate a very restricted knowledge, indeed, of the subject under discussion; perhaps it will be useful to state for their information that the clearances in the turbine are arranged to allow for expansion due to superheat, and if, on occasion saturated steam is used, the economy is not let down to any greater extent than in the case of reciprocating engines designed to run with superheated steam, running on saturated steam, and probably not so much. Exactly what is meant by the "maximum possible superheat," I am unable to say, but it is an undoubted fact that turbines give no trouble when working with superheated steam, whereas the troubles with reciprocating plants on high superheats are many.

It is true that I prefer to compare results "under actual daily working conditions" and to have "the outcome of every-day practice," but the table given in the letter gives neither one nor the other; there are so many additional factors controlling the figures given therein as to render them valueless and irrelevant to the subject under discussion.

I will, however, submit a proposal to Messrs. Belliss which is quite relevant to the present controversy—viz., that Messrs. Belliss select any 300-kw. alternating-current plant running on superheated steam and driving its own condensing plant, and of which they have manufactured the engine. The plant selected shall have been in daily work on a lighting or traction load for the past two years without any renewals or repairs to the pistons and valves. This plant to be tested on full, half, and quarter loads by an independent engineer. I will arrange to place a steam turbo set of the same output, and which fulfils the

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same conditions, at the disposal of the same engineer for a like test, and the steam consumption per kilowatt output on both tests shall be published in the technical Press. It shall be a condition of this contest that both Messrs. Belliss and myself shall have representatives present at the tests.

In conclusion, will Messrs. Belliss say what extra clearance they give piston valves for 600deg. F. superheat?—Yours, etc., GEO. WILKINSON.

"THE PHIELASHOK."

SIR,—I notice in your last issue that exception is taken by Messrs. Oliver and Co. to my remarks concerning their "Phielashok." I have read their letter with interest. I may state that I only understood the method of applying the instrument as was given by the illustration itself. Surely one hand is there shown actually placed upon one of the fittings. Why Messrs. Oliver and Co. are surprised at my drawing attention to this I fail to see.

I still claim that the method, as shown, would be positively unsafe in a great many of our large installations. I will admit that if two "Phielashoks" were used (one in each hand) then the operator might be safe, but I am not aware that Messrs. Oliver and Co. have pointed this out.

It is incorrect to think that I "apparently would place a hand *directly upon* any terminal that may be alive." Reference to my letter will show that I am opposed to this, and in no slight measure. The makers also say that it was for earthed systems that the "Phielashok" was especially designed. Again, I think they have missed their point and seized mine, for I did not notice that the instrument was especially adapted to earthed systems.

By the way, I do not wish to make it appear that the use of the instrument would be attended with any more danger when used on a system consisting of one insulated conductor and earth return than when used on one consisting of insulated metallic return. The danger referred to is when that *which ought to be* an insulated system *has an accidental "dead earth"* on one pole, for the full potential then exists between the *other pole* and earth. This may occur at any time suddenly and *without warning*. In conclusion, I may say that I have never used a "Phielashok," nor even heard of such an instrument before.

As to my electrical susceptibility I cannot exactly state, but I dare say my medical man would be willing to present his certificate, especially if it will be of any assistance in the design of an instrument particularly adapted to my physical system. However, jokes aside, I wish to thank Messrs. Oliver and Co. for their offer, which I shall be extremely pleased to accept. Our voltages are respectively 220 and 240, direct current. But what am I to do with the other hand?—Yours, etc., J. ISAACS.

11, Highfield-terrace, Somerby-road, Grantham,
Nov. 23, 1903.

APPOINTMENTS VACANT.

Engine-Room Attendant. Salary 35s., rising to £2 per week. Particulars from the Secretary, South-Western Polytechnic, Manresa-road, Chelsea, S.W.

Shift Engineer, Tunbridge Wells, £100 per annum.

Tramways General Manager, Sheffield Corporation, Dec. 1.

Engineering Assistant, used to tramway work, Finchley Urban District Council, £175 per annum. Application by Dec. 3.

Assistant Electrical Engineer, Sanitary Commissioners, Gibraltar. Salary, £200 per annum. Applications by Dec. 16. See advertisement in last issue.

Under-Foreman, electric repair shop. See advertisement in last issue.

Armature Winder, Blackburn Tramways Depôt, Nov. 30.

Tramways General Manager, Bolton. Salary, £500 per annum. Dec. 4.

Traveller with connection amongst buyers of arc lamps and switchboards, Box 808, *Electrical Engineer* Office.

Junction Box Fitter, used to fitting house fuse boxes, Box No. 909, *Electrical Engineer* Office.

Cable Jointer, York Electric Lighting Station, Dec. 7. See advertisement.

DESTRUCTOR AND ELECTRICITY STATIONS IN SMALL TOWNS.*

BY S. D. SCHOFIELD.

Electricity supply in small towns has not made the progress that one might have expected, though within the last few years a number of stations have been started where the refuse of these towns is destroyed by fire in special furnaces, and the steam raised by this heat is utilised for driving dynamos for lighting and power. Opinions differ as to the wisdom of this combination, varying from the extreme at one end, which is the view that a destructor station is a veritable gold mine, where steam can be raised *ad lib*, driving electric generators producing an unlimited supply of energy, sufficient to light all the streets of a town, propel all cars, supply all private lighting, and drive all the motors which may possibly be required, to the view that, at its best, a destructor is an unmitigated nuisance; and if the electrical engineer of the town is your bitterest enemy, you will have satisfaction, indeed, if you can arrange for the destructor to be tacked on to the electricity supply station.

First and foremost, it must be understood that the destruction of refuse is a purely sanitary matter, and under no circumstances may that work be jeopardised for the sake of power production. However, the modern high-temperature destructor may be used for steam-raising without any fear as to that use being a cause of nuisance. The higher the temperature of the furnace, the less will be the risk of any noxious gases escaping into the atmosphere, and the higher will be the duty of the plant. Any of the leading makers will erect plant capable of destroying the refuse of a town without any nuisance, and without any dust being allowed to escape from the chimney, giving a guaranteed evaporation of 1lb. to 1½lb. of water for each pound of refuse destroyed, according to the value of the refuse. A test at Cleckheaton, on Oct. 9, 1903, shows that during a run of eight hours, 51·7 units were generated per ton of refuse destroyed.

In January, 1902, at Shipley, during a run of one month, 37·4 units were generated per ton of refuse destroyed, and with a similar plant at Wrexham 37·8 units per ton of refuse were obtained at a test of the same duration. A further test of the value of refuse may be obtained from the accompanying Table A, giving the results of a three weeks' test of the steam-raising plant at Shipley, the first week with the destructor in use supplemented with a coal-fired boiler; the second week with the destructor off, the coal boiler alone being used; and the third week with the destructor in use again. As all the boilers feed into one common pipe range, it is not possible to run the destructor straight on to one steam dynamo, and meter the output in that manner. The object of this test was to find the ratio between the fuel value of refuse and the steam coal in use, and as the generating plant was the same during the whole of the time, the figures given below are reliable, in that they are obtained under ordinary conditions, without special preparations for a test.

Taking the five days, Sept. 21 to 25 inclusive, the units generated were 12,961, and 41 35 tons of coal were used. This gives an average of 313 units generated per ton of coal used and 7·1lb. of coal per unit. At an average price of 7s. per ton of coal delivered, this equals ·266d. per unit generated. If we take the figures from Sept. 14 to 20 and Sept. 26 to Oct. 2, each inclusive, we find that 36,196 units were generated for the destruction of 265,075 tons of refuse with the aid of 73·8 tons of coal. Taking a basis of 313 units per ton of coal, 23,100 units were generated by coal, leaving 13,096 units generated by refuse, being an average of 49·8 units per ton of refuse. No doubt these figures are well above the average for a destructor, but the exceptionally good daily load factor assists materially to produce this result.

During the 12 months ended March, 1903, 6,525 tons of refuse were destroyed, the six stokers' wages amounted to £486. 13s. 8d, including labour in stoking 1,502 tons 7cwt. of coal. This is equal to a cost for labour alone of 1s. 5·89d. per ton of refuse, and includes all cleaning of boilers,

* Abstract of paper read before the Leeds Local Section of the Institution of Electrical Engineers.

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TABLE A.

Date.	Refuse destroyed.	Coal used.	Coal used.	Units generated.	Daily load factors — Traction.	Daily load factors — Lighting and power.
1903.	t. c. q.	t. c. q.	t. c. q.		Per cent.	Per cent.
Sept. 14	21 6 1	5 19 3	—	2,289 —	23 2	54 8
,, 15	26 16 2	3 1 2	—	2,320 —	21·5	61·9
,, 16	23 3 2	3 8 1	—	2,481 —	17·2	62·5
,, 17	19 8 2	4 5 2	—	2,486 —	18·2	55·7
,, 18	20 7 3	4 1 1	—	2,789 —	18·5	45·1
,, 19	23 1 2	5 4 1	—	3,059 —	27·1	68·6
,, 20	—	5 4 1	—	1,610 —	31 4	17·6
,, 21	—	—	9 6 1	— 2,434	24·0	63·0
,, 22	—	—	7 3 3	— 2,411	21 8	66·8
,, 23	—	—	7 8 1	— 2,663	21·0	48·1
,, 24	—	—	7 15 3	— 2,482	23·3	63·7
,, 25	—	—	9 13 0	— 2,971	22·3	53·3
,, 26	14 4 3	7 18 3	—	3,310 —	26·8	50 2
,, 27	-	7 18 3	—	1,921 —	22·3	38·4
,, 28	19 4 1	6 1 1	—	2,767 —	22·4	48 5
,, 29	28 17 0	6 0 1	—	2,582 —	19·6	40·6
,, 30	23 2 2	4 4 2	—	2,917 —	19·9	53·3
Oct. 1	21 1 1	4 4 4	—	2,800 —	17·2	56·0
,, 2	24 7 3	6 3 2	—	2,865 —	18·4	35 4
	265 1 2	73 16 3	41 7 0	36,196 12,961		

flues, economisers, etc. Without a destructor two stokers would be required for coal firing, and, on the other hand, at least five men are required for the furnaces. If 4½ men are taken for the furnaces and 1½ for the coal boilers, the cost of labour will be 1s. 1½d. per ton of refuse destroyed. Thus, for an expenditure of 1s. 1½d. we get 49·8 units from each ton of refuse, which, if generated from coal, with the same plant and all other conditions equal, would have cost 1s. 1d. (49·8 × ·266), so that as far as an electricity department is concerned, is at least no gain, but a slight loss.

Where, then, is the pecuniary advantage of a destructor plant? It has been previously stated that sanitation must be the aim of a destructor station. Tipping, barging away to sea are obsolete methods of disposing of refuse. The only sanitary method is complete destruction by fire. This being granted, then municipal authorities are justified in seeking to obtain a remunerative outlet for the power that may be produced in the destruction of refuse. The figures of the tests already referred to, made during September, 1903, at Shipley, are better than those which would be obtained over a whole year's working, but the writer is of opinion that it would be perfectly safe to assume that 40 units per ton of refuse would be the figure for the year ending March, 1904; 6,000 tons of refuse will then give 240,000 units, and at a cost of ·266d. for fuel per unit generated will reduce the coal bill by £270, as a set-off against £332. 10s. (6,000 × 1/1½), the cost of destroying the refuse under the most favourable conditions. To the town, then, this is a clear gain of £270, as destruction by fire is the only possible way, and this is the saving if arrangements are made to utilise the power obtained from destruction.

But to an electricity department this steam is not worth the £270 mentioned; against that must be set the unreliability of the refuse, the quality and quantity varying from day to day; the supervision to be given to a destructor steam-raising plant as compared with a coal steam-raising plant is far more, and necessitates a larger staff. It is impossible to keep out of the engine-room all the dust incidental to works of this description, and these and other disadvantages reduce the pecuniary value of the steam thus generated. From the Health Committee standpoint, the reduction of management expenses, and the fact that a skilled staff at the electricity station is available for repairs and attention to the destructor plant, are obvious advantages.

The day load of a central station—that is, traction, motor load, battery charging, etc.—provides a remunerative outlet for the power generated, enabling the refuse to be dealt with as delivered. The results given above show that it is possible for a council to combine the two undertakings, but the advantage to the electricity department is questionable. No engineer would prefer a destructor if he could turn his generators without one. The calorific value of the refuse varies almost directly as the price of coal in that district; if the coal is cheap, the refuse is good, and if coal is costly, the refuse is of less value. The figures given in Table A show that, with the best results, it it is more expensive to generate from a destructor than from coal, and so we cannot look to a destructor to be a certain factor in economical generation of electricity.

(To be continued.)

FORTHCOMING EVENTS.

SATURDAY, NOV. 28.

Glasgow Scientific Society.—At 7.30 p.m., ordinary meeting. Paper: "Some Remarks on the Willans Engine," by Mr. J. Herbert Pocock.

MONDAY, NOV. 30.

Society of Engineers.—At 7.30 p.m., ordinary meeting. Paper: "Mechanical Stokers for Electricity Generating Stations," by Mr. Albert Gay.

Society of Arts. — At 8 p.m., Cantor lecture: "The Mining of Non-Metallic Minerals," by Mr. Bennett H. Brough. (Lecture II.).

TUESDAY, DEC. 1.

Institution of Civil Engineers.—At 8 p.m., ordinary meeting. Paper to be further discussed: "On the Distribution of Mean and Extreme Annual Rainfall over the British Isles," by Dr. H. R. Mill, LL.D.

Institute of Builders.—At 8 p.m., at the Society of Arts. Lecture: "A Comparison of English and American Methods in the Erection of Buildings," by Mr. Chas. Heathcote.

WEDNESDAY, DEC. 2.

Liverpool Engineering Society.—At 8 p.m., ordinary meeting. Paper: "Recent Telephone Developments in Liverpool," by Mr. E. J. Hidden.

Society of Arts.—At 8 p.m., ordinary meeting. Paper: "The Fiscal Problem," by Sir Chas. Malcolm Kennedy, K.C.M.G., C.B.

Institution of Electrical Engineers (Students' Section).—At 7.30 p.m., ordinary meeting. Paper: "The Operation of Electric Lifts," by Mr. H. Church.

THURSDAY, DEC. 3.

Rontgen Society.—At 8.30 p.m., ordinary meeting. Paper: "The Production of Photographic Reversal under the combined action of various radiations," by Mr. C. E. S. Phillips.

Institution of Electrical Engineers (Birmingham Section).—At 8 p.m., opening meeting. Address by Mr. J. C. Vaudrey (chairman).

Chemical Society.—At 8 p.m., ordinary meeting.

FRIDAY, DEC. 4.

Institution of Civil Engineers (Students' Section).—At 8 p.m., ordinary meeting. Paper: "Artificial Draught as applied by Fans to Steam Boilers," by Mr. W. H. A Robertson.

Junior Institution of Engineers.—At 8 p.m., ordinary meeting. Paper: "Recent Developments in the Construction and Working of Gas-Engines," by Prof. D. S. Capper.

SATURDAY, DEC. 5.

Glasgow Scientific Society.—At 7.30 p.m., ordinary meeting Paper: "Superheat," by Mr. W. H. Booth.

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QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any questions should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

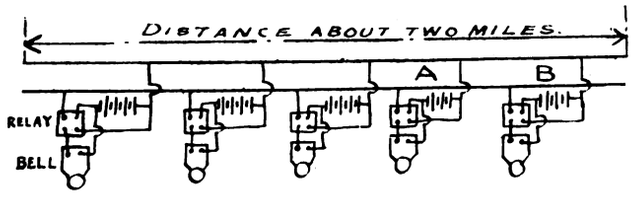
QUESTIONS.

639. A 60-h.p. direct-coupled motor, shunt-wound for a speed of 280 revolutions per minute, is to be started up so that it runs very slowly for only a few seconds and then stops dead. This is required for the purpose of setting the machine. It really only has to just move round and then stop in the exact position that is wanted on the machine.—E. B. C.

640. Explain fully what is the use of the copper earth sheath as used on three-phase cables, and why the lead sheath is not used.—C. W. G.

ANSWERS.

631. The diagram shows an underground signalling circuit with five bells in parallel. The line wires are galvanised iron wires on porcelain insulators. By putting together the two wires anywhere all five bells ring, which is necessary. It is desired to fix a telephone (wall pattern) at stations A and B, and to have a portable (watch pattern) to speak from any part of the line. Can this be



done with the present wires by placing switches at A and B, or, if not, what would be the best and cheapest means of getting the required communication?

Best Answer to No. 631 (*awarded* 10*s.*).—"Pitman" asks in his question whether it be possible to connect two telephones, respectively at stations A and B, so that anyone at, say, X can communicate with either A or B along the present two wires. This is possible under certain conditions, and in Fig. 1 will be found a diagram of all the

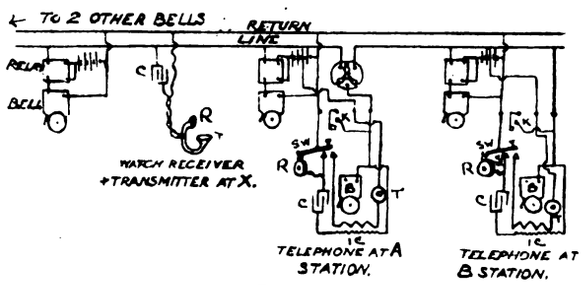


FIG. 1.

necessary connections to accomplish this end. On studying the above connections on the telephones, it will be noticed that there are a few varieties to the ordinary methods of connections on the instruments themselves. These are on account of the two line wires being used for the bells as well, as on this account it will be noticed that these are both always live owing to the bell batteries at all five stations. In Fig. 1, R is the receiver; T is the transmitter; I C is the induction coil; B is the bell; K is the key for ringing up other stations; C is a small capacity; S W is the switch hook on which the receiver hangs; S is the spring to pull S W down when R is off it

Owing to the fact that space is limited for showing the connections clearly on the telephone instruments, below will be found Fig. 2, which gives the ordinary method of connecting one, so that we can then compare these two figures and account for the differences. On comparing these two, it will be at once noticed that (*a*) the bell is not connected up in Fig. 1; (*b*) there is no connection to the carbon of the battery on terminal C in Fig. 1; (*c*) there is a condenser in series with the receiver in Fig. 1 and not in Fig. 2.

The reasons for these are as follows: (*a*) If the bell were to be connected up in Fig. 1 it would ring always, as there would be a complete circuit from any of the five batteries through its relay along the return line wire to the Z E terminal on the telephones, thence to the switch hook arm which is hard against the bell contact, and so through the bell and back again *viâ* the line wire. Of course, it would never do to have a circuit like this, as the batteries would all very soon get run down, so this connection to the bell has to be cut out. (*b*) The connection on to the terminal of the instrument from the carbon of the battery is simply used in the key circuit to ring up another instrument. As, however, above I have just shown

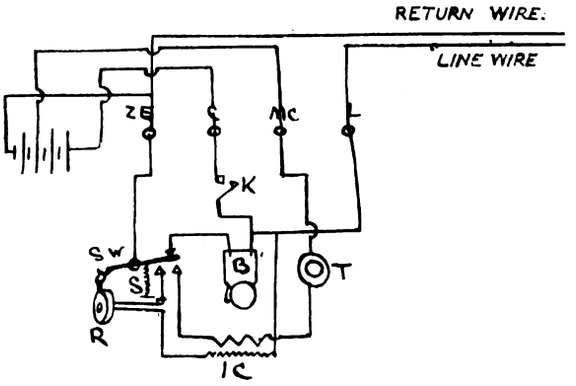


FIG. 2.

it is impossible to use the bells of the instruments, this connection becomes quite unnecessary. (*c*) With reference to the condensers, it will readily be seen that if there were none, and the receiver be taken off the hook, when the arm has sprung back, making the other two contacts below, there is a circuit now through the bell batteries, relay, line return, receiver, induction coil, etc., in instrument back to the battery, which would completely interfere with any conversation which might be going on along the line. Inserting the condenser in series with the receiver stops all these continuous currents, but does not affect any alternating currents due to speech which apparently pass through it.

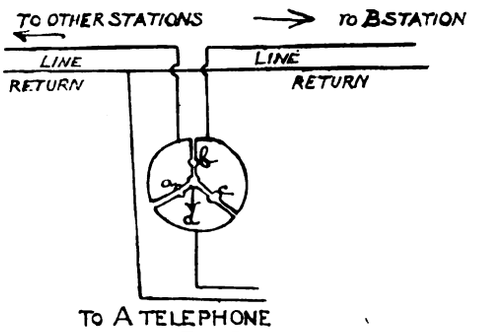


FIG. 3.

There must also be a three-way plug switch (Fig. 3) at A, so as to be able to cut B out if X is speaking to A, and *vice versâ*, and also to allow A to speak to B. It must be remembered, however, when any conversation is finished to replace the plug in the central position, otherwise station B is entirely cut off for bells and all.

Procedure is now as follows: When X requires to speak to either A or B he must first bring the two bare line wires together, thus ringing bells at all five stations. To indicate that this is not an ordinary bell signal, he must give a certain number of rings in succession. X now connects his portable instrument on to the two bare wires and listens till A answers, when he expresses his wishes. A must first shift the plug in the switch to the *a* position, so as to cut B's instrument out, as otherwise A and B would be in parallel, and probably neither understand. Now, if

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X requires to communicate with B, A must put plug in *b* position so as to cut himself out of circuit. After the conversation is over a certain "ring off" signal must be given, which rings on all five bells, and then A must shift the plug to the *d* position. Position *c* is obviously for use when A and B are conversing. Speech on these two lines may be fairly satisfactory, but it will be seen that much depends on the switching at A station; also all the alternating currents corresponding to the sound waves have to go through two condensers in series, and so the whole system, I am afraid would be rather poor; but it is the only method which can be adopted if only the present two bell line wires are to be used.

I should, however, strongly advise "Pitman" to instal either of the two following methods: Firstly, it will be necessary to run another bare wire the whole distance on insulators like the present two wires, one of which will be used together with the new one. This method, it will be found, entirely does away with the necessity of using condensers in the receiver circuits, and so will be found to be much more satisfactory; also X can ring up direct on the telephones, and so does not interfere with the other bell stations. Fig. 4 gives a diagram of the necessary connections, where C and D are the present bell wires, and E is the additional line wire for the telephones, and C is used as the return wire. As in the former case, it will be found necessary to have a three-way plug switch at the A station, and with the use of this it is possible for A to call up B direct, but it will depend on the position of the plug as to whether B will be able to call A direct, but, of course, if not, he can call A by a signal of all the five bells, when, on shifting plug to C position, connection is made through.

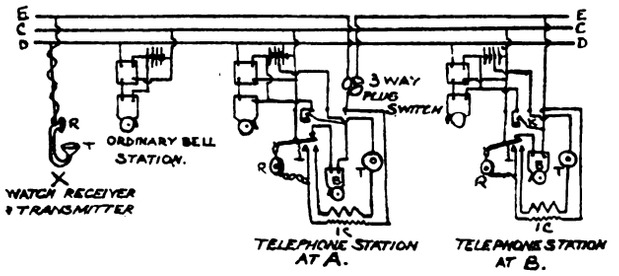


FIG. 4.

In passing, it might be as well to draw attention, when connecting on the telephone to the battery, in all cases to make the connection from the zinc direct on to a wire which will be the return wire, and to connect the Z E terminal on the telephone to this. Otherwise it will be seen that the relay of that particular bell will be short-circuited, and so that bell could never ring.

Procedure is now as follows: When X requires to call up a station he must bring the two bell lines, C and D, together as before, and so ring all five bells, unless he carries a small pocket accumulator, or two or three dry cells, in which case, if he connects these across the two lines C and E, he rings up direct on the telephone instruments, which is obviously the better method. After this, procedure is the same as in the first method as to switching, etc., at the three-way plug switch.

My last method is, in my estimation, the best of the three, but necessitates still another wire being run, making four in all, C, D, E, and F. The necessary connections are shown in Fig. 5, and it will now be seen that stations A and B each have a separate line wire, whilst using the common return, C, as before In this it will be seen that each station, A and B, has a separate line to itself, so that X simply has to hook his portable on to the line of the station he wishes to call up and on to the common return wire, C. This entirely does away with the three-way plug switch at A, and its attendant trouble as to where the plug is, which occurred in the last two cases. Now, if A requires to call up B, or *vice versâ*, as each has a separate line, it becomes necessary for him to switch his instrument on to the other's line, which is accomplished by means of the single-way plug switches at P. At ordinary times, however, except when in use, it will be necessary for both plugs to be out, as otherwise both telephone stations would be in parallel. When X calls he will connect his battery across the line wire of the station required and the return, and so ring, unless he ring up all five bell stations, when he will remove the battery and substitute his portable telephone. This last method I should recommend "Pitman" to adopt, on account of its greater simplicity and therefore reliability, and he will find that the only extra cost above method 2 is for the extra line and necessary insulators, which will be amply repaid by the better working. If this method be more costly than is required he had better adopt the second system, which is far and away better than my first, which, personally, though I think it might work, I should not be at all keen on adopting.

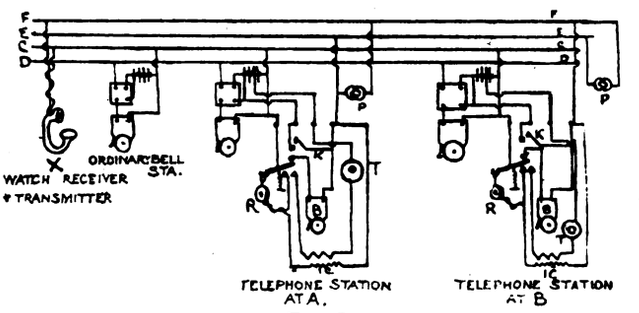
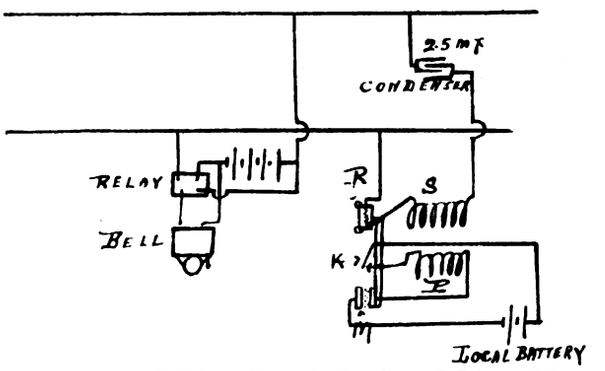


FIG. 5.

I have been wondering if an earth-return system could be devised, but it will be seen that there becomes trouble in earthing one terminal of the portable telephone, and the only way I see of getting over this is to use one of the existing bell wires earthed, and in this case the method becomes identical with the first given in Fig. 1. I feel perfectly confident that if "Pitman" adopts my third method, wherein each station has a separate line wire, he will have a very satisfactory and efficient telephone system down his mine, and might just as well conclude by saying that if there are at present any other electric wires, either for traction or light, down the pit running anywhere near the bell wires, it would be as well to cross any extra wires he may run and the bell wires once or more in the parts affected, so as to overcome any inductive effects which might possibly occur.—E. R. ALEXANDER.

Answer to No. 631 (*awarded* 5*s.*).—The simplest method of fulfilling the requirements of "Pitman" is to bridge the main circuit at point A or B (or, in fact, any other point) with a telephone instrument consisting of a "Handcom" combination receiver and transmitter, together with an ordinary telephone induction coil, in the secondary of which a condenser is inserted having a capacity of about 2·5 microfarads, as shown in diagram herewith. The



R, Receiver; K, Primary Key; M, Microphone; P, Primary Coil; S, Secondary Coil.

portable set must also have a condenser fitted, the function of which is to prevent the "ringing" circuit being completed whilst telephones are being used, but at the same time it offers no impediment to "speech" currents, which are of an alternating nature. Ringing is done in the usual manner, as described by enquirer, and any station called by a prearranged code of rings.—A. R. P.

Answer to No. 631 (*awarded* 5*s.*).—The best and cheapest means of fixing telephones between stations A and B would be to make C the line for the telephones, and bring the

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telephone return to earth. To make C line wire we would still keep the bells on metallic circuit, thus allowing them no earth connection. It would not answer for the telephones to have A to earth. The bells could thus be put into circuit without their return flowing through and ringing the telephones. Care must be taken that all the three wires, A, B, and C, are free from earth, because if either of them got to earth great trouble would be caused to the telephones, and if A and C got earthed together it would make a complete circuit and run the cells down. Of course, the watch pattern telephone would only be connected when required for use. When it was disconnected,

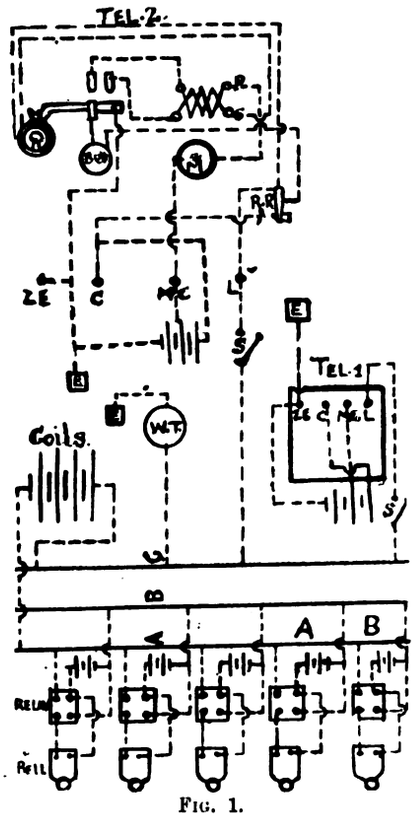

FIG. 1.

the two wall telephones would answer all right, but when the watch telephone was put into circuit it would ring telephones at A and B station, and neither would know which was required. The way I would suggest to get over this difficulty is, as is done in many pits, have certain rings for telephones—say, from telephone 1, to ring up telephone 2, one short ring; and from telephone 2, to ring up telephone 1, one short ring: then, when watch telephone was used, to give one loud ring for telephone 1 and two loud rings for telephone 2. By this method the difficulty could easily be got over, the only fault being that all the time conversation was going on between the watch telephone and one of the wall telephones, the other wall telephone bell would be constantly ringing. This can be got over by fixing switches at each wall telephone, as in Fig. 1, so that the telephone that is not in use could be switched off till conversation was finished, and then put the switch back so that communication can again be made between the two wall telephones.—J. P. S., SUNDERLAND.

Question No. 632.—Is there any advantage in compounding a motor which is needed to be started up quickly on full load very frequently? The idea is that it can be started up as a series machine, the shunt being thrown in afterwards. The motor would be of 8 h.p., and work at 550 volts.

Best Answer to No. 632 (*awarded* 10*s.*).—The advantages of using a compound-wound motor for handling intermittent and heavy loads are considerable, provided, of course, that *both* windings are made use of at starting, and that the windings are connected up "cumulatively." It may be pointed out that compound-wound motors are of two classes. In one case the series winding opposes the shunt winding, with the object of compensating for fall in speed with load, or for obtaining speeds increasing with the load. Such motors are rarely required at the present day, for the same result can be obtained with a plain shunt motor of good design by setting the brushes with such a forward lead as to maintain a constant speed through the influence of armature reaction. The other case of compound winding, and the one that is of much more use, is that with the series coil *helping* the shunt. A motor connected up in such a manner is called "cumulatively compounded," while "differentially compounded" is used to signify the previously mentioned connections. Manufacturers have accepted the former method of connections as standard for compound-wound motors, the latter arrangement being only supplied unless specially requested.

The writer does not recommend the arrangement mentioned in the question for starting up. At starting up, especially on heavy loads, the maximum possible torque is required if the moter is to start up quickly. This result can be obtained by making use of both shunt and series windings. The curves of Fig. 1 bring out this point very strongly. The two sets of curves show the performance of a shunt and a compound wound motor with respect to running current, torque, and speed. The abscissæ are torques expressed in percentage of full-load running torques, and the heavy line at 100 per cent. represents normal full load for both motors. The ordinates are current, efficiency, and speed, also expressed in percentages for comparison. The curves were obtained from actual tests on modern commercial motors, the shunt motor having a rating of 5 h.p., 230 volts, 950 revolutions per minute, and the compound motor having a rating of 5 h.p., 230 volts, 1,025 revolutions per minute. The speed and current tests were made by applying a Prony brake to the motor running free and gradually tightening it until the motor stopped. The efficiency curve is the same for both motors up to 150 per cent. of full load torque. The speed curves, which originate in the upper left-hand corner, show that at full load the shunt motor falls off about 4 per cent, and the compound motor about 7½ per cent. The shunt motor stops when the torque reaches 6·4 times the normal torque, and the compound motor stops at 10·8 times normal torque. This is a very important point, and clearly shows the advantage of a compound motor for starting up against heavy loads. It will also be seen from the current curves that the current consumption of the compound motor is materially less at heavy loads than that for the shunt motor. The starting torque of the compound motor is 70 per cent. greater than that of the shunt motor, while the starting current is less than that of the shunt motor when starting up. The curves serve also to illustrate the disadvantage and impracticability of starting up a compound motor on a heavy load by means of the series coil only. The torque developed in this case will be practically the starting torque of the compound motor minus the starting torque of the shunt motor (see Fig. 1), and this works out at about 40 per cent. of the starting torque when both shunt and series coils are used. It will also be clear that the starting current will be higher when the series coil only is used than that when both sets of windings are made use of. The extra complication of the switchgear also makes the method suggested unpractical.

Besides the great advantage of the compound motor enumerated in the above discussion—viz., the facility with which it can start against heavy loads in comparison with the shunt motor—there are other advantages attending the use of the compound-wound motor. In a compound-wound motor with the windings connected up cumulatively, the speed obviously decreases with increasing load, and the extent of the decrease is dependent on the relative strengths of shunt and series fields. The full-load speed of compound motors varies, in practice, from about 7 per cent. to 15 per cent. of the no-load speed. Much more extreme proportions may be used, and this is very desirable in the case of motors required to handle intermittent and very heavy loads, where there is no objection to the heaviest work being performed at much slower speeds. This is of great advantage to the whole supply system; the generating plant is more evenly loaded and the pressure regulation is better. Moreover, it is a considerable advantage as regards good commutation that a motor should carry its heaviest loads at reduced speeds. This is because the frequency of commutation, and therefore the reactance voltage, for a given current is proportional to the speed. The compound-

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wound motor has, in this respect, to a certain extent, the advantage obtained in a series motor—viz., less tendency to spark with increasing load. A shunt motor does not possess this property; in fact, a shunt motor has a greater tendency to spark on overloads, and to overcome this the reactance voltage should be low.

The chief point wherein calculations relating to a compound-wound motor differ from those of a shunt motor, relates to its speed at various loads. The estimation of a compound motor's speed may be illustrated by the case of a 30-b.p. 500-volt motor. It has a shunt winding giving a constant magnetomotive force of 3,000 ampere-turns per spool. When developing 30 h.p. the motor consumes a

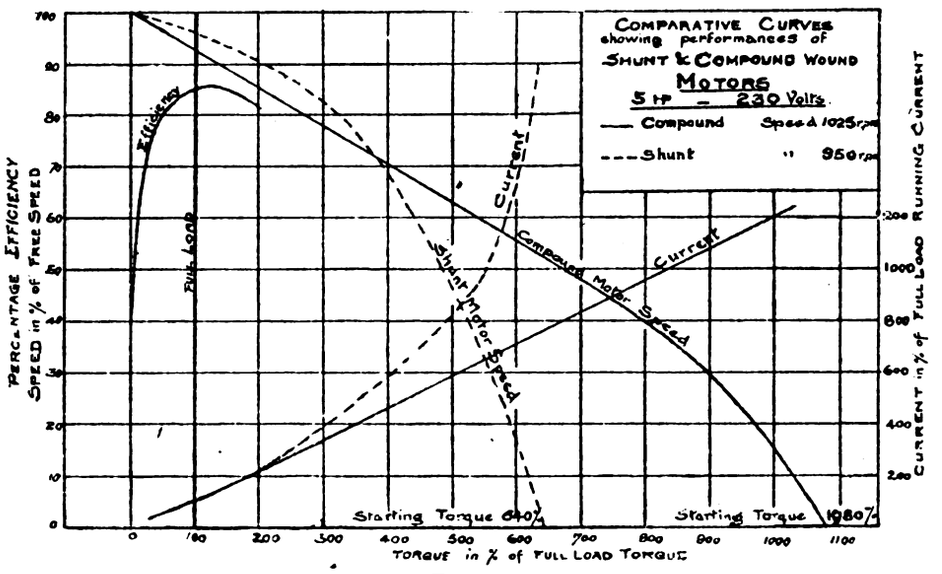

FIG. 1.

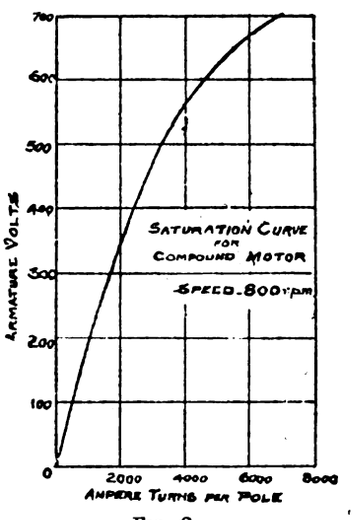

FIG. 2.

current of 50 amperes, which pass through a series winding with 50 turns per pole. Therefore, the series excitation at full load is 50 × 50 = 2,500 ampere-turns per pole. The saturation curve of the machine at its no-load speed of 800 revolutions per minute is given in Fig. 2. From the saturation curve the speeds for various loads and 500 terminal volts may be calculated, as indicated in the following table:

CHARACTERISTICS OF 30-H.P. COMPOUND-WOUND MOTOR AT VARIOUS LOADS.

—	Per cent. of full load.					
	0	25	50	75	100	125
Amperes input	4	15	26	38	50	63
Series excitation per pole	200	750	1,300	1,900	2,500	3,150
Shunt " "	3,000	3,000	3 000	3,000	3,000	3,000
Total " "	3,200	3,750	4,300	4,900	5,500	6,150
Voltage for 800 r.p.m. (from saturation curve)	500	550	585	620	650	680
Speed for 500 volts (r.p.m.)	800	727	682	645	615	588

In this illustration it is convenient to assume—for the sake of simplicity—that the brushes are so placed that armature reaction compensates for the C R drop.

It may be mentioned that compound-wound motors are finding a wide application for special purposes, such as for mining plants and rolling mills. In one instance a large steel-wire rolling mill in Sweden is driven by a 400-h.p. 500-volt compound motor. This machine has two commutators, which are connected in series for low and parallel for high speeds. A wide speed regulation is also obtained by shunt regulation. The practical operation of this motor has been very satisfactory, and an abrupt variation of the load, from 100 h.p. to 600 h.p., can be safely stood without sparking and with fixed brush position.—A. D.

Answer to No. 632 (*awarded* 7*s.* 6*d.*).—The starting power of a compound-wound motor is always greater than that of the same motor with a plain shunt winding, because, with the former, the effect of armature reaction in reducing the torque is partially or wholly avoided.

When a shunt motor is switched into circuit by means of an ordinary starting switch, the action is somewhat as follows: (1) the shunt winding alone is connected to the supply mains, and the shunt current and magnetic flux gradually increase to their full values, the time taken for this depending on the self-induction of the shunt circuit and the eddy currents set up in the magnet iron by the change in flux; (2) the armature is switched into circuit in series with the whole starting resistance, and a certain small current passes, producing a torque which is proportional to the product of armature current and magnetic flux; (3) the starting resistance is gradually cut out, and the armature current increases until the normal full-load value is reached, when if sufficient time has elapsed to permit the flux to reach its full value, as described in (1), the full-load torque will be developed and the motor will start; (4) as the motor speed and the back voltage increase more of the starting resistance is cut out so as to maintain the armature current at its normal value, until, finally, all the resistance is cut out and the motor runs at full speed.

If during this process the starting resistance is cut out too quickly, bad results may be expected from two causes. Firstly, if the full-load current is reached before the full flux is attained, the motor will not start until an excess armature current is supplied, and the field-weakening effect of the armature reaction due to this excess current may lead to an actual reduction instead of an increase in the torque. This is shown in Fig. 1, which represents the

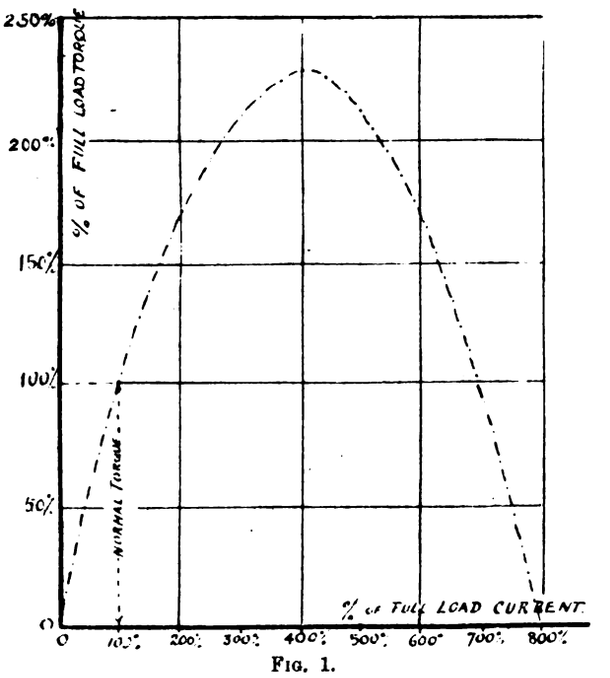

FIG. 1.

torque current curve of an ordinary shunt motor, in which the armature back ampere-turns at normal full load have

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been assumed to equal one-eighth of the total field ampere-turns—a not unusual proportion. It will be seen that, even with the shunt fully excited, the maximum possible torque is slightly over twice the normal, whilst with the shunt only partially excited, or with a motor having a greater ratio of armature back ampere-turns to field ampere-turns, this maximum torque would be proportionately lower and would be reached at a correspondingly lower current. The second cause of trouble is the fact that, even if the full flux has been attained before the armature current reaches its normal value, the inertia of the armature and machinery driven by it may cause an excessive current to pass if the switch is moved too quickly. This would lead to the same result as above—viz, the reduction rather than increase of the torque with increasing armature current

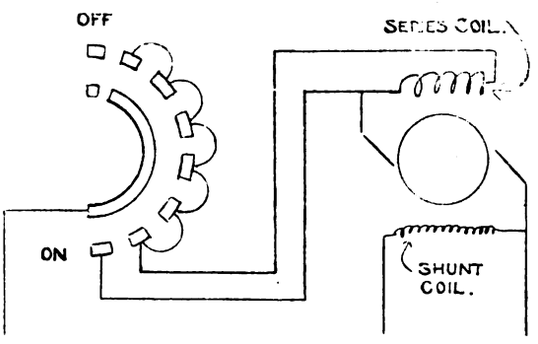
Trouble from both these causes can be avoided by the employment of a compound winding. For then, if the amount of series winding is chosen to neutralise or more than neutralise the effect of armature reaction, it is clear that no sudden increase of armature current, however great, will be able to affect the flux. Consequently there is no longer any chance of the torque diminishing with increasing current. The self-induction of the series winding will, of course, be very much less than that of the shunt winding owing to the lower number of turns in the former, and it would, therefore, seem advantageous to disconnect the shunt until after the full armature current is reached, so as to avoid the retarding effect of the closed shunt winding on the flux produced by the series winding. In practice, however, especially with small motors, the retardation of the flux due to self-induction and eddy currents is small compared with the time taken for the machine to attain full speed so that certainly no harm, and probably some good, would be done by leaving the shunt winding connected throughout.—Q.

Answer to No. 632 (*awarded* 5*s.*).—When any particular continuous-current motor is supplied with electrical current, the torque exerted upon its shaft in any condition of the motor, whether running or stationary, is proportional to the product of the flux per pole passing through the armature and the current flowing in the armature circuits. Hence, if in a shunt-wound motor we put on the normal field, and then pass the normal full-load current through the armature when stationary, we shall get full-load torque exerted, but no more, and as a motor which must start against what is colloquially termed "full load" has to start against a torque equal to that met at full load, it is easy to see that the torque exerted by the armature at starting and while running up to speed must be *more* than that when running at full load, since the motor must supply not only the normal torque to turn the shafting or lift the load, as the case may be, but must supply, in addition, the torque necessary to speedily accelerate the motor and its load up to full speed. An ordinary shunt motor can only give increase of torque by a proportionate increase of armature current, since its field, placed directly across the supply mains, cannot have its current raised. Hence, in starting a shunt motor against "full load," an excessive rush of current is bound to be taken; and if, as in cranes and lifts, the starting torque to be overcome is considerably greater than the running torque (owing to the friction of bearings being greater when standing than when in motion) the necessary current to start up and reach full speed quickly may be very great indeed. Here, then, is the advantage of supplying a compound-wound motor, for the poles being equipped with series coils for starting purposes, these give an additional number of ampere-turns on the poles, and by raising the flux give an increase of torque with normal current. And, again, if the current is allowed to rise above its full-load value, the torque will increase in a higher ratio than the current, since it is raised by the increase both of armature current and of field strength.

In the particular case cited, the motor of 8 h.p. at 550 volts will take a normal armature current of about 12 amperes. Its speed not being stated, one can only approximate at its dimensions, but being four polar it will probably have a normal flux of 1·5 megalines per pole, requiring, say, 4,500 ampere-turns. If, now, in addition to the shunt coils producing these, each pole has a series coil of 100 turns, there will be available (at normal armature current) an extra 1,200 ampere-turns per pole, making 5,700 in all, and raising the flux to about 1·7 megalines, giving, therefore, an increase of 13 per cent. in the starting torque when drawing, but normal full load current from the mains. The exact number of series turns must depend upon the requirements of the motor, and if very excessive starting torque is desirable it will be advisable to work the motor normally at some distance below the magnetic saturation point, so as to allow a big increase of flux when the series coils are in use. But it may be pointed out that as these coils will only be used at starting up—*i.e.*, for short periods at a time—it will be quite safe to work them at a much higher current density than can be allowed for the shunt coils, and hence the series coils will not occupy much space on the poles.

From the wording of the question, it appears that "G. H." considers there is something special in the flux produced by series coils, and that that excited by shunt coils is of no service in starting up, since we are told that "the idea is to start up as a series machine, and throw in the shunt afterwards." This is an utter fallacy, though by no means an uncommon one. The flux is just as useful whether produced by series or by shunt coils, and the sole advantages of series coils for starting (or, indeed, for running at any time) is that as pointed out above, with their use an increase of current causes the torque to increase in a greater ratio. But since we already have on the motor this shunt winding, we may avail ourselves of the ampere-turns this will give us, and use this advantage of the series coils to afford any extra ampere-turns that may be required. If the shunt coils are not to be used during starting, it will mean a very great increase in the amount of series copper to be put on the fields, and will certainly necessitate the use of a carcase a good deal too large intrinsically for this output, in order to afford room for all this copper.

If the speed at which the motor runs may vary considerably without harm, then one may use a compound motor, which would virtually be a series motor with shunt coils added to prevent racing. This would be used with both sets of coils permanently in use. If, on the other hand, a set running speed is required, then a shunt motor must be used normally—*i.e.*, the series coils must be cut



out when speed is reached—but special series coils will be added for use in starting in conjunction with the shunt coils. The annexed sketch shows the connections on the starting switch for this latter mode of operation. The arm of the switch would be furnished in the usual manner with a spring, so that the circuit can only be left "off" or "full on"—*i.e*, as shunt motor. If a maximum release is to be fitted, then the lead *to* the switch must be carried round the solenoid, since there are two leads thence to the motor, either of which may be overloaded. The shunt connection is not shown in the sketch. This would preferably be made by a subsidiary arm on the switch, and should be provided with a "kicking coil."—C. E. C.

Answer to No. 632 (*awarded* 5*s.*).—The object of compounding a motor which is started up with full load on is to obtain a large starting torque. In the case of elevators, hoists, etc., the power required to overcome the inertia of the moving parts at starting is very great, but after the motor has been running a few seconds the power required to keep the various parts moving falls off very considerably. The usual arrangement is to have, in addition to the shunt winding, a few series turns, just sufficient to

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obtain the extra torque necessary at starting. This series winding is automatically cut out of circuit by the controller or starting switch some few seconds after starting, and the motor is left running as an ordinary shunt-wound machine.

The diagram (Fig. 1) shows the starting switch of a controller. The arm, A, moves slowly over the contacts, gradually cutting resistance out of the armature and series field. As soon as the arm reaches the contact marked C_1 half the series field is short-circuited, and when the arm reaches the contact C_2 the whole of the series winding is short-circuited, leaving the motor running with shunt field only. The foregoing arrangement is in use on several motors for working hoists, elevators, etc., to the writer's knowledge, and is found very satisfactory in practice. If the load on the motor after it has once been started is not of a very varying nature, "G. H." will find a shunt-wound

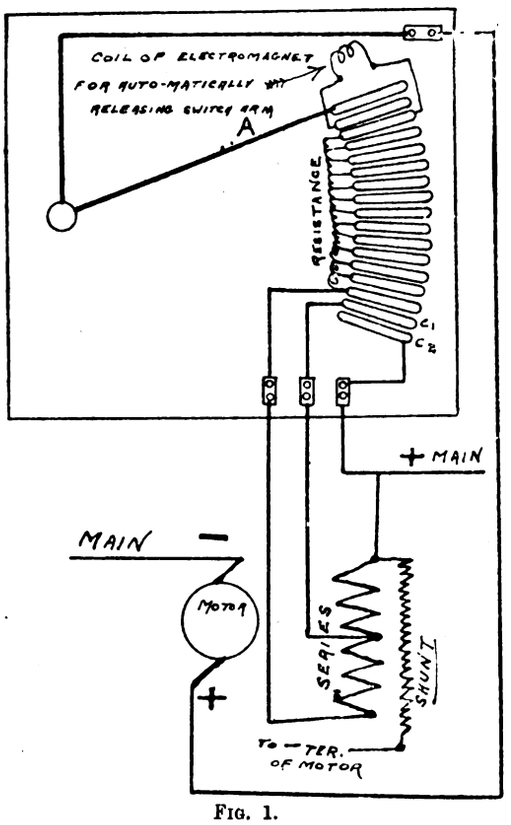

FIG. 1.

motor work quite satisfactorily, and run at practically constant speed.—C. V.

[N.B.—Will "C. V." kindly forward to us his name and address.—ED., *E. E.*]

PROVISIONAL ORDERS.

The following notices of intended application for provisional orders appear in the *Gazette*:

ELECTRIC LIGHT AND POWER.

Birkenhead Corporation, electric lighting extension; Lichfield City Council, electric lighting extension; Saffron Walden Corporation, electric lighting; Mansfield Woodhouse Urban District Council, electric lighting; Huddersfield Corporation, electric lighting extension to Golcar; Acton Urban District Council, electrical fitting and supply; Thornbury Rural District Council, electrical power and lighting; Gainsborough Urban District Council, electric lighting; Maldens and Coombe Urban District Council, electric lighting and power; Keynsham (Somerset) Electric Lighting and Power Company; Horley (Marshall Handyside Bennet, of the Chesnuts, Horley, and Robert Cornelius Quin, 13, Victoria-street, London). Watford Urban District Council, electric lighting: Newquay, Southern District Electricity Corporation, electric lighting; Ely, Southern District Electricity Corporation, electric light.

TRAMWAYS.

London United Tramways Company; Wardle Urban District Council; Leyton Urban District Council; Rotherham Corporation; Ossett Corporation; Bournemouth Corporation; Folkestone Corporation; Wallasey Urban District Council; Middlesbrough, Stockton-on-Tees, and Thornaby Imperial Tramways Company, Limited; Brighton Corporation; Wolverhampton Corporation; Altrincham Urban District Council; Harrow-road and Paddington Tramways Company; Hope and Castleton Light Railway Commissioners; West Metropolitan Railway Company; Chesterfield Corporation; Saddleworth and Springhead Tramways Company (abandonment of undertaking); West Ham Borough Council.

LEGAL INTELLIGENCE.

ELECTRICAL PUBLISHING COMPANY, LIMITED.

In the Chancery Division of the High Court of Justice on Tuesday, Mr. Justice Buckley, sitting for disposal of companies' business, had before him a petition to wind up the Electrical Publishing Company, Limited, the petitioner being Thomas Wm. Sheffield, of Trevellyan-buildings, Corporation-street, Manchester.

Mr. Astbury, K.C., for the petitioner, said the company was formed in July, 1902, for the purpose of carrying on the business of and publishing an electrical review, with offices in London. The nominal capital of the company was £14,500, of which £8,800 had been allotted. It was not quite correct to say they were all paid up; only part were paid up. The object was to carry out an agreement with one Theodore Feilden, who was to be the editor and publisher of this magazine. By the agreement of July, 1902, and referred to in the memorandum and articles of association, it was provided that the company should acquire the publications—meaning thereby the copyright of the title of the *Electrical Magazine* and other property and assets—from Feilden, who was appointed managing director and editor of the publication, in consideration of which the vendor was allotted 5,500 ordinary shares and 1,000 preference shares, and the remuneration for his services was to be £6 per week from the date of the registration of the company up to the date of publication, with travelling expenses in London at 10s. 6d. a day, and in the provinces at two guineas a day. What the petitioner complained of was that Feilden had nothing to sell. It turned out that there was no publication, and no preparation for publication. Mr. Feilden had been going on drawing money from the company, and great pressure had been brought to bear upon him. He now suggested that he might publish the magazine early next year, but nothing had been done at all, and petitioner alleged that the company was simply a company for putting a monthly or weekly sum into Mr. Feilden's pocket. The petitioner set forth that the company went to allotment in June, 1902, and at the date of the balance-sheet of June 30, 1903, 9,099 ordinary shares and 2,255 preference shares, including the vendor's, had been issued. Theodore Feilden had continued to draw his salary and expenses, and a sum of £1,350. 2s. 7d. had been expended on manager's salaries, directors' expenses, office furnishings, stationery, and other expenses at the date of the balance-sheet, leaving a balance in the bank at that date of £1,012. 17s. 7d. Between the months of March and September, 1902, there were circulated a large number of copies of the prospectus of the company, and many copies of the prospectus were distributed amongst electrical engineers, general engineers, and members of local authorities. The prospectus contained, among other statements, the following: "The maturation of Mr. Feilden's project has been the work of much careful thought. In the result Mr. Feilden has conceived and perfected a magazine entirely different to anything hitherto existing in this or any other country, rivalling the best productions of the United States, which are such enormous successes—in effect an international monthly record of things electrical, a compendium of information which should form an indispensable adjunct to every worker and thinker in the electrical science and progress, a journal presenting the mature thought of the pure scientist and authority in carefully selected signed articles, expert descriptions, fully illustrated, of the latest and best productions of the engineer and manufacturer of every country. Further technical details of the *Electrical Magazine* would be unpolitic to divulge, but leading authorities who are interested in the enterprise have declared that the publication is virtually unique in its comprehensiveness and utility." The petitioner upon the faith of the statements contained in the prospectus, which he believed to be true, applied for and was allotted 100 ordinary shares of £1 each, and had paid up £50 in respect of the shares and induced many of his friends to take shares in the company, and to promise to support the magazine with advertisements and subscriptions. The allotment took place in June, 1902, and the petitioner, relying upon the statements in the prospectus that the magazine had been perfected and approved by leading authorities, and that a profit was anticipated on the first year's working, expected the magazine to be published at once, and frequently urged Feilden to publish the magazine. In April, 1903, a paragraph appeared in the *Electrical Times* commenting unfavourably on the delay in the production of the magazine, and plainly insinuating that Mr. Feilden was working for his own interests and not for those of the shareholders. It was a very bitter paragraph. The petitioner called Feilden's attention to the article, and Feilden said he would take proceedings for libel against the writer of the article, but he had not done so. Up to the present time the magazine had not been published, nor, said counsel, was there any prospect of its ever being published. Feilden had produced a few dummy copies of the proposed magazine, which represented a week's work and a cost of 10s. per copy. Petitioner believed that if the whole of the remaining capital were subscribed, it would be totally inadequate to meet the expense of producing this magazine and maintaining it for 12 months until the advertisements began to pay; and Theodore Feilden, with his experience as a printer and of journalism, must have been fully aware of this at the time the company went to allotment. If the magazine were published, an outlay of from £400 to £500 per month would be required for 12 months to successfully establish the undertaking, and no return from the advertisements, on which the success of the magazine depended, could be expected during that period.

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The amount available for calls upon shares was £2,404, and the number of shares remaining unallotted was 3,146, making a possible available capital of £5,550 to meet an estimated expenditure of £6,000 Owing to the delay in the publication of the magazine, many firms who had promised petitioner to advertise in the magazine had withdrawn their support. The dissatisfaction of the shareholders with the conduct of the undertaking was so great, and the undertaking had been so unfavourably criticised in the Press and among electrical people, that it was unlikely that any more shares would be taken up by the public. The only asset of the company was the bare copyright in the name, the office furniture, the cash now remaining in the bank, and a few contracts for advertisements, which were liable to be cancelled on the ground of the long delay in the publication of the magazine. Concluding, counsel submitted that the company was being called on solely in the interests of Feilden, and petitioner asked that it should be wound up.

Replying to questions by his Lordship. **Mr. Astbury** said his client held 100 shares, and he was supported by 27 shareholders holding 541 shares. The total number of shareholders was 154.

Mr. Hart, who opposed the petition, said he appeared for 58 shareholders holding 3,613 shares paid for in cash.

Mr. Astbury: My client states that they only hold 2,000 odd shares. I am told they have not given notice.

Mr. Hart said practically all had given notice.

Mr. Buckmaster, K.C., who appeared for the company, said further notices had been received that morning representing 160 shares. The petitioner had circularised shareholders and had received no more support than that stated.

Mr. Astbury said the opposing shareholders seemed also to have sent out circulars.

His Lordship: Assuming Mr. Feilden was to blame in every respect—I don't say he is for a moment—but let us discuss the matter on the footing that he has got 6,500 shares. If a meeting were held of shareholders and a vote taken on the question of whether there should be a voluntary winding-up, of course, he would be defeated.

Mr. Astbury: It would be hopeless.

His Lordship: You are a small minority of the shareholders, and the majority want the thing to go on. How can I, therefore, wind it up?

Mr Astbury: That is the difficulty. If I went into a lot of details I could show a good many things about this company which are unsatisfactory. As your Lordship takes the view expressed, I don't think I should waste the time of the Court.

His Lordship: I dismiss the petition with costs.

Mr. Buckmaster, K.C.: It may please my friend to know that the first number is ready for him.

WORKMEN'S COMPENSATION.

The case of Joseph Dixon *v.* the Darlington Corporation and J. G. White and Co., brought under the Workmen's Compensation Act, came before Judge Templer at Darlington County Court. Dixon was, it seems, employed by Mr. Peter Wilkinson, a sub-contractor for Messrs. White and Co., contractors for the new Corporation tramways. Owing to a horse taking fright in Parkgate he received personal injuries.

Mr. G. H. Watson, who appeared for Dixon, said Messrs. J. G. White had agreed to pay the injured man 12s. a week, and he asked for an order accordingly.

The **Town Clerk,** representing the Corporation, said his contention was that the Corporation were not liable, and he asked that they should not appear on the records.

Mr. Priestley, for Mr. Peter Wilkinson, against whom Messrs. White and Co. claimed indemnity, said he was prepared to go into the question of liability.

The Corporation was withdrawn.

The **Judge** said he would without prejudice make the award against White and Co., allowing costs on scale B.

The question of indemnity as between Messrs. White and Co. and Mr. P. Wilkinson was arranged to be heard later.

POST OFFICE TELEPHONES.

His Honour Judge Russell held a special sitting at the Kingston-on-Thames County Court on Friday to hear an action, by way of an application by the Postmaster-General to compel the Urban District Council of Wimbledon to consent to the erection of telephone poles and wires in certain parts of the urban district.

Sir Robert Hunter, for the Postmaster-General, explained that the Post Office sought the authority of the Court for the construction of three small lines of telephone wires and posts in Gap-road, Haydon's-road, Beulah-road, Dundonald-road, and Garfield-road, and the action arose under the Telegraph Acts of 1863 and 1878, which gave the Postmaster-General power to place telegraphs or telephones in, under, on, over, along, or across any public road, and to erect posts thereon for the purpose, subject to the consent of the local authority, and if the local authority withheld consent, then the matter was to be referred for decision to a county court judge. Application for consent was made to the Wimbledon District Council on Aug. 27, 1903. The Council refused, unless the lines were laid underground in Gap-road and Haydon's-road and ornamental iron poles were erected in the other roads. This the Postmaster-General was unable to consent to, on the ground of the great expense that would be entailed. If they were to be compelled to lay the lines underground and to erect ornamental iron poles it would be impossible, having regard to the rates charged to the public, to provide the system which Parliament expected and the public required.

Evidence having been heard,

His Honour, in giving his decision, said that, having regard to the appearance of Gap-road and Haydon's-road, he did not think the erection of iron poles would very much interfere with it, and the proposal of the Postmaster-General to erect iron poles there instead of laying underground wires he considered a proper one. As to the other roads, judging from the photographs before him, he did not think that painted wooden poles would interfere with the æsthetic character of the neighbourhood, so he thought the proposal of the Post Office was a fair one. He refused to allow costs.

COMPANIES' MEETINGS AND REPORTS.

GENEVA TRAMWAYS.

The report of the directors for the period from the incorporation of the Company to Sept. 30 last states that the Company was registered on Dec. 6, 1901, for the purpose of acquiring shares of the Compagnie Genevoise des Tramways Electriques, a company incorporated under the laws of the Swiss Republic, and owning and working a complete system of tramways about 136 km. in extent in and about the city and canton of Geneva. Solely dependent as it is for its revenue upon the profits of the Swiss company, this Company has become financially involved. In the belief that the suspension of profit-earning by the Swiss company was occasioned by temporary causes only, the directors obtained from Messrs. L. Hirsch and Co. loans amounting to £38,250, with which to meet the interest on the debentures falling due on July 1, 1902, and Jan. 1, 1903, but when it became apparent that a protracted period must elapse before the Swiss company could earn sufficient profit to provide this Company's debenture interest, and that further funds would possibly be required for the purposes of the Swiss company and of this Company, the directors were compelled to propose to the debenture holders a rearrangement of the finances of the Company. At a meeting of the debenture holders held on June 25, 1903, it was resolved to postpone for three years from Jan. 1, 1903, the payment of interest on the 4½ per cent. debentures, and to authorise the Company to create £20,000 of 5 per cent. short term prior lien debentures charged upon the shares held in the Swiss company, and to issue £39,692 5 per cent. third debentures in satisfaction of the previous advances of Messrs. L. Hirsch and Co. Neither the prior lien nor the third debentures have yet been issued.

NEW COMPANIES REGISTERED.

T. H. Wathes and Co., Limited.—Capital, £3,000. Objects: to adopt and take over and carry on the business of T. H. Wathes as an electric power, light, and telephone engineer at 13, Belgrave-gate, Leicester, etc.

Western Electric Distributing Corporation, Limited.—Capital, £10,000. Objects: to adopt an agreement with the Bristol Trust, Limited, and to carry on the business of suppliers of electric light and power, electricians, electrical engineers, etc.

Werner Freres, Limited.—Capital, £120,000. Objects: to take over and carry on the business of Werner Freres at 10bis, Avenue de la Grande Armee, Paris, and Rue Grefhulle, Levallois-Peret (Seine), France, for the sale of motors, motor-cycles, motorcars, cycles, vehicles, batteries, accumulators, cells, and the like, electricians, etc.

St. Albans and District Electric Supply Company, Limited (79,078).—Capital, £25,000. Objects: to carry on the business of suppliers of electricity, carriers of passengers and goods, electrical engineers, etc.

Power Plant Company, Limited (79,151).—Capital, £500. Object: to carry on the business of engineers, merchants, agents, contractors, builders, ironfounders, etc. Registered office: 20, New Bridge-street, E.C.

Manchester Carriage Company (1903), Limited.—Capital, £30,000. Object: to carry on the business of proprietors, manufacturers, repairers, and hirers of and dealers in omnibuses, motorcars, and other vehicles, whether propelled or drawn by manual, animal, electrical, or other power. Registered office: 6A, Wilmslow-road, Rusholme, Manchester.

Electrical Turnery, Limited.—Capital, £2,000. Object: to adopt an agreement between Electrical Turnery, Limited, and to carry on the business of turners, pattern-makers, founders, telegraph, telephone, electric, and general engineers, and dealers in electrical and other bells, telephones, lamps, and apparatus, etc.

British Accumulator Company, Limited (79,191).—Capital, £5,000. Object: to acquire and carry on the business of electric accumulator merchants carried on as the British Accumulator Company, at Parliament-mansions, Westminster.

Additional Traffic Returns.—Anglo-Argentine, £1,963 increase; Barcelona Ensanche y Gracia, £133 increase; Barcelona, £32 decrease; Brisbane, £90 decrease (month of August, £11,736, increase £294), British Columbia Electric (month of March), gross earnings £10,352, net income £2,659; Buenos Ayres and Belgrano Electric, £205 increase (month of October, £14,055, increase £1,002); Calcutta, £288 increase; Cape Town (month of October), receipts £16,229, expenditure £9,044; Isle of Thanet Electric, £29 increase; Lisbon Electric (month of October), receipts 93,725 milreis, expenses 50,350 milreis; Mexico Electric (month of August), receipts £48,600, expenses £27,900; Perth Electric, £266 increase; Port Elizabeth (month o October), receipts £3,972, expenditure £2,879.

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CONTRACTS FOR ELECTRICAL SUPPLIES.

Pontypridd.—The District Council invite tenders for the supply of six single and six double-deck electric cars.

Middlesbrough.—Tenders are required by the Corporation for dynamos, boilers, and condensers, by 28th inst.

Preston.—The Corporation invite tenders for a traction switchboard and accessories. Tenders by Dec. 12. See advertisement.

Maidstone.—The Corporation invite tenders for the construction and equipment of light railways. Tenders by Dec. 7. See advertisement in last issue.

Canosa di Puglia (Italy).—The Municipality will receive tenders for installing and working electric lighting for 50 years. Tenders by 30th inst.

Hornsey.—The District Council invite tenders for one 300-kw. steam dynamo to be delivered in October, 1904, and another in March, 1905.

Dudley.—The Guardians invite tenders for the supply and fixing of the various appliances for the electric installation to the laundry and boiler house.

Wood Green.—The Urban District Council invite tenders for the erection of a power station and the buildings in connection with the Council's electric lighting scheme.

Birmingham.—The Birmingham Tame and Rea District Drainage Board, 9, Bennett's-hill, Birmingham, invite tenders for three steel Lancashire boilers. Tenders by Dec. 8.

York.—The North-Eastern Railway Company invite tenders for telegraph apparatus, telegraph wire, and line stores. Forms of tender from Mr. C. H. Ellison, superintendent, York. Tenders by Dec. 7.

Batley.—The Town Council invite tenders for the erection of building for refuse destructor. Specifications, etc., may be obtained from the Borough Surveyor, Branch-road. Tenders by 30th inst.

Greenwich.—The London County Council invite tenders for six electrically-driven three-throw boiler feed pumps. Specifications, etc., at the County Hall, Spring-gardens, S.W. Tenders by Jan. 19.

Cape Town (South Africa).—The Directors of the Cape Town Industrial Exhibition (International) invite offers for lighting the grounds, etc. Tenders to Palmerston House, Old Broad-street, London, E.C.

Greenwich.—The London County Council invite tenders for the supply delivery, and erection of four 3,000-kw. generators with exciters. Tenders by 10 a.m. on Dec. 8. See advertisement in former issue.

Wisby (Sweden).—Tenders are invited for a private and public electricity supply estimated to cost 180,000 kroner. Particulars may be obtained from the Director of the Draetselkammaren at the above place.

King's Norton and Northfield.—The Council invite tenders for the erection of car-sheds and waiting room. Tenders by 30th inst. to Mr. Edwin Docker, clerk to the Council, 10, Newhall-street, Birmingham.

Sydney (N.S.W.).—Tenders are asked for the supply of continuous and alternating current meters. Specifications, conditions, and forms of tender are obtainable from Messrs. Preece and Cardew, 8, Queen Anne's-gate, S.W.

London, W.—The Great Western Railway Company invite tenders for the supply, delivery, and erection of water-tube boilers, engines, three-phase generators, and auxiliary plant at Park Royal, near Acton. Tenders by Dec. 7.

North-Eastern Railway.—The Directors invite tenders for arc lamp carbons and electric wires and cables, etc., for the first half of 1904. Specifications, etc., from Mr. E. H. Clark, Stores, Gateshead. Tenders by Dec. 7.

Burslem.—The Electric Lighting Committee invite tenders for the erection and completion of the generating station on a vacant site at the gasworks, Longport. Specifications, etc., from the Borough Electrical Engineer. Tenders by 30th inst.

London County Council Tramways.—The Council invite tenders for the wiring and fitting for electric lighting of five substations and three car-sheds in connection with the tramways. Tenders by Dec. 5. See advertisement in former issue.

Brighton.—The Council invite tenders for six water-tube boilers; a system of steam, exhaust, feed, blow-off, and suction pipes; and cast-iron storage tanks. Specifications, etc., may be obtained from Mr. Francis J. Tillstone, Town Hall, Brighton. Tenders by Dec. 7.

London, N.—The Hornsey Urban District Council invite tenders for the supply of meters, indicators, and consumers' fuse boxes. Specifications, etc., may be obtained from Mr. Norman Staniland, Electricity Works, Tottenham-lane, Hornsey. Tenders by 30th inst.

Christchurch (New Zealand).—Tenders are invited for the complete installation of electrical tramways, other than buildings. Specifications, etc., may be obtained from the Agent-General for New Zealand, Victoria-street, S.W. Tenders by March 17. See advertisement in last issue.

Dublin.—The United Tramways Company invite tenders for the supply of general stores, including car fittings, iron, steel, castings, oils, paints, glass, brushes, ironmongery, harness materials, electrical supplies, timber, etc., for year ending Dec. 31, 1904. Tenders by 30th inst.

Belfast.—The Committee invite tenders for the supply and erection of a complete heating and ventilating system, including steam boilers, heaters, etc., engines, blowers, and electric fans. Tenders by Dec. 4 to Messrs. Young and Mackenzie, architects, Scottish Amicable Buildings, Belfast.

Brussels.—Tenders are required for the electric lighting of the law courts. Specification, No. 111 (3½d.), and plans (4s. 9d.), may be obtained from 15, Rue de Augustine, Brussels. Tenders by registered letter to Direction générale des ponts et chaussées, 38, Rue de Louvain, Brussels, by Nov. 30.

Culiacan (Mexico).—Tenders are invited for lighting the town by electricity: 60 arc lamps of 1,200 c.p. and 110 incandescents of 50, 30, and 16 c.p. will be required. Propositions will be received by letter until Dec. 31 in the Secretaria del Ayuntamiento, Culiacan, where further information may be obtained.

West Ham.—The Education Committee invite tenders for the electric wiring and fittings and for the hot-water heating apparatus required at the Whalebone-lane Higher Elementary School, Stratford, E., and Shipman-road School, Custom House, E., now in course of erection. Tenders by Dec. 14. See advertisement in last issue.

Madrid.—The Government have issued an order granting an appropriation of 6,000 litres of water per second from the River Tea, in the municipal boundary of Mordariz, province of Pontevedra, for the production, by a fall of 6·40m., of electrical power for industrial uses, for which water power electric plant will be required.

Handforth (near Manchester).—The Guardians of Chorlton-upon-Medlock Union invite tenders for an electric motor for the new laundry at Styal Cottage Homes, Handforth, near Manchester. Specifications, etc., can be obtained from the consulting electrical engineer, Mr. G. R. Peers, A.M.I.E.E., 16, John Dalton-street, Manchester.

London, S.W.—The London County Council invite tenders for the supply and delivery of about 6,850 tons of steel girder tramway rails, fishplates, and bolts and nuts, and for 4,100 tons of steel slot rails, and 1,490 tons of steel conductor tee rails required for electric traction on the Council's tramways. Specifications, etc., from Engineers' Department, and tenders to the Clerk, County Hall, Spring-gardens, by Dec. 15.

Sydney (New South Wales).—Tenders will be received at the office of the Deputy Postmaster-General, Sydney, New South Wales, up to 2.30 p.m. on Dec. 30, for the supply and delivery at the departmental stores, Sydney, of telegraph, telephone, and electric light material. Specifications, etc., may be seen and tender forms obtained at the General Post Offices, Sydney, Melbourne, Brisbane, Adelaide, Hobart, and Perth.

Italian Arsenals.—Tenders are invited for the supply of electric lamps for the lighting of Italian warships, and will be received simultaneously at the Directorates General of Royal Arsenals at Spezia, Naples, and Venice, at 11 a.m. on Dec. 1. The electric lamps to a total value of 40,000 lire (about £1,600) are to be delivered at the Royal Arsenals at Spezia, Naples, Venice, and Taranto. Particulars may be obtained from the Admiralty, Rome.

Colombo (Ceylon).—The Government of Ceylon invite proposals from persons willing to enter into a contract for the supply of electrical energy to the various offices, buildings, and premises of the Government, within the Municipality of Colombo, for a term of years commencing on or about Aug. 1, 1905 Proposals must be delivered at the office of the Colonial Secretary, Colombo, by Dec. 1. The *Ceylon Government Gazette* containing above notice may be seen on application at the Commercial Intelligence Branch of the Board of Trade, 50, Parliament-street, S.W.

RESULTS OF TENDERS.

Barton.—The Guardians have accepted the tender of Mr. E. M. Evans for the electric lighting of the old infirmary at £89.

Wicklow.—The Urban District Council have accepted the tender of Messrs. Blakes and Knowles, at £120, for condensing plant.

Wakefield.—The Guardians have accepted an offer from Messrs. A. Hirst and Sons, Limited, to provide a larger dynamo for £115.

Plymouth.—The Corporation have accepted the tender of Mr. Crabb, coach builder, Union-street, at £15 per car, for painting tramcars.

Brighton.—The Town Council have accepted the tender of the General Electric Company, Limited, for the supply of 31 street police call fire-alarms for £368.

St. Olave.—The Board of Guardians have accepted the tender of the Salisbury Electrical Engineering Company, of Lee, for the supply and fitting up of the electric lighting installation at the workhouse for £365.

Battersea.—The Borough Council have accepted the tender of the General Electric Company for supply of fuseboards, etc., for the lighting of the staircases of the mansions for £19. 6s. 3d.

South African Railways.—Contracts of the estimated value of over £49,000 for electrically-controlled signals have been placed by the Central South African Railways Company with Tyers's electric signalling system.

Blackpool.—The Electricity and Tramways Committee have accepted the tender of the British Westinghouse Company for new 450-kw. traction set (vertical triple-expansion Browett engine and multipolar generator).

Swindon.—The Corporation have accepted the tenders of Bradbury, Son, and Co., Billiter-street, London, and L. Twining and Co., Bristol, for supply and delivery of Somerset small steam coal and Forest of Dean small steam coal at their electricity works.

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BUSINESS NOTES.

TRACTION.

Ipswich.—The new electric trams were run for the first time on Monday for the convenience of the public.

Shildon.—The United Kingdom Tramways Syndicate intend to apply for powers in respect of this district.

Chatham.—An agreement has been arrived at in respect to certain matters in dispute between the tramway company and the Corporation.

Bristol.—The tramways company will apply in the next session for powers to construct further tramways representing a road mileage of about 12 miles.

Johannesburg.—We are informed that a further contract of over £2,000 has been secured by Hadfield's Steelfoundry Company, Sheffield, for points and crossings.

Londonderry.—The Donegal County Council have given their consent to the construction of the proposed electric tramways from Londonderry to Moville.

Colchester.—A start had been made with the new electric tramways, but the work has been suddenly stopped, the reason assigned being the non-arrival of a consignment of rails from Belgium.

Lancashire and Yorkshire Railway.—It is officially stated that when the Liverpool, Crosby, and Southport line is worked electrically it is only intended to provide first and third class carriages.

Soothill Upper.—The tramway scheme is reported to have fallen through, owing to difficulties in the negotiations with the traction company, and the application for parliamentary powers has been abandoned.

Competition.—It is stated that up to date the City and South London Railway Company have experienced a decline of £8,197 in the receipts for the current half year, due to tramway competition.

Dartford.—The scheme for the construction of an electric tramway system here at a cost, with generating plant, of about £90,713, is to be proceeded with forthwith. A committee has been appointed to take the matter in hand.

Worcester.—The City Council have decided to allow the tramway company three months' extension of time for completing the light railways in St. Swithin's-street, High-street, College-street, Sidbury, London-road, and Bath-road.

Electric Pneumatic Signalling.—We understand that the Nord of France Railway and the Bengal-Nagpur Railway Company have entered into contracts with the British Westinghouse Company for pneumatic signalling installations.

Bath.—The British Westinghouse Electric and Manufacturing Company have secured a further order for 10 magnetic brake equipments for the new cars of the Bath electric tramways. These sets will be duplicates of those already in order.

Sunderland.—At a special meeting of the Borough Council on Wednesday the requisite authority was given for making application for a provisional order authorising the Council to construct new and additional tramways within the borough.

Derby.—The Tramways Committee have under consideration the advisability of running the new electric cars from the Cavendish Hotel and along Wallbrook-road. This route will shortly be recommended to the Town Council for adoption.

Glasgow.—The proposals of the Tramways Committee for the several extensions of the present system (mentioned in our last issue) have been approved by the Town Council. The extension from Crookston to Paisley was opened for traffic yesterday.

Light Railways.—The Board of Trade have confirmed orders made by the Light Railway Commissioners amending the Bere Alston and Calstock Light Railway Order, 1900, and authorising the construction of a light railway in the county of Southampton from Totton to Fawley.

London Traffic Enquiry.—At Friday's sitting of the Royal Commission on London Locomotion, Superintendent Cole, of the E division, gave evidence as to the congested state of the traffic in the Strand, New Oxford-street, High Holborn, Clerkenwell-road, Chancery-lane, Gray's-inn-road, and Theobalds-road.

Lincoln.—Another effort has been made by the Electricity Works Committee to arrive at an amicable settlement with the tramways company. Now only about £250 divides what the Corporation offer and what the company are prepared to accept. It is probable, therefore, that arbitration will not have to be resorted to.

Colne Light Railway.—Major Druitt and Mr. A. P. Trotter have inspected on behalf of the Board of Trade the new line constructed by the Colne and Trawden Light Railway Company. The new line joins on to the Nelson Corporation tramways, and completes a large electric tramway system, joining several of the main centres of population in North-East Lancashire.

Royton.—Among the measures that are being promoted for the next session of Parliament is the Royton Urban District Tramway Bill. Its object is the revival and extension of powers to construct and complete tramways authorised by the Royton Urban District Tramways Order, 1901, the amendment of that order, extension of powers of borrowing, and other purposes.

Doncaster.—Major Druitt has inspected the recently completed tramway to Oxford-street, the new passing place at Hexthorpe, and the extended passing place at Balby-road. The new line to Oxford-street has a total length of 26 chains. Major Druitt expressed his satisfaction with the line, and the cars began to run yesterday. This completes the whole of the lines authorised by the light railways orde 1899, 1902-3.

Electrification of Railways.—Mr. Wilson Worsdell, chief mechanical engineer of the North-Eastern Railway Company, speaking at Gateshead on Friday, said railways in this country were making more rapid progress in electrification than in America, instancing the case of the North-Eastern Company, who are electrifying 47 miles of branch roads, in support of the statement.

Ripon.—At this week's meeting of the City Council the town clerk submitted the draft order of the Light Railway Commissioners for the tramway scheme, the Highways Committee recommending a length of wood pavement 18in. outside the rails between Coltsgate-hill and the Spa Gardens. It was stated that the order would next go before the Board of Trade, who would hear any further objections before giving their approval.

Newport (Mon.).—The question of substituting a motorcar service for the Stow Hill district of Newport instead of laying an electric tramway, as the Corporation is authorised by Parliament to do, it still exercising the attention of the Electricity and Tramways Committee. The tramways manager (Mr. H. Collings Bishop) has been making enquiries in various directions, and has been authorised to pay visits to places where such services are being run to see the working results.

Blackburn.—The half-yearly report—March to September—of the Corporation tramways undertaking shows a loss, after allowing for repayments of capital and interest, of £600. The total loss on the undertaking since the Corporation acquired the tramways four years ago is £21,000. The revenue is gradually improving, however, and certain extensions have lately been entered upon which are expected to prove remunerative. The new tramway proposals of the Corporation provide for an expenditure of £100,000.

Bradwell and Castleton Light Railway.—The Light Railway Commissioners will hold an enquiry into the proposed light railway to Bradwell and Castleton. The proposed line commences by a junction with the Midland Railway near Hope Station, and proceeds through Brough to Bradwell, where there will be a station, and from thence to Castleton, where there will be another station. The entire length will be just under three miles. About four acres of land is to be acquired at Bradwell for the building of a generating station and car-sheds.

Romford.—Plans of proposed extensions to the scheme of electric tramways for the town have been considered in committee by the Urban District Council. It is said that the Empire Electric Light and Power Company are desirous of extending their scheme so as to take the tramways along Mawneys-road to Pretoria-road, along Victoria-road to Squirrels Heath, and from Oldchurch along Hornchurch-road to Hornchurch village. It is understood that the plans were disapproved, and that the Council also did not look with favour on the plans of proposed widenings of South-street and High-street.

Leeds.—At a lengthy meeting of the Tramways Committee a communication was considered from the Wakefield and District Tramways Company, requesting the City Council to grant them permission to run their cars over the Leeds route from Thwaitgate, the terminus of the company's line, to the centre of the city, thus giving a through tram service between Leeds and Wakefield. After considerable discussion the matter was deferred for further consideration. A scheme was brought forward by the general manager, Mr. J. B. Hamilton, to equalise the 1d. stages on the various routes of the Leeds city tramways. In this scheme it is proposed to have a 1d. fare for every two miles. The consideration of this matter was also deferred.

Exeter.—The Board of Trade have appointed Colonel Sir Colin Scott Moncrieff as referee to determine the value of so much of the tramways undertaking as is within the city in connection with the proposed purchase of such lines by the Corporation. At the last meeting of the Tramways Committee the deputation appointed to visit the experimental line constructed by the G.B. Surface Contact Company at Ilford presented their report. The deputation strongly urged upon the committee that both for economy of working and simplicity of management there is no system that can be in any way compared to the overhead trolley. The surveyor and electrical engineer were requested to report upon the first cost and subsequent working expenses of the conduit system and the conduit and trolley system combined.

Paisley.—As a result of negotiations between the Town Council and Mr. Murphy, the promoter of the Paisley and district electric tramways, a compromise has been come to regarding the dispute in connection with the construction of the system in Paisley. Certain concessions have been granted by Mr. Murphy as to the use of setts, and the Tramways Committee have on their side agreed to setts proposed and to withdraw their application to the Board of Trade for the appointment of an arbiter to settle the points in dispute. The work of constructing the system in Paisley will now be carried out without delay, though the agreement meantime arrived at has to be approved by the Council. Already a considerable portion of one of the lines has been laid on the Glasgow-road within the burgh, and the work of laying the double line has been commenced.

Morecambe.—Speaking at the seventeenth annual meeting of the Morecambe Tramways Company, the Chairman said that during the year the directors had given a good deal of consideration to the question of electrifying the line, and had been hopeful, until quite recently, of being in a position to report to the meeting that they had made arrangements with the local authorities to bring this about. He very much regretted that they were not able to do so. There could be no two opinions as to the advantage of electric traction over all other systems for tramway purposes, as it was the most satisfactory means of haulage at present in use, and it was the most suitable for the company and conducive to the interests of Morecambe. The time had come when the local authorities should deal seriously with the ques-

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tion, and either take the matter in their own hands or grant facilities to the tramways company, or to some other company prepared to electrify the system.

South Lancashire Parcels Service.—The South Lancashire Tramways Company have established a through parcels service between Liverpool and Birkenhead to the various towns on their system, including St. Helens, Wigan, Bolton, Leigh, Prescot, Rainhill, Haydock, Ashton-in-Makerfield, Brynn, Hindley, Atherton, Tyldesley, etc., at rates much below those previously obtaining for the conveyance of parcels. The service has been in operation but a few weeks, and already promises to become popular, the frequent dispatches and prompt deliveries of parcels being much appreciated. Parcels weighing up to 1½lb. each are accepted for conveyance by the tramways company. The rates for the conveyance of parcels weighing up to 3lb. is 3d. each, up to 14lb. 4d. each, 28lb. 5d. each, and so on in proportion, including collection within the area covered by the Liverpool express agencies, and delivery within a reasonable distance of the tramways system, or *vice versa*.

West Riding.—The West Riding tramways scheme is to be revived in the next session of Parliament. The idea is to construct a tramway from the centre of Wakefield to Normanton, *via* the villages of Stanley and Altofts. With Normanton it is intended to connect Castleford, Pontefract, and Knottingley, as well as the smaller communities of Whitwood, Featherstone, Methley, Glass Houghton, Oulton-with-Woodlesford, and Ferry Fryston. Under the present scheme it is intended to make the gauge of the whole system one standard width of 4ft. 8½in., so that one type of car may suit the whole system. This will necessitate the relaying of the lines that have been put down in the Normanton and Castleford districts. The tramway from Wakefield to Leeds is making rapid progress, the contractors having reached Bell Hill—on the Leeds side of Rothwell—within easy reach of the Leeds city boundary. The syndicate has just acquired the Bell Isle Dyeworks, off Sandal-road, which they propose to convert into a power station of some 6,000 h.p. to 8,000 h.p.

Lancaster.—At the meeting of the Lancaster and District Tramways Company on Saturday the Chairman explained the negotiations for the sale of the company's concern to the Corporation. The valuer appointed by the Corporation estimated the concern as worth £30.610, and this did not include stables, horses, etc. The Corporation offered £27,000, but the directors asked for £30,000, or expressed their willingness to themselves appoint a valuer to act in conjunction with the valuer to the Corporation, and to accept whatever sum these two gentlemen decided upon. The Corporation declined those terms and withdrew their offer. Both the ex-mayors of Lancaster and Morecambe had recently expressed their hope that an agreement would be effected, and he, as chairman of the directors, personally felt it would be in the best interests of both sides if terms could be arranged. If the directorate could do anything to bring about that arrangement on fair and reasonable terms, they were anxious to do so. He believed that by electrifying and doubling the line the traffic between Lancaster and Morecambe could be increased six-fold.

Edinburgh.—At a meeting of the Edinburgh Association of Science and Arts last week Prof. Baily referred at some length to the question of changing of the present cable system of tramways in Edinburgh to electric traction. Without discussing whether a change would be advisable or not, he said few people would deny that it was feasible. He alluded to the length and steepness of the hills on certain routes in the city, where the cable system had its advantages, but pointed out that outside the city the hills on most of the roads were comparatively harmless. He characterised the cable to Portobello as undeniably a mistake, and suggested that there should be a continuous line of electric trams through Portobello, Musselburgh, Prestonpans, Aberlady, Gullane, and even to North Berwick. While there was some justification for the cable to Braids, the lines to Craiglockhart, by Gilmore-place, to Gorgie which could be continued to Mid-Calder, and to Slateford, which might eventually go to Colinton, were suited for electrification. The Ferry-road would give a route by which Leith, Granton, and Trinity could be connected to Edinburgh without using the Dean Bridge.

"Three Towns" Scheme.—The Devonport and District Tramways Company have decided to apply to the Light Railway Commissioners for powers to extend their line from the Pennycomequick terminus, *via* Cemetery-road and Ford Park-road, to form a junction with the Plymouth Corporation tramways at Mutley Plain, and also from Pennycomequick, *via* Saltash-road and Coburg-street, to join the Plymouth tramways in Tavistock-road. The company already own the lines from Fore-street, Devonport, to Pennycomequick, from Fore-street to Milehouse, from Morice-square to Camel's Head, and from Pennycomequick to Camel's Head; and they also lease from Devonport Corporation the lines from Milehouse to Tor-lane, from Tavistock-road, Stoke, *via* Stoke-terrace, to Exmouth-road; from Keyham North Gate, *via* St. Levan-road, to Ford-hill; and from Camel's Head to Saltash Passage. The system at present worked by the company is about 10¼ miles, and if the powers now sought are granted they will have about 15 miles of lines. Wherever practicable, the proposed new lines will be double, and we understand that the application will have the support of the Plymouth Tramways Committee. The effect of the proposed scheme will be to connect the three systems of tramways in the Three Towns, and Mr. J. W. Endean, manager and engineer of the Devonport and District Tramways, hopes eventually to inaugurate a system of interchangeable tickets available over all the systems.

Overcrowding of Tramcars.—An interesting debate has taken place in the Bristol City Council on a resolution calling attention to the recent prosecutions against the tramway company for overcrowding their cars. It was suggested that the Watch Committee should be instructed to consider the by-law under which the proceedings were instituted, as on some occasions an excess number of inside passengers might be justified. The chief overcrowding was during the sittings of the Church Congress and at important football matches. At present no extra passenger is allowed, and it was pointed out that the by-laws were made at a time when horse-cars were used, and that their stringency could not apply to electric traction. A speaker instanced what had happened at Plymouth. There a by-law was introduced which permitted certain extra traffic on the tramcars, and in 18 weeks that the by-law was in operation there was an increase in the takings and a saving in management which represented £2,000. That would mean in the course of 12 months £6,000 would come into the coffers of the Plymouth Corporation through a slight alteration in the by-law. If they followed the example of Plymouth, Bristol would immediately be placing in the hands of its tramways company £18,000 clear profit over and above what they were making at present. He suggested that they should ask the tramways company what they were prepared to give in exchange for this valuable concession. It was pointed out that the company were about to go to Parliament for a Bill which would contain fresh by-laws, and the matter dropped.

London County Council.—At the usual weekly meeting of the London County Council on Tuesday the report of the Highways Committee with reference to the erection of car-sheds at New Cross led to some discussion. The first recommendation of the committee was adopted. It was as follows: "That expenditure on capital account of sums not exceeding £91,030 in all be authorised in respect of (1) the erection of the superstructure of the New Cross car-sheds required in connection with the electrical working of the London County Council tramways, and (2) the execution of granite paving works, the laying of rails, and the construction of conduits in and in connection with the car-sheds." A further proposal that the superstructure of the car-sheds should be built by the Works Department without the intervention of the contractor was at once objected to. The estimate for the work was £80,530. Mr. Goodrich moved as an amendment that the committee be instructed to advertise for tenders. The proposition of the committee was, he said, a monstrous one, for the work was to be given to the department without the Council having any particulars before it. It was not to the interests of the ratepayer that the department should carry out this work. Mr. E. White, who seconded the amendment, said recently a contractor erected sheds at a cost considerably under the architect's estimate, and consequently there was a large profit for the tramways. Colonel Rotton supported the amendment, which was opposed by Mr. Torrance, who said it was their duty to offer work to the department whenever the department could undertake it. On a division the amendment was defeated by 80 votes to 23. A sum of £35,000 was also voted for rebuilding the car-sheds at Streatham, in readiness for the time when the cable line from Kennington shall be replaced by electric traction. The committee also had a recommendation in reference to the Elephant and Castle sub-station required for the electrical working of the tramways. In July, 1902, the Council decided that this should be carried out without the intervention of a contractor, on the basis of the priced bills of quantities under which the erection of the Clapham fire brigade station was then being erected by the Works Committee, and the expenditure of £10,725 was sanctioned. The Works Committee, at the request of the Highways Committee, expedited the building work, on an undertaking that in consideration of the exceptional circumstances an extra percentage should be allowed, and the Highways Committee propose to pay an increase of 5 per cent. on the schedule prices. Mr. Williams Benn, in reply to questions, stated that it was not correct that spare men engaged on the tramways were paid 1s. per day less than they received under the companies. As a matter of fact, they were much better paid than under the companies.

LIGHTING AND GENERAL.

Battersea.—Extensions of mains estimated at £665 have been agreed to.

Keighley.—The Town Council have approved the proposed extensions of cables for motor purposes.

Wicklow.—The Urban District Council have sealed an electric light contract with Callender's Cable Company.

Bradford.—The Electricity Committee of the Corporation have decided in future to charge for power on the maximum demand system.

Plymouth.—An enquiry has been held into the Town Council's application for sanction to borrow £41,465 for electric supply extensions.

Whitby.—The Guardians have decided upon the installation of the electric light in the union offices, and tenders will be invited for carrying out the work.

Change of Address.—Mr. James N. Shoolbred, consulting engineer, has changed his address from 32, Victoria-street, to 47, Victoria-street.

Trowbridge.—The Western Electric Distributing Company propose to apply for a provisional order empowering them to supply electricity in the Council's district.

Johnstone.—The Clyde Valley Electrical Power Company propose to apply for power to supply electricity for lighting and power purposes in the burgh of Johnstone.

Brechin.—The offer from the Angus Electric Light and Power Company, Limited, to light the almshouse will be discussed at the next meeting of the Parish Council.

Watford.—The Urban District Council have asked Messrs. Ferranti Limited to overhaul their 300-kw. engine. A supplemental loan of £1,550 is to be applied for in January, 1904.

Gelligaer and Rhigos.—The Rural District Council contemplate asking Messrs. Guest, Keen, and Co. whether they would supply Bedlinog with electric light from their works.

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Long Eaton.—The Urban District Council have sealed a loan of £5,000 for works of electric supply, purchase of land, etc.

Dunfermline.—The Town Council will oppose the application of the National Electric Construction Company for a provisional order.

Rawmarsh.—The Urban District Council are urging Messrs. Clegg and Sons to take such steps as may be necessary to complete the transfer of electric lighting order within 14 days.

Water Power.—The ancient flour mills at Greenham, Newbury, Whitchurch, and Pangbourne have been purchased by electric lighting companies, who need water power to carry out their undertakings.

Infringement of Trade Mark.—We are asked to draw attention to an announcement in another page referring to the recent decision in the Chancery Court with regard to the use of the word "Simplex."

Whitehaven.—Twenty-one tenders have been received for lighting the workhouse and infirmary with electricity, and referred to a committee for report. The committee have been empowered to consult an expert.

Brierley Hill.—The Urban District Council are asking the Board of Trade to allow a further period of two years, or such time as they would allow, in order that the Council could deal with their electric lighting order.

Widnes.—A special meeting of the Council has been called for Dec. 21 to decide whether application shall be made to the Board of Trade for a provisional order for amending the Widnes electric lighting order of 1901.

Sale of Plant.—Particulars of a sale by Messrs. Weatherall and Green, 22, Chancery-lane, of plant and stock, comprising the complete equipment of an incandescent electric lamp factory, will be found in another column.

Basingstoke.—The Urban District Council have decided that steps be at once taken to promote a Bill in Parliament for powers to borrow £25,000 for electric lighting and free wiring, and other purposes that may be desirable.

Nuneaton.—The Gilbert Arc Lamp Company, Limited, are installing their 6ft. carbon lamp, burning 30 to 40 hours with yellow flame carbons, or 60 to 80 with ordinary carbons, in place of those previously in use in the town.

Londonderry.—The electrical engineer, Mr. Macrory, in his last report recommends, in connection with the private lighting scheme, the purchase of larger fuse-box boards than those specified, to accommodate the meters as well.

Stoke-on-Trent.—An enquiry has been held into an application of the Town Council for sanction to borrow £30,640 for an electric lighting scheme and the provision of a refuse destructor in connection with the electricity works.

Ilfracombe.—On Monday Mr. H. A. Palmer, J.P., the chairman of the Urban District Council, opened the new electricity works at Shepherd's-park. The company started work on Feb. 24, and the first light was switched on May 30

Maidstone.—The Urban District Council have received sanction to the borrowing of £1,770 for purposes of the electricity undertaking. Thirty-seven lamps are to be placed in the various courts and small streets abutting on those streets where mains are at present laid.

Stratford.—The Town Council intend to apply to the Board of Trade for a provisional order to extend the period for doing the work authorised by the electric lighting provisional order of 1901, and to endeavour also to obtain further powers in connection with the subject

Brixham.—The District Council are consulting Mr. E. S. Sanders, Bristol, who is to prepare plans and estimates for a scheme for the electric lighting of the compulsory area, with provision in station plant for extensions, and a scheme for the whole district as now lighted by gas and oil.

Frinton-on-Sea.—The electric light installed by the Frinton and District Electric Light and Power Company was inaugurated last Friday by the High-Sheriff (Colonel R. P. Davis, J.P.). The installation was designed and carried out by Messrs. Christie Bros. and Middleton, electrical engineers, of Chelmsford.

Kensington.—Notices from the undermentioned electric lighting companies relative to proposed extensions of their mains, etc., in the borough, have been agreed to: Kensington and Knightsbridge Electric Lighting Company, Beauchamp-place; Brompton and Kensington Electricity Supply Company, Collingham-gardens, Bina-gardens, and Wetherby-gardens.

Maryport.—The District Council are explaining to the Board of Trade the circumstances which influenced the Council in delaying the carrying out of the works specified in the electric lighting order, giving at the same time an undertaking to proceed with the said works so as to complete the same within two years provided the Board of Trade allowed the provisional order to remain in force.

Stirling.—The last report report by Mr. Hanson, the burgh electrical engineer, shows that for the four weeks ending Oct. 31 the number of units generated was 22,482, as compared with 18,011 for the corresponding period last year. The total number of private consumers in equivalent 8-c.p. lamps connected up to date was 11,263, and for public lighting the number was 12,343.

"Tuffarine" Grey Valves.—We are informed that Messrs. Mosses and Mitchell are making an improved "Tuffarine" grey valve for air and circulating pumps, etc., which will be found even more durable than their well-known "red valves," which have now been in use some 20 years, and are still working most satisfactorily on nearly 6,000 ocean steamers, in addition to stationary engines of all kinds.

Bath.—The last report of the Electric Lighting Committee states that the committee had been informed by Mr. Manville, the consulting engineer, that the boiler foundations at the extension of the lighting station would not be ready in time for the boilers to be fixed and in use for the heavy load, and upon his advice they decided to erect the new boiler *pro tem.* in the old boiler-house at an estimated cost of £250.

Chester.—At a conference, to which all telephone subscribers in the Chester and North Wales district and others interested were invited, on Friday a committee was formed for the purposes of obtaining the support of local authorities throughout the district, and also of the county councils, in obtaining increased telephone facilities.

Southwark.—The Council, in connection with their scheme for extending electric lighting to Rotherhithe, have obtained the Surrey Commercial Dock Company's permission to carry electric cables through the company's premises and across the Surrey and Lavender Docks, subject to an agreement embodying provisions for the protection of the company's interests, terminable at six months' notice, at a rental of £5 per annum.

Northfleet.—The District Council have informed the Kent Electric Power Company, Messrs. Fowler and Co., and the Corporation of Gravesend, that they would assist (at the expense of the promoters) in the promotion of a supplemental or fresh electric lighting provisional order for the district, provided the undertakers would contribute £250 to cover the costs incurred by the Council in obtaining the existing order.

Wilts.—The County Council have sanctioned the expenditure of £6,150 for electrical arrangements at the county asylum as to do away entirely with the use of gas, and increasing electric motor power as well as lighting, duplicating to some extent the electrical apparatus so as to avoid the danger attending breakdown of a single system, and providing for the collection and storage of rain-water in connection with the disused gas-pits.

Stock Exchange.—Applications have been made to the Stock Exchange Committee (1) to appoint a special settling day in and to grant a quotation to the Metropolitan District Railway Company's partly-paid scrip of a further issue of £500,000 4 per cent. perpetual debenture stock; and to allow the Blackheath and Greenwich District Electric Light Company, Limited, 50,000 7 per cent. cumulative preference shares of £1 each, fully paid, to be quoted in the official list.

New Firm.—We are informed by the B. & S. Folding Gate Company that their business, originally started for the manufacture and sale of the B. & S. patent folding gates, has increased to such an extent and other productions introduced by them now form so large a proportion of it that the title, "The B. & S. Folding Gate Company," has become a misnomer, and the cause of misunderstanding. In the future, therefore, the business will be conducted under the name of Arthur L. Gibson and Co.

Frome.—At a special meeting of the Urban District Council on Monday a report was received by the Council's consulting engineer (Mr. F. H. Medhurst) on an offer made by the contractors for the electrical works to light the whole town by electricity at a cost of £849 per annum. It was decided to accept the contractor's offer, and the clerk was instructed to apply for sanction to take up a further loan of £8,500. When this sum has been obtained, the total sum borrowed for the electrical works will be £28,500.

Dust Destructors.—At a meeting of the Leeds Section of the Institution of Electrical Engineers held on Nov. 19 at the Yorkshire College, Mr. S. D. Schofield read a paper on the production of electricity in small towns by the steam raised by the consumption of refuse. He gave the results of some tests. At Cleckheaton, on Oct. 9 last, during a run of eight hours, 51·7 units were generated per ton of refuse destroyed. At Shipley, during a month's run, the result was 37·4 units per ton destroyed, and at Wrexham 37·8 units.

London Gazette.—A general meeting of the members of the British Electric Transformer Manufacturing Company, Limited (in liquidation) will be held at Dacre House, Victoria-street, Westminster, S.W., on Dec. 23, at 12 noon, to have an account laid before them showing the manner in which the winding-up has been conducted and the property of the company disposed of, and of hearing any explanation that may be given by the liquidator, and to determine the manner in which the books, accounts, and documents shall be disposed of.

Glasgow.—The minutes of the Electric Supply Committee submitted at the last meeting of the Town Council recommended that the extension of the Corporation electricity generating station at Port Dundas be proceeded with, but as regarded the additional plant required to be put down within the extended station there and at Pollokshaw-road station the committee recommended that they be empowered, if they thought proper to do so, to appoint a deputation to visit Sunderland and any other English town where turbine plant has already been adopted for generating electricity.

Chesterfield.—At the enquiry last week into an application by the Corporation to borrow £15,000 for electric light and power supply purposes, the Town Clerk said the loan was required in consequence of the growth of the demand for light and power. The committee commenced to supply current in October, 1901, and at the end of December, 1902, £31,274 had been expended. At the end of 1902 there were 192 consumers, who took an equivalent of 15,204 8-c.p. lamps. By the end of October, 1903, there were 291, and a demand equivalent to 22,855 8-c.p. lamps. The demand was still increasing.

York.—The demand for electric light in the city has increased, so that the reserve power at the generating station has for a long time been constantly employed. On Tuesday the continuous working at high pressure told—a cast-iron tee-piece burst. A big load was taken from the accumulators for 25 minutes, and eventually such measures were adopted as to provide an adequate supply, and the police station, the library, the shops, and the streets were enabled to resume their usual brilliancy. When the new extensions to the electric depôt are completed there will be no reason to apprehend a breakdown, but the present state of the plant being made to do more than should fairly be expected of it has existed for over a year.

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Aberdeen.—Mr. A. R. Bennett, who has acted as general manager and engineer of the Glasgow Corporation telephone department since its establishment, has intimated to the committee that, owing to the many claims upon his time entailed by his outside duties, he wishes to retire from the general managership. The Telephone Committee in their last report recommend that Mr. Bennett continue in his present position until the close of the financial year, and that thereafter he be retained as consulting engineer; that Mr. John Macfee, who has been throughout the assistant manager, be appointed general manager; and that Mr. John MacCallum, who has hitherto held the office of cashier, be appointed assistant manager.

Ham.—The District Council were asked last week to formally consent to the application of the Teddington and Twickenham Electric Lighting Company for an electric lighting provisional order. The company are prepared to insert clauses in the order to give the Council the right to purchase the undertaking at a valuation as a going concern at the end of 7, 14, or 21 years; to supply electricity to private consumers at 6d. per unit for the first hour per day, at the maximum demand or its equivalent, and 3d. per unit for any further quantity. As it would be impossible to insert a clause in the order, the company would be prepared to enter into an agreement to supply electricity for public lighting at a price not exceeding 2½d. per unit. The Council decided to consent subject to the private rate being 6d. and the public rate 2d.

Hamilton.—The lessees for the electric lighting of Hamilton under the Town Council, Edmundson's Electricity Corporation, Limited, whose resident engineer and manager is Mr. T. M. Colson, A.M.I.E.E., announce that owing to the liberal patronage extended to them, having connected 9,000 lamps to their mains in nine months, they have been able to effect a very considerable reduction in their scale of charges both for electric lighting and power. The reduced rate for lighting, which comes into force as from Nov. 1, is a flat rate of 4d. per unit, and for power 2d. per unit for the first hour, 2d. per unit for the second hour, and 1d. per unit for every succeeding hour per day. The company are fitting up five public Gilbert arc lamps for the Town Council's inspection, and on their approval these lamps, it is expected, will be adopted for lighting generally throughout the burgh.

Erith.—It is proposed that application be made for sanction to the borrowing by the Council of a further loan of £5,000, allocated as follows: extensions of mains, £3,000; house services, meters, etc., £2,000. The Electric Lighting Committee have resolved that before any capital expenditure for extensions of mains or other purpose is incurred, the consulting or resident electrical engineers, as the case may be, be instructed to submit to the committee a detailed estimate of the cost of the proposed work; also that the resident electrical engineer be instructed to submit a monthly statement showing the expenditure on capital account to date, the balance of loans unexpended, and the total amount required to complete outstanding works. The committee have instructed the resident engineer to report as to cost of laying a public lighting cable in Lower-road.

Newton Abbot.—A petition of residents of the district of Knowles-terrace asking the District Council to supply proper and efficient means for lighting the road leading from Fern-terrace to Knowles-terrace is before the Lighting Committee; also a letter from Mr. F. C. Pay, engineer and manager to the Urban Electric Supply Company, Limited, stating that he had started to connect up the incandescent lamps in the town, and that he would be ready to connect up the arc lamps probably within two or three weeks. The company had been greatly hindered in their progress with the public street lamps by several persons stopping them from putting their wires to those lamps on the plea that the lamp was private property. As they had to finish a circuit completely before they could light any of the lamps on that circuit, he would be pleased if the Council would come to some arrangement with the owners of such property. They also desired to obtain permission to fix their bracket lamps to the walls of private houses as the gas lamps were fixed at present.

Acton.—At the last meeting of the District Council a letter was read from Messrs. Frank Suter and Co., of Berners-street, W., offering to provide and carry on a complete electric lighting installation for Acton. The conditions are that the cost of building works and installing plant should be borne by the Council, who should also lease a suitable site to the contractors. The latter would carry on the undertaking on behalf of the Council, any profit earned after providing for interest and sinking fund to be equally divided between the contractors and the Council, any loss incurred to be paid by the contractors, but to be refunded to them with interest at the rate of 5 per cent. per annum out of any profits which might be subsequently earned. The Council are given the option of taking over the undertaking at any time, provided one year's notice be given; and the firm offer to guarantee to the Council the whole of the interest and sinking fund of the capital and the whole of any loss which may be incurred. The letter was ordered to lie on the table, the Council having decided to carry out its own installation.

Allgemeine Elektricitaets-Gesellschaft.—From the report for the year ended June 30, 1903, we gather that 8 per cent. dividend has been paid, and the number of workmen employed augmented from 14,897 to 18,278. The factory in the Brunnenstrasse turned out 25 per cent. more dynamos and motors, not counting transformers, the figures rising from 15,283 to 21,850 items, representing 197,327 kw. and 268,100 h.p., against 155,927 kw. and 211,851 h.p. in 1901-2. The largest dynamo made in the year was of 6,000 h.p. Similar increases are recorded with regard to arc lamps, meters, incandescent, and Nernst lamps. The cable works used 10,000 tons of copper; other metals, 13,000 tons; yarn and textile materials, 850 tons; indiarubber and caoutchouc, 200 tons; and insulating material, 900 tons. More important installations for light and power laid down, or in course of erection, included 50 for local authorities, 28 for ships, 50 for mines, etc., 25 for factories, and 10 for theatres; also three for harbours—*i.e.*, Cape Town, Barcelona, and St. Petersburg. Forty other contracts, with an aggregate of 67,540 h.p. and a length of 475 miles of cables, are in hand.

St. Marylebone.—Last night it was asked that a return be presented to the Council showing (1) the total cost of obtaining the Act of Parliament authorising the Borough Council to negotiate for the purchase of the Metropolitan Electric Supply Company's St. Marylebone undertaking. (2) The entire cost of the arbitration, specifying (*a*) the amount paid to the arbitrator; (*b*) counsel engaged, and fees paid to each; (*c*) professional witnesses engaged, and fees paid to each; (*d*) payment to solicitors, and general charges; (*e*) amount paid to electric company for their costs in the arbitration. (3) Costs incurred (*a*) by the Borough Council; (*b*) by the Metropolitan Company as taxed in the action for specific performance before Mr. Justice Buckley, stating if the Borough Council had to pay costs of both parties; (*c*) amount to be paid to the company for works executed since the appointed day for taking over the concern. (4) Amount of counsel's fees for opinions and consultations and other fees and expenses paid or to be paid by the Borough Council up to the end of October, 1903. (5) Total amount paid by the Borough Council or to be paid (including salaries, which are to be specified) to the end of October, 1903, in connection with and in consequence of having obtained the abortive Act of Parliament. (6) From what fund all these expenses are paid.

Derby.—Mr. W. O. E. Meade King, M.I.C.E., has held an enquiry into an application for sanction to borrow £33,400 for extensions of their electricity generating plant and mains, and the provision of generating plant for supplying power to the proposed Corporation electric tramways. The Town Clerk said the loan was required for the extension of the electricity works of the borough, and this had become necessary owing to the growth of the demand for electricity for general purposes, power as well as light, and also in part for the purpose of making provision for the generation of the energy required for the proposed electric tramways. These tramways had just been commenced. Mr. T. P. Wimshurst explained the scheme in detail, and said the area of the particular piece of land required for the battery-house was about 400 yards, and the total area of the land acquired for the baths was about 1,400. He proceeded to state that in the present generating station they had about 4,000 h.p., and up to last March there were 87,000 8-c.p. lamps or their equivalent connected with the station. At the present time the number of lamps connected was about 100,000. The total capacity of the present plant was equivalent to about 110,000 8 c.p., and there was a spare set of machinery for emergency. They proposed to put in a 500-h.p. dynamo for traction and a battery, a 500-h.p. dynamo and another battery for lighting and general purposes, and a 500-h.p. dynamo for reserve for either system. The present spare machine would be brought into use. They were proposing to convert the middle of the town from the alternating to the direct current, and the present system would have no electrical connection with either the tramway or the new lighting extensions. When they had the new plant their total power with reserve would be equivalent to 150,000 8-c.p. lamps. In March, 1901, they had 46,000 8-c.p. lamps connected; on March 31, 1902, 75,972; on March 31, 1903, 87,502; and at the present time 100,000. The proposed plant would probably be working at its full capacity at the end of two years. The present system of lighting had been sanctioned by the Board of Trade, and application had been made for sanction to change the alternating system to the direct three-wire system of 500 volts. Nothing had been included in the present application for mains under the system not yet approved, but application would be made regarding these at a future time. The tramway scheme had been approved, and very little of the present work would be superseded. They had a good gravel foundation for the battery-house. About £2 000 of the loan had been anticipated in boilers, foundations, etc.; the boilers were very necessary, and they could not have gone over the winter without them.

National Cycle and Motor Show.—This exhibition, now open at the Crystal Palace, shows great progress both in quantity as well as in quality of exhibitors. There are over 100 of the best firms in the trade represented, and the secretary (Mr. Frank Peach) has prepared an artistic catalogue with a plan, which serves as an efficient guide to the whole. Light motors form the predominant feature this year. Amongst the novelties we note a model illustrating the original Buckley patent open-sided electric motor wheel for cycles and light cars, temporarily driven with electric motor in centre exhibited by the Buckley Patent Motor Wheel and Carriage Company, 197, Loudon-road, Sheffield, who also show their motor cycles in connection with trailers and governess cars, the advantage being that the person driving is comfortably seated in the latter instead of on a saddle. We are informed that this machine will shortly be put on the market with an electric 2-h.p. motor in the wheel, driven by accumulators placed on the light car, the body of which will be widened several inches so as to accommodate two adults in comfort. The Booth Motor Syndicate, Limited, 19, Grand-parade, Putney, show various types of motor cycles, fitted with a Bassee Michel trembler coil and two accumulators, with two-way switches, in a special case, apart from the petrol tank, and placed immediately behind the engine. Less than 1ft. of wire is to be seen on the machine, practically all the wiring being in the accumulator box. Messrs. J Lacoste and Co., 176A, Shaftesbury-avenue, London, E C., show: (1) An inside wipe contact breaker for motor cycles, the contact being made at the firing point between a steel roller and a tempered steel block let into a fibre ring. The whole is enclosed in a gunmetal casing, made dust-proof and oil-containing, thus eliminating practically all friction. This contact breaker is absolutely self-adjusting, the roller being pressed outwards by means of a spring. (2) An ordinary pattern wipe contact breaker, made with a hammer-shaped blade pressing on a fibre cam, with brass contact piece let in. Its great point is its extreme simplicity and neatness. It is about the size of an ordinary watch, its thickness being well under ¾in. (3) Ignition controllers for testing the firing in each

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cylinder separately. They are fitted with push buttons, numbered in consonance with the cylinders, so that by depressing any one button the corresponding cylinder is cut out. If three are depressed (in the case of a four-cylinder car), then the remaining cylinder must be sparking if the engine continues to run. When the engine is at rest there is a separate row of buttons to adjust the tremblers. The Woodcote Engineering and Motor Works, Stafford-road, Wallington, Surrey, exhibit current-saving coils, accumulators, charging boards, charging batteries, inspection lamps, and accessories. There is also a new speed-gear by the Variable Gears, Limited, 50, Coldharbour-lane, Camberwell, S E., which is applicable to pedal and motor cycles and motorcars. This is not an interchangeable gear with a number of fixed speeds, but is a true variant with a definite drive, capable of being set to any point between the highest and lowest speeds. The alteration of the speed can be effected without releasing the drive, and consequently should not occasion jars or shocks in setting the gear to any speed. Messrs. H. W. Cocks and Co., 143, Kew-road, Richmond, Surrey, show their accumulators for ignition, made in celluloid, ebonite, and polished teak or walnut cases. All the batteries have the plates well raised from the bottom of cell, and are fitted with non-short-circuiting separators. The accumulators are sealed with composition, and a special acid-proof cement is used, for which it is claimed that it neither cracks nor allows acid to creep to the terminals. The exhibit of Longstreth's, Limited, 427A, Strand, London, W.C., includes lithanode high-rate discharge batteries, electric lighting or traction sets, hand lamps, ignition batteries for motors, etc. Messrs. Charles Peacock and Co, 35, Clerkenwell-road, E.C., have "S" accumulators for 10, 20, and 40 ampere-hours; also traction batteries with special guaranteed acid non-splash vents; also pocket ammeters, voltmeters, and pole-finders, small switchboard instruments, new battery sparking plugs, and speed indicators for car, showing total mileage, miles per hour, and the maximum speed attained during the last 110 yards. Amongst the motorcars a four-seated coupé by the Duryea Company, Coventry, attracted much attention, it being a departure from the conventional models, which still too closely resemble carriages with the pole cut off.

PROVISIONAL PATENTS, 1903.

Nov. 16.

24847. Improvements in or relating to electro-mechanical automatic switches for surface contacts for electric tramways and railways, also applicable for automatic signalling on railways and tramways, and for other similar purposes. Matthew George Waggott, 104, Colemore-row, Birmingham.

24848. Improvements in the electro-deposition of zinc. Sherard Cowper-Coles and Co., Limited, and Sherard Cowper-Coles, 82, Victoria-street, Westminster, London.

24864. Improvements in or relating to electrical clocks. Frederick Augustus Chandler and Bahne Bonniksen, 18, Hertford-street, Coventry.

24905. Improvements in connection with electrolytic cells. Arthur Geoffrey Haddock, 55, Chancery-lane, London.

24909. Improvements in electric lamps and methods of making the same. Charles Proteus Steinmetz, 83, Cannon-street, London. (Date applied for under Patents Act, 1901, Nov. 17, 1902, being date of application in United States.) (Complete specification.)

24912. Improvements in and relating to apparatus for utilising electrical energy in igniting, heating, and lighting, or such like uses. James Isaac Ayer, 55, Chancery-lane, London. (Complete specification.)

24914. Improvements in and relating to engaging devices and magnetic lifting contrivances for cranes and other lifting devices. Wolfgang Reuter, 55, Chancery-lane, London. (Complete specification.)

Nov. 17.

25006. Improvements in or relating to electric ignition apparatus for internal-combustion motors and the like. Edmund Woodward Lewis and the Daimler Motor Company, Limited, 18, Hertford-street, Coventry.

25012. Improvements in systems of electrical regulation. Abraham Sandford Adler, 28, New Bridge-street, London. (Complete specification.)

25016. Improvements in electrical storage batteries. Thomas Edward Cornwell, 5, Fenchurch-street, London.

25020. Improvements in or relating to means for automatically governing electric motors, especially applicable for breaking or reducing the current in electric motor vehicles when a given speed of such vehicle is exceeded. Francis Malger Staunton, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

25022. Improvements in couplings for electrical conduits. Adnah McMurtrie, 55, Chancery-lane, London. (Date applied for under Patents Act, 1901, Nov. 21, 1902, being date of application in United States). (Complete specification.)

25028. Improved adjustable electric light pendants or fittings. Montague Herbert Galsworthy and the London Electrical Fittings Company, Limited, Roberts Works, Roberts-mews, Hampstead-road, London. (Complete specification.)

25026. Improvements in magnetic tachometers. Arthur P. Warner and Charles H. Warner, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

25047. Improvements in brackets for telegraph and like posts. Arthur George Bloxam, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Joseph Goffin, Belgium.)

25053. Improvements in electric lighting and power systems. George Gamble Milne, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

25074. Improvements in electrical demand or rebate indicators. George William Lewis Case and the Reason Manufacturing Company, Limited, Norfolk House, Norfolk-street, Strand, London.

Nov. 18.

25087. Improved method and devices for preventing interference in wireless telegraphy and the like. John Gardner, 51, Deansgate-arcade, Manchester.

25098. Improvements in and in the manufacture of terminal fittings for electric cables. James Samuel Foley, 24, Temple-row, Birmingham.

25110. Electric tramcar trolley pole attachments. James Henry Airey, 195, High-street West, Sunderland.

25114. Improvements in or relating to coin-freed electric meters. James Allan, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

25122. Improvements in electric arc lamps. Joseph Barbe Fournier, 178, Fleet-street, London. (Complete specification.)

25127. Improvements in telephone exchange systems. William Aitken, Milton-road, Edge-lane, Liverpool.

25132. Improvements in or relating to electrolytic cells. Edgar Arthur Ashcroft, 111, Hatton-garden, London.

25133. Improvements in or relating to plates for electric storage batteries. Edgar Arthur Ashcroft, 111, Hatton-garden, London.

25146. Improvements in controllers for electric motors. George Laird and John Percival Todd, Westinghouse-building, Norfolk-street, Strand, London.

25150. Improved magnetic ignition device for explosion engines. Gottlob Honold, 322, High Holborn, London. (Complete specification.)

25153. Improvements in or relating to arc lamps. Léon Cibié, 322, High Holborn, London.

25162. Improvements in the electrolytic refining of copper. The Metals Corporation, Limited, and Sherard Cowper-Coles, 70, Chancery-lane, London.

Nov. 19.

25189. Improvements in electric switching devices. Matthew Henry Barber and George Harold Larmuth, 3, Brown-street, Market-street, Manchester.

25197. Improvements in dynamo-electric machines and motors. Wilfrid Robert Vernet Marshall, 121, West George-street, Glasgow.

25222. Protective device for electric circuits. Harry Hay Hornsby and Edward William Anger, jun., 65, Chancery-lane, London. (Complete specification.)

25228. An improved form of electric fuse head and method of manufacturing same. Leonard Percy Asbury, Summerhill, Pickford-road, Bexleyheath, Kent.

25235. Improvements in apparatus for commuting electric currents passing through combined arc lamp and incandescent lamp circuits. Campbell Smart, 65, Chancery-lane, London.

25244. A novel electric lamp. William Phillips Thompson, 322, High Holborn, London. (Ernest Léon Frenot, France.)

25245. New or improved electric lighting system. William Phillips Thompson, 322, High Holborn, London. (Ernest Léon Frenot, France.)

25280. Improvements in electric sparking devices for internal-combustion motors. Laurence Hugh Strain, 46, Lincoln's-inn-fields, London.

25284. A new or improved support for electric cables. Ethelbert Thomas Ruthven-Murray, Norfolk House, Norfolk-street, Strand, London.

Nov. 20.

25322. Improvements in or connected with electrical resistances. Percy Macaulay Ashworth Matthews and Henry Philip Hoghton, 17, St. Ann's-square, Manchester.

25341. Improvements in contact-breaking devices for the electric ignition apparatus of gas, petrol, and the like engines. Laurence William Huber and George Barker Mercer, 34, Castle-street, Liverpool.

25343. A new self-testing electric sparking plug for motors—viz., "desideration plug." Emanuel Myer Goldburgh, 6, Disraeli-road, Forest Gate, London.

25349. New or improved radiator or reflector applicable to incandescent electric or other lights or lamps when arranged as letters and signs for advertising purposes, or when used for lighting. John Alfred Stevens, 114A, Chancery-lane, London.

25362. Improvements in signalling keys. John Ambrose Fleming and Marconi's Wireless Telegraph Company, Limited, 24, Southampton-buildings, Chancery-lane, London.

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25381. Improvements in circuit breakers and closers especially suitable for the transmitting instruments used in wireless telegraphy. Marconi's Wireless Telegraph Company, Limited, and Andrew Gray, 24, Southampton-buildings, Chancery-lane, London.

25383. Improvements in the transmitting instruments for wireless telegraphy. John Ambrose Fleming and Marconi's Wireless Telegraph Company, Limited, 24, Southampton-buildings, Chancery-lane, London.

25386. Improvements in electro-magnetic tremblers. Barthélémy Becker, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

25389. Improvements in magneto-electric induction apparatus. Arthur George Bloxam, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Alfred Schoeller, Germany). (Complete specification.)

Nov. 21.

25451. Improvements relating to arc lamps. Herbert John Haddan, 18, Buckingham-street, Strand, London. (The firm trading as Samuel Zielenziger, Germany). (Complete specification.)

25461. Improvements in apparatus used in wireless telegraphy. Marconi's Wireless Telegraph Company, Limited, Charles Samuel Franklin, Henry Ashley Madge, and Edgar Berry, 24, Southampton-buildings, Chancery-lane, London.

25462. Improvements in transmitting instruments for wireless telegraphy. Marconi's Wireless Telegraph Company, Limited, and Robert Grenville Kindersley, 24, Southampton-buildings, Chancery-lane, London.

COMPLETE SPECIFICATIONS ACCEPTED.

To be published Dec. 10, 1903.

1902.

22732. Electric switches. Zani.

23066. Systems of electric lighting. Leitner.

25149. Apparatus for distributing alternating currents. Berry.

25532. Boosters for charging and discharging storage batteries and regulating the pressure of the 'bus bars. Crompton and Co., Limited, and MacIntosh.

26040. Systems of electric motor control. Carolan. (General Electric Company.)

26764. Regulating electric generators. Leitner and Lucas.

27301. Method of amplifying electromagnetic signal waves. Lake. (Stone.)

27760. Magnetic core structures of electric apparatus especially applicable to reactance coils. Carolan. (General Electric Company.)

28509. Transmission without wires of electromagnetic signals. Lake. (Stone.)

28515. Wireless electric telegraph systems. Lake. (Stone.)

28521. Electric wireless telegraph systems. Lake. (Stone.)

28549. Wireless electric telegraph systems. Lake. (Stone.)

28550. Electric wireless telegraph systems. Lake. (Stone.)

28551. Conductors or oscillators for use in electrical wireless telegraphy. Lake. (Stone.)

1903.

415. Negative electrodes for secondary batteries. Roderbourg.

695. Electric lighting of railway trains. Pieper and L'Hoest.

896. Electric arc lamps. British Thomson-Houston Company, Limited, and Murphy.

1057. Thumb-pieces for electrical switches. Carolan. (General Electric Company.)

1058. Electric switches. Carolan. (General Electric Company.)

1059. Hangers for overhead electric conductors. Carolan. (General Electric Company.)

1060. Electric fuses or cut-outs. Carolan. (General Electric Company.)

1061. Electric switches and method of making the same. Carolan. (General Electric Company.)

1062. Electric arc lamps. Carolan. (General Electric Company.)

1065. Electric couplings or connectors. Carolan. (General Electric Company.)

1066. Combined electric switches and cut-outs. Carolan. (General Electric Company.)

1069. Conductor connections on third-rail or like electric railways. Carolan. (General Electric Company.)

1155. Manufacture of electric cables. W. T. Henley's Telegraph Works, Limited, and Pfiffner.

1157. Method of apparatus for electric ignition for internal-combustion engines and the like. Head.

1830. Third rail insulators of electrical railways. Bullers, Limited, and Chambers.

3281. Electric controlling apparatus for lifts and the like. Hein and Möller-Holst.

4163. Electromatic agitating instrument for vibratory massage. Müller. (Date applied for under International Convention, Feb. 22, 1902.)

11129. Ozonisers of low frequency adapted to be connected directly to a dynamo. Otto.

12377. Process and apparatus for the production of metals of the alkali group by electrolysis. Ashcroft.

15600. Voltaic batteries. Gladstone. (Date applied for under International Convention, Dec. 17, 1902.)

18323. Machine for making battery grids. Coster and Smith Storage Battery Company.

18867. Telegraph apparatus. Imray (Soc. des Telegraphes Multiplex) (Systeme E. Mercadier.)

19250. Telephone receiver holders. Briggs. (Date applied for under International Convention, Sept. 6, 1902.)

19520. Systems for controlling alternating-current motors. Scott. (Date applied for under International Convention, Sept. 13, 1902.)

19748. Means for protecting the terminals of electrical apparatus and ensuring good electrical contact. Peto.

19801. Electrochemically deposited jacket for explosion engines and the like. Baylay and Tritton.

20012. Electric cable terminal. Ballard and Howard.

22101. Coupling apparatus for tapping electric circuit wires. Daniels. (Date applied for under International Convention, Jan. 2, 1903.)

22432. Electrical ceiling fittings. Dorman and Smith.

22572. Method of and means for working electrical winding engines Siemens Bros. and Co., Limited. (Siemens und Halske Actiengesellschaft.)

22573. Safety fuse device for electrical installations. Siemens Bros. and Co., Limited. (Siemens und Halske Actiengesellschaft.)

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.		Last price
Commercial and Industrial.—	£		£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1	..	¼-¾
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1	..	¾-1
British Insulated and Helsby Cables, Ord., 1-100,000	5	..	6-6½
—— 6 per cent. Cum. Pref., 1-100,000	5	..	5½-5¾
—— 4½ per cent. Mortgage Debentures	100	..	103-108
British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red.	100	..	103-105
British Westinghouse Elec. and Manur., 6 per cent. Pref., 275,001-375,000	5	..	5⅜-5⅝
—— 4 per cent. Mortgage Debenture Stock	100	..	100-102
Brush Electrical Engineering, Ordinary, Nos. 1-105,731	2	..	¾-1¼
—— Non. Cum., 6 per cent. Pref.	2	..	1-1¼
—— 4½ per cent. 1st Debenture Stock	100	..	97-100
—— 4½ per cent. 2nd Debenture Stock	100	..	85-90
Callender's Cable, Debentures	100	..	106-110
—— Ordinary	5	..	11-12
—— 5 per cent. Pref.	5	..	5½-5¾
Crompton and Co.	3	..	1¾-2¼
—— 5 per cent. Debentures	100	..	100-104
Edison and Swan United, "A" Shares, 1-98,261	3	..	¼
—— "A" Shares, 01-017,139	5	..	1-2
—— 5 per cent. Debentures	100	..	76-81
—— 4 per cent. Deb. Stock, Red.	100	..	72-77
Electric Construction, Limited, Nos. 1 to 112,100	2	..	1½-1⅝
—— 7 per cent. Cumulative Pref.	2	..	2½-3
—— 4 per cent. Perp. 1st Mort. Deb.	100	..	97-100
Ferranti Limited, 5 per cent. 1st Mort. Deb. Stock, Red.	100	..	90-95
General Electric Company (1900), 5 per cent. Cum. Pref.	10	..	9¾-10¼
—— 4 per cent. 1st Mort. Deb. Stock	100	..	96-99
W. T. Henley's Telegraph Works, Ordinary	5	..	14-15
—— 4½ per cent. Preference	5	..	5-5½
—— 4½ per cent. Debentures	100	..	108-112
India Rubber, Gutta Percha, and Telegraph Works	10	..	18-19
—— 4 per cent. Debentures	100	..	100-103
Parker, Thos., Limited, Ordinary	10	..	14½-15½
Telegraph Construction and Maintenance	12	..	34-37
—— 5 per cent. Bonds	100	..	101-104
Electric Lighting and Supply.—			
Blackheath & Greenwich District Ordinary 1,201-101,200	1	..	⅝-¾
—— 4½ per cent. Deb. Stk. Certs., Red. and Conv.	100	..	116-119
Bournemouth and Poole, Ordinary	10	..	12½-13½
—— 4½ per cent. Cum. Pref., 7,501-15,000	10	..	10-11
—— 6 per cent. Cum. Second Pref., 15,001-22,500	10	..	11-12
—— 4½ per cent. Debenture Stock, Red.	100	..	103-106
Bromley (Kent) Electric Light and Power Co., 4½ per cent. 1st Debenture Stock, Red.	100	..	100-103
Brompton and Kensington, Ordinary	5	..	10¼-10⅜
—— 7 per cent. Preference	5	..	10-10½
Calcutta Electric Supply Corp., Ordinary, Nos. 1-40,000	5	..	6½-7⅛
—— Nos. 20,001-30,000	5	..	7-8
Cambridge Electric Supply Company, Ltd., £10 Ord.	8	..	14½
—— " £10 Ord.	6	..	10⅜
Central Electric Supply, Ld., 4 per cent. Guar Deb. Stock	100	..	107-110
Charing Cross and Strand, Nos. 1-70,000	5	..	9-9½
—— 4½ per cent. Cum. Pref.	5	..	5¼-5⅜
—— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000	5	..	4¾-5
—— 4 per cent. Debenture Stock, Red. (Prov. Certs.)	100	..	104-106
Chelsea Electricity Supply	5	..	5½-6
—— 4½ per cent. Debentures	100	..	107-110
City of London, Ordinary	10	..	10-10½
—— 6 per cent. Cumulative Pref.	10	..	13-14
—— 5 per cent. Debenture Stock	100	..	122-127
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100	..	102-105
County of London and Brush Provincial, Ordinary	10	..	7½-8½
—— 6 per cent. Cum. Pref.	10	..	11½-12½
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	100	..	108-111
Edmundsons' Electricity Corporation, Ordinary, 1-50,000	5	..	6½-6⅝
—— 6 per cent. Cum. Pref.	5	..	6-6½
—— 4½ per cent. First Mort. Deb.	100	..	104-107
Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-30,000	5	..	3¼-4¼
—— 5 per cent. Debenture Stock, Red.	100	..	95-98
Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000	5	..	5⅜-6
—— 4½ per cent. First Deb. Stock, Red.	100	..	100-103
Hove Electric Lighting, Limited, Ord., 1-13,000	5	..	7½-8½
Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000	5	..	10¾-11¼
—— per cent. Debenture Stock Red.	100	..	100-105

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Name.	Amount paid.	Last price.
	£	£
Kensington and Knightsbridge and Notting Hill	100 ..	101-104
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10 ..	9½-10½
London Electric, Ordinary	3 ..	1¾-2¼
—— 6 per cent. Pref.	5 ..	5-5½
—— 4 per cent. 1st Mortgage Debenture Stock, Red...	100 ..	98-101
Metropolitan, Ordinary	10 ..	17-18
——4½ per cent. First Mortgage Debenture Stock	100 ..	110-114
——3½ per cent. Mortgage Debenture, Red.	100 ..	96 99
Newcastle-upon-Tyne Electric Supply, Ordinary.....	5 ..	28-101
—— Preference.....	4 ..	100-103
Notting Hill Electric Lighting	10 ..	12½-13½
—— 4 per cent. First Mort. Debs., Nos. 1-500(Reg.) ..	100 ..	98-101
Oxford Electric, Ordinary, 1-96 and 407-14,310	5	5½-6¾
—— 4 per cent. Debenture Stock	100	98-101
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	10 ..	95-102
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000 ..	5 ..	3-3½
—— 4 per cent. Debenture Stock	100 ..	85-90
South London, Ordinary	..	3½-3¾
St. James's and Pall Mall, Ordinary, 101-20,080	5 ..	14-15
—— 7 per cent. Pref.	5 ..	7½-8¼
—— 3½ per cent. Deb.....	100 ..	98-101
Urban Electric Supply Co., Ordinary, 8-30,007	5 ..	4¾-5¼
—— 5 per cent. Cumulative Preference, 50,001-80,000	5 ..	4¾-5¼
Westminster, Ordinary	5 —	11½-12
—— 5 per cent. Cum. Pref., 110,101-138,251	5 ..	6-6½

Electric Railways.—

Central London, Ordinary.....	100 —	91-94
—— 4 per cent. Pref.	100 ..	99-102
—— ,, ,, deferred	100 ..	99-102
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)..	100 ..	115-118
City and South London, Consolidated Ordinary	100 ..	50-52
—— 4 per cent. Debenture Stock	100 ..	109-112
—— 5 per cent. Pref. Stock '91	100 ..	127-130
—— ,, ,, ,, '96	100 ..	125-128
—— ,, ,, ,, '01	100 ..	120-125
Liverpool Overhead, 5 per cent. Pref.	— ..	13-13½
—— Ordinary, 1-50,000	— ..	7¾-8
—— 4 per cent. Mortgage Debentures, Red., 1-1,700 ..	— ..	102-104
Waterloo and City, Ordinary	100 —	91-94

Electric Tramways.—

Anglo-Argentine, 1-260,007	5 ..	4¼-4¾
—— Permanent 6 per cent. Debenture Stock, 1888....	100 ..	125-130
Blackpool and Fleetwood Tramroad.....	10 ..	13½-14½
Brisbane Tramway Invest., Lim., Ord., 1-75,000	5 ..	2-3
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5 ..	3¾-4¼
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100 ..	98-102
British Columbia Electric Railway Co., Ord., Nos. 1-20,000	100 ..	80-83
—— Non-Cum. 5 per cent. Pref., Nos. 25,001-38,600 ..	100 ..	93-96
—— 4½ per cent. 1st Mt. Debs., Nos. 1-6,250, of £40 each	40 ..	102-104 p.c

Name.	Amount paid.	Last price
	£	£
British Electric Traction, Ord. 1-300,000 & 60,001-80,000..	10 —	11½-12
—— 6 per cent. Cm. Pf., 30,001-60,000	10 —	11-11½
—— 5 per cent. Perpetual Debenture Stock	100 ..	120-123
Buenos Ayres and Belgrano Tram., Ord., 1-100,000	5 ..	2¾-2¾
—— "A" 6 per cent. Cm. Pf., 1-40,000	5 —	5-5½
—— "B" 6 per cent. Cm. Pf., 1-27,500	5 —	4¾-5¼
—— 5 per cent. Deb. Stock, Red.	100 ..	106-109
—— Prov. Cert., all paid	100 ..	98-101
Cape Electric Tramways, Nos. 1-480,000	1 —	1¾-2
City of Birmingham Tramways, 5 per cent. Cum. Pref.....	10 ..	5-5½
—— 4 per cent. 1st Mortgage Deb., 1-3,000 (1917)	100 ..	98-101
Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red.	100 ..	100 103
Cork Electric Tramways and Lighting Co., Ordinary	10 ..	13-14
—— 5 per cent. Cum. Pref.	10 ..	11-12
—— Debentures	100 ..	96-99
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10 ..	12-13
—— 6 per cent. Pref., Nos. within 1-60,000	10 ..	15-16
—— 5½ per cent. Mort. Debs., 1-3,000, Red.	100 ..	94-97
Imperial Tramways Ordinary.....	all —	22-22½
—— 6 per cent. Cum. Pref.	all —	14½-15½
—— 4½ per cent. Deb Stock	100 —	112-114
Isle of Thanet Electric Tramways and Lighting, 5 per cent. Cum. Pref., Nos. 30,001-60,000	5 ..	3¾-4¼
—— 4 per cent. Debenture Stock	100 ..	92-95
Kidderminster and District Lighting and Traction, Pref...	5 —	3¾-4
London United Trys.(1901), 5 per cent. Cum. Pref.	10 —	11¼-11¾
—— 4 per cent. 1st Mt. Db. Stock, Red	100 ..	104-106
Metropolitan Electric Trams., Deferred, 1 000 001-1,314,016	1 ..	3/16-5/16
—— 5 per cent. Cum. Pref., 500,001-814,016..	1 ..	¾-1⅛
New General Traction, Ordinary	5 ..	¼
—— 6 per cent. Cum. Pref.	5 —	1¾-2¼
—— 5 per cent. Mortgage Debentures, 1-1,713 (Regd.).	100 ..	88-93
Oldham, Aston, and Hyde Tramway, Ordinary.....	10 ..	10¼-10¾
—— 5 per cent. Cum. Pref.	10 ..	11¼-12¼
Perth Elec. Tramways (W.A.) 5 per cent. 1 Mort. Deb. Stk.	100 ..	100-103
Potteries Electric Traction, Ordinary, 20,001-40,000	10 —	8¼-8¾
—— 5 per cent. Cum. Pref., 1-20,000	10 —	8¼-8¾
—— 4½ per cent. Debenture Stock.....	100 ..	102-105
South Lancashire Electric Traction and Power Company—		
—— £250,000 Ordinary	1 —	1
—— £101,132 6 per cent. Preference.....	1 —	1
—— £528,093 4½ per cent. Debenture Stock	100 p.c. —	100 p.c.

Telephones.—

National Telephone, Preferred	100 —	101-103
—— Deferred Stock	100 ..	79-81
—— 6 per cent. Cum. First Pref.	10 ..	13-14
—— 6 per cent. Cum. Second Pref.	10 —	13-14
—— 5 per cent. Non. Cum. Third Pref.	5 —	5¼-5¾
—— 5½ per cent. Deb. Stock, Red.	100 —	95 97
—— 4 per cent. Deb. Stock, Red.	100 —	102-104
Oriental Telephone and Electric Company	1	13/16-15/16

TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line	Traffic Returns for week			Increase or decrease.		Miles of single track open.		Accounts for past year.				Receipts per			Cost per car mile
	Ending	1903.	1902.	Week.	Current year.	1903.	1902.	Ending	Total receipts	Passengers carried.	Car miles run.	Pas-s'nger	Car mile.	Mile of track.	
		£	£	£	£				£			d.	d.	£	d.
Aberdeen Corporation.....	Nov. 21	1,040	801	+ 238	+ 5,267	19¼	17¼	May 31	37,931	9,099,715	794,641	0·98	13·02	1,970	6·1
Ayr Corporation.....	,, 21	170	166	+ 4	+ 52	8	6	Sept. 25	12,503	2,979,276	290,099	1·00	10·34	1,560	4·7
Birmingham Tramways	,, 21	4,877	4,635	+ 242	+ 9,479	6½	6½	—	—	—	—	—	—	—	—
Blackburn Corporation	,, 20	731	718	+ 13	+ 863	24	24	March 25*a*	40,964	7,234,106	826,558	1·36	11·87	1,705	7·44
Blackpool Corporation.....	,, 19	300	285	+ 15	+ 203	17½	16½	,, 31	211,168	6,169,121	784,443	1·52	10·8	—	—
Blackpool-Fleetwood Tramways	,, 21	186	185	+ 1	+ 110	16½	16½	Dec. 31	30,923	2,049,677	584,989	3·62	12·68	1,932	6·99
Bolton Corporation	,, 22	1,637	1,462	+ 175	+ 7,700	38	25	March 31	85,704	17,761,605	1,896,247	1·15	10·75	3,430	5·87
Bournemouth Corporation.....	,, 18	779	—	—	—	10½	—	—	—	—	—	—	—	—	—
Bradford Corporation	,, 22	3,353	3,077	+ 276	+15,277	41	—	—	—	—	—	—	—	—	—
Brighton Corporation	,, 22	751	649	+ 102	+ 6,414	6½	—	,, 31	—	10,432,508	1,031,928	1·00	10·10	—	—
Bristol Tramways Company	,, 20	4,303	4,037	+ 266	—	51½	51½	Dec. 31	223,480	41,192,899	5,724,114	1·30	9·38	4,348	—
Burnley Corporation	,, 21	751	656	+ 95	—	—	—	—	—	—	—	—	—	—	—
Burton Corporation	,, 22	295	—	—	—	—	—	—	—	—	—	—	—	—	—
Cardiff Corporation	,, 21	1,769	1,336	+ 433	+18,863	—	—	—	—	—	—	—	—	—	—
Carlisle Tramways Company....	,, 23	158	124	+ 34	+ 721	—	—	,, 31	—	2,216,583	320,129*h*	—	—	—	—
Central London Railway.....	,, 21	7,138	7,233	— 95	— 6,719*h*	6	—	,, 31	367,225	45,305,110	1,276,971*a*	1·87	66·6*a*	59,076	35·6*a*
City and South London Railway	,, 22	3,030	3,491	— 461	— 8,658	6⅝	—	,, 31	165,003*a*	19,069,319*a*	—	—	—	—	—
Cork E. T. and L. Company	,, 19	391	353	+ 37	— 3,382	—	—	—	—	—	—	—	—	—	—
Darwen Corporation.....	,, 20	208	211	— 3	— 211	7·23	—	March 31*g*	12,341	2,360,735	254,279	1·25	11·65	1,707	9·36
Dover Corporation	,, 21	158	151	+ 7	+ 58	3	—	—	—	—	—	—	—	—	—
Dublin & Lucan Electric Railway	,, 22	86	80	+ 6	+ 171*h*	—	—	Dec. 31	5,796	364,796	102,087	3·81	13·62	359	7·68
Dublin U. T., electric cars.....	,, 20	3,458	3,413	+ 45	} —	46	46	March 31	126,121	24,553,133	3,429,356	1·23	8·82	2,741	5·06*h*
Dublin S. District, Electric	,, 20	725	688	+ 37											
Dundee City Tramways	,, 18	792	746	+ 46	—	22	22	May 15	35,874	9,084,522	752,814	0·93	11·276	1,630	—
East Ham Corporation	,, 21	598	398	+ 190	+ 6,935	10·75	7·52	March 31	25,341	9,971,337	650,224	0·61	9·35	2,357	—
Farnworth U.D.C.....	,, 18	133	126	+ 7	—	—	—	—	—	—	—	—	—	—	—
Glasgow Corporation	,, 21	13,312	12,038	+1,294	+35,298	124	101	May 31*g*	656,572	177,179,549	14,008,750	0·88	11·25	5,489 *b*	7·40*d*
Halifax Corporation.....	,, 18	2,352	2,139	+ 213	+ 5,336	30¼	27½	—	—	—	—	—	—	—	—
Huddersfield Corporation	,, 21	1,103	971	+ 132	—	34	35	March 31	56,631*h*	9,738,213	1,218,539	1·4	11·14	1,618	6·38
Hull Corporation, E. S.....	,, 21	1,834	1,614	+ 220	+ 3,583	19	19	,, 31	87,707*h*	21,065,999	2,218,696	1·00	9·49	5,004	5·07
Ilkeston Corporation	,, 18	124	—	—	—	—	—	—	—	—	—	—	—	—	—
Kirkcaldy Corporation	,, 18	147	—	—	—	—	—	—	—	—	—	—	—	—	—
Leeds Corporation	,, 21	4,992	4,660	+ 332	+11,792	77	—	March 25	262,656	57,239,779	5,773,651	1·11	10·91	3,283	—
Liverpool Corporation.....	,, 14	10,165	9,708	+ 455	+14,281	101	95	Dec. 31	504,304	108,906,472	11,705,425	1·11	10·34	5,000	6·88
Liverpool Overhead Railway....	,, 22	1,592	1,488	+ 104	+ 2,313	15½	15½	June 30	79,252	10,466,726	986,185*a*	1·82	19·30*a*	5,110	— *e*
Lowestoft Corporation	,, 24	142	—	—	—	—	—	—	—	—	—	—	—	—	—
Nelson Corporation	,, 21	78	—	—	—	3	—	—	—	—	—	—	—	—	—
Newcastle-on-Tyne Corporation	,, 21	3,447	2,881	+ 566	—	38½	36	March 25*g*	150,334	33,474,122	3,379,119	1·08	10·93	4,175	6·17
Portsmouth Corporation.....	,, 21	1,319	1,047	+ 271	+ 4,140	29	29	Sept. 30	47,651	9,168,137	868,157	1·24	13·17	1,643	—
Rochdale Corporation	,, 2	117	121	— 4	—	4½	..	March 31	5,416	925,281	127,456	1·38	10·27	—	7·66
Rotherham Corporation	,, 19	433	—	—	—	—	—	—	—	—	—	—	—	—	—
Salford Corporation	,, 23	3,604	2,986	+ 618	+38,727	—	—	—	—	—	—	—	—	—	—
Sheffield Corporation	,, 22	4,236	—	—	—	53½	46¼	Mar. 25*g*	216,709	56,812,049	4,926,083	0·904	10·428	7,510	7·0
Southampton Corporation	,, 19	854	841	+ 12	—	11	11	,, 31	35,874	9,084,522	752,814	0·946	11·436	3,760	—
Sunderland Corporation	,, 22	1,055	973	+ 82	+ 2,083	18·48	17·18	,, 31	59,930	13,987,121	1,270,957	1·03	11·3	3,243	6·43
Wallasey U.D.C.	,, 21	569	481	+ 87	+ 3,102	10·5	10·5	,, 31*g*	31,474	5,685,182	654,742	1·30	11·53	3,593	7·03

a Includes maintenance of permanent way and proportion of profits paid to the tramway companies for term of unexpired lease. *e* Train mile.
b Per mile of single track. *e* Include rail and tram. *d* Including depreciation. *f* Including one section of horse traction. *g* 1903. *h* Half-year's figures.

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INSTITUTION OF ELECTRICAL ENGINEERS.

Inaugural Address.

BY ROBERT KAYE GRAY, PRESIDENT.

(Concluded from page 723.)

It remains to consider what is, perhaps, the most remarkable feature in recent electrical progress — the development of the electric tramway. The law relating to this branch of the subject is, unfortunately, still more unsatisfactory than that dealing with lighting and power, for the controlling Act is still the Tramways Act of 1870, which was passed before electric traction was introduced, and was intended to deal simply with the ordinary horse tramway. The defects of that Act are too well known to require mention here; the objectionable veto given to the local authorities has once more been sufficient in itself to retard progress to an extraordinary degree. The fact that in the last few years electric tramways have developed so much in this country is not due to the existence of the Tramways Act, but principally to the fact that it was found possible to evade that Act to a considerable extent by promoting these concerns under the Light Railways Act, 1896—an Act which was really intended for another class of undertaking altogether. That Act has proved beneficial to a high degree, as it lowers the cost and simplifies the procedure when a tramway scheme is promoted; but in the years during which it has been in operation various defects have been discovered, and attempts have from time to time been made to have them remedied. My predecessor, Mr. Swinburne, pointed out these defects to the President of the Board of Trade when our deputation waited upon that Minister last year, and here, again, we were promised a measure to remedy them. A Bill *was* introduced this year, but it was unsatisfactory in the extreme, as it made no attempt to deal with the whole subject, but merely tinkered at one or two details, and we cannot regret, therefore, that it made no progress. The Board of Trade had previously appointed a committee to consider what amendments of the Act of 1896 were desirable, and as the President of the Board of Trade told our deputation that a report had been received from that committee, we naturally expected that the new Bill would deal comprehensively with the subject, but in this we have been disappointed. The old Tramways Act ought to be repealed and replaced by a measure suitable for modern needs. Under the Light Railways Act the powers of the Commissioners might with great advantage be extended. At present they are hampered by the feeling that, if not bound by the letter of the Tramways Act, they must, as far as possible, respect its spirit, and hence the absence of consents from local authorities has more weight than is proper. In cases where a light railway scheme is likely to compete with an existing railway company, the provision that the promoters must proceed by private Bill, and not by an enquiry before the Light Railway Commissioners, also militates considerably against the usefulness of the Light Railways Act by curtailing the powers of the Commissioners, and this restriction ought to receive attention in any amending measure.

These are but a few of the numerous points in the present law which call for attention. The whole of our electrical legislation is in urgent need of reform, and, after so many promises have been made, it will be very regrettable if nothing is done to remove the existing defects. While the electric light and power undertakings have obtained but little legislation in their favour, it is a relief to see that Parliament has granted railway companies certain advantages. By the Railways (Electrical Power) Act, which received the Royal assent on Aug. 14 last, existing railway companies, desiring to convert any of their lines to electric traction, are enabled to obtain sufficient powers for so doing by means of an order of the Board of Trade. They may become interested in power companies, and may take from them electrical energy for the supply of their main or branch lines. In spite of the legal impediments referred to, it will be found on investigation that substantial progress has been made in Great Britain in the utilisation of the electric current for both light and power purposes Exclusive of traction motors, in March of this year, lamps and motors equivalent to over 14,000,000 8-c.p. lamps were connected to the mains of public electricity supply undertakings, the Metropolis being represented to the extent of about 5,000,000. There were about 300 towns enjoying the advantage of an electricity supply, this number including, with two exceptions, all the towns whose population exceeds 100,000. The exceptions were Tottenham and the Rhondda district, which did not seem anxious to be alongside of their 38 fellows. It appears that at this period, exclusive of power companies, the public supply stations had motors amounting to 55,000 h.p. connected to their mains. Municipal undertakings own generating plant of a rated capacity of 320,000 kw., and private undertakings are represented by 160,000. In the Metropolis the companies are proprietors of about 100,000 kw., whereas the public bodies are responsible for approximately 28,000. The pre-eminence of the companies in London is due to the fact that they acted as the pioneers and were first in the field. The average rated capacity of a British station appears to be about 1,400 kw. It is to be remarked that, while in the provinces the average municipal station has a capacity of nearly three times that of a company station, in the Metropolis the ratio is reversed. Again, the average metropolitan company has, approximately, 10 times the plant capacity of the average provincial company.

It is interesting in this investigation to note that modern tendencies in this country are decidedly in favour of the direct-current system with a three-wire distribution. The number of direct-current undertakings increased from 139 in 1901 to 214 in 1902 and 260 in 1903. For these three years the alternating-current stations numbered 67, 68, and 69 respectively. There are now established in Great Britain 13 two-phase and 5 three-phase stations, exclusive of power transmission stations. In 29 cases supply is given on two or even more systems. Many of the alternating-current stations have taken up the supply of direct current, others have added two-phase or three-phase supply to their single-phase service, or have changed over completely to one of these. The direct-current system appears to be in no immediate danger of supersession, in part owing to the raising of the voltage, and the consequent possible extension of the service area. The number of voltages in use is somewhat confusing, and presents to the Standards Committee a difficult problem to solve. These voltages now amount to about 16, and out of 289 examples of pressures nearly one-third are declared at 230, more than one-sixth are given as 220, while voltages of 240, 200, and 100 claim about one-eighth each. There are between 50 and 60 stations which revel in more than one declared pressure. The extent to which the change from one voltage to another has taken place may be judged from the fact that in 234 cases the pressure is upwards of 200 volts; 64 supply current both above and below 200, and there are only 29 whose supply is entirely under 200 volts.

Although at the present moment the efficiency of carbon glow lamps and, in certain cases, of arc lamps is not so great at the higher voltages, yet it cannot be gainsaid that the change of voltage has been a beneficial one both for the supplier and the consumer. The supplier has benefited through a more profitable use of his current conductors; this benefit has considerably more than outweighed the expenditure in other directions that the change entailed. In many cases one of the large expenditures must have been in the purchase of storage batteries, for it appears that out of 330 stations no fewer than 240 use these batteries to a greater or less extent. The only drawback to the change would appear to exist in the case of small motors. Some remarks on the methods of charging for current could be made, but I limit myself to pointing out that the number of lighting undertakings in which the maximum demand system is employed alone is now 104, as compared with 114 in 1902, or, say, 31½ per cent., instead of 40 per cent. of the totals of the respective years. The maximum demand system, in conjunction with one or more other systems, is used in 74 cases, as against 38 in 1902, or, say, 22½ per cent., as compared with 13½ per cent. A simple uniform rate gives the corresponding figures of

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70 and 63, representing 21½ per cent., against 22 per cent. I regret I have not been able to collect information with regard to private installations in Great Britain which would prove sufficiently comprehensive. I have therefore decided to leave this portion of the subject alone. There is still room for improvement in the carbon glow lamps. I am given to understand that 16-c.p. lamps for 200 volts and upwards, with a life of 1,000 hours at an average consumption per candle of even four watts, can hardly be obtained as a commercial article. The production of the Nernst lamp seems to be improving, and its employment in a large number of towns for street-lighting, and in many private installations, will enable people to thoroughly appreciate its merits and utility. I find that the most recently introduced pattern gives three-quarters of a candle per watt when new. Nernst lamps are used by about 1,000 supply companies in the United States, the Hartford (Connecticut) Company alone employing about 4,000. In many cases these lamps are maintained by the supply company without extra charge, or at a nominal cost. The osmium lamp of Auer von Welsbach is well spoken of for low voltages in some quarters. Twenty-five to 30-volt lamps have been made which show little diminution in light-giving power after 800 to 1,000 hours burning. Apparently they absorb about 1·5 watts per candle, but are expensive to purchase. We shall doubtless hear more of the mercury vapour lamp associated with the name of Mr. Cooper Hewitt.

While with alternating-current work the tendency is always to simplify the switchgear to the utmost, this does not seem to be universally the case in direct-current practice, at any rate in the smaller public supply stations Some of these have elaborate plug boards, numerous 'bus bars, expensive battery regulators, and all sorts of alternative ways of doing the same thing. In many cases where these complications do not exist, not only the comfort of the staff but the efficiency of the service are greatly increased. It appears to be forgotten that everything tending to simplicity has a beauty of its own which no complication can ever rival. In spite of the absence of any notable development in switchgear, a very high standard has been attained by British designers, especially in heavy power and lighting work with alternating currents at high pressure. Following a totally different line from the Continental and American practice, our engineers have evolved apparatus which is at the same time safe, simple, and reliable, while occupying a minimum of space. In the early days of the electrical industry when the range of possible distribution of current was restricted, the engineer had to seek a site for his generating station in crowded and expensive districts. To economise space he employed high-speed reciprocating engines and water-tube boilers. At that period he could doubtless do this with advantage, as the generator units in use were, comparatively speaking, small. To-day the units are larger and the range of possible distribution is increased. It is not, therefore, so necessary to follow the old practice, and in many cases to do so is inadvisable.

Among the remarkable things of the year may be mentioned as in course of construction four turbo-generators of the Parsons type, each rated at 5,500 kw. to 8,280 kw., and occupying a space measuring only 51¾ft. × 14ft × 12ft. A 6,500-kw. turbo generating set is being built by Brown, Boveri, and Co. which measures 59ft. × 10ft. × 10ft. A Curtis turbine of 5,000 kw. is running in Chicago; this turbine is a combination of the Parsons and De Laval systems, and is arranged with a vertical shaft, a somewhat inadvisable design. In shape it is cylindrical, and, including turbine and generator, stands 25ft. high, with a diameter of 14ft. It may be interesting to note that there are over half a million horse-power of turbines in use or on order, and 24 stations in this country use the turbine more or less. While referring to large units, it may be of value to state that the Société Cockerill of Seraing is expected to show at the St. Louis Exhibition next year a gas-engine of 3,000 h.p.; this engine will have two cylinders, each of 51in. diameter, and will run at 85 revolutions per minute. It is said that the Gasmotoren Fabrik Deutz is designing a 6,000-h.p. engine.

With relation to electric driving in factories and ships, we all remember the excellent papers read before this Institution by Mr. Williamson and by the late Mr. C. E. Groves. The contribution of the latter was especially interesting to me, as it showed in a striking manner the progress in the employment of the electric current on shipboard from the time of the Silvertown Company's installation on their cable steamer "Dacia," in 1879, down to the huge developments already reached at the time the paper was read.

Among the recent varied uses to which electromotors can be put may be mentioned gold-mining at the Klondike, where they are employed in dredging, washing, and conveying the material to the tip. Another instance is the driving of a rolling-mill, where a 400-h.p. motor is coupled direct to the rolls. In a large plate-glass works in America there are four generating sets of 4,000 kw. each and one set of 350 kw.; there are also 20 motors of 450 h.p. each and 20 of 200 h.p.; the three-phase system is in use at 5,800 volts with frequencies of 40 and 25 cycles per second. A large colliery in the same country has plant of 2,900 kw., the installation comprising 44 mining locomotives and 75 miles of underground trolley wire; the power is transmitted at 5,600 volts, three-phase, 25 cycles per second, but is converted for use at 275 volts. At the Carnegie Works electricity is used for almost everything requiring power, and it is stated that in the Homestead Steelworks of Pennsylvania, by the aid of electricity, 4,000 men make as much steel as is made at Krupp's with 15,000 men.

Since the establishing of the Portrush electric tramway in 1883 the electrical engineer has encroached on the field of the tramway engineer, and consequently the purely tramway work, as apart from the electrical work, has often shown the mark of the active, clever, but untrained mind, impossible curves and grades being attempted, and unnecessarily expensive work being done. There has been some advantage in this no doubt, as the experience gained by these works, although expensive, has tended to improvements in practice. There is an American manner in this mode of procedure which leads to a free use of the scrap heap The individual suffers, but the community eventually gains by the survival of the fittest. It is, I suppose, a rule which applies and must apply to all young nations and industries. The rough and tumble while it lasts is interesting and exciting, and doubtless drives the workers to put their best foot foremost. The golden rule, "Be sure you are right and go ahead," is the best to follow, but it often happens that one dies and is taken from the arena before even the first part of the rule is complied with. On the whole, therefore, it is perhaps as well that chance should be allowed to play its part, and that activity and energy should not be troubled with a too severe bearing-rein. The rule before cited should probably be modified in the manner of the saying of the northern farmer to his son, and should read, "Be sure you are right and go ahead, but go ahead." I think this has been the motto that has been adopted by electrical engineers since 1877, with the much-desired effect that sufficient improvement has been made to enable the electrical bark of this country to be steered into still water for a time. This happy condition does not, I believe, exist in Germany or America, where apparently there are "more heads to be broke." We have been toiling up a steep hill for many years, and the time has now arrived when we should stop and survey the landscape as a whole, instead of narrowing our view to the particular point towards which we happen at the moment to be ascending. Already many of the paymasters are questioning the scrap-heap theory, as they know by experience that this is often evolved from nothing but a craving for change and a want of appreciation of the true value of money on the part of their advisers. I make these remarks with no desire to convey the idea that work in this country is not carried out conscientiously and well, but rather with the view of suggesting a curbing of the expenditure of money which produces a semblance for the moment of unbounded prosperity, while in reality it only means riding full gallop for a fall. If the fall should occur, the many men who are entering our ranks every day and swelling our numbers will find their prospects blighted owing to a disturbance of the trust which is placed in the

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electrical engineers of to-day by those who supply the sinews of war. I, therefore, think it incumbent on every electrical engineer to carefully weigh every recommendation he may make, not from the point of view of immediate, but rather from that of ultimate efficiency, and to deal with every possible factor in drawing his estimates. The papers read, and the discussions which take place in this hall, and in the meeting places of our local sections, tend to this end.

I am afraid I am wearying you by reiteration, but I feel strongly on this subject, which, in my opinion, affects the vital interests of the Institution, and I venture to lay before you things that, though perhaps to many of you are platitudes, may prove of use to our younger colleagues. The establishing of electrical tramways, and the electrification of existing railway and tramway lines, are rapidly assuming great proportions, and it is not difficult to predict that this branch of electrical engineering will continue to advance by leaps and bounds, providing employment for many electrical engineers connected with the Institution. From the report of the London County Council on the excellent work they have been doing in South London, it would appear that the difference in prime cost between laying an urban line on the conduit system and construction on an overhead trolley system, is not so great as to render the former altogether impracticable. I think, therefore, those authorities in the municipal areas are acting in the best interests of the inhabitants of this crowded Metropolis who refuse to authorise the erection of the unsightly, and in many cases dangerous, overhead conductors. The utilitarian may argue that whatever increases prime cost goes in restriction of development, and in this he is to a certain extent correct. But apart from the question of danger avoided, it is usual in civilised communities to have some respect for forms and appearances as well as for the purely useful. Moderation should reign in all things, and in relation to electrical tramways, London does better to employ the conduit system and follow the example of Budapest and Paris, rather than erect an overhead system similar to that which disfigures my native city of Glasgow and many other towns in this country. The conduit system has cost London per mile of single line about £14,000, an overhead installation would have cost £7,000. In my opinion the difference is well spent. It may be argued that this difference does not represent the whole difference, and that many electrical arrangements can be made in an overhead system that would not be permitted in a conduit system. My answer to this is that it comes within the province of us engineers to overcome these difficulties—overcome them we shall if we only apply ourselves seriously to the task, and produce results which will pass the severest test that the Home Office, Board of Trade, or other authority may impose.

Passing on to the nature of the current supply, the continuous current system predominates at present in Great Britain for all kinds of electric traction. Its supremacy is again being threatened by the monophase system, whose employment in certain cases possesses advantages that are greater than the disadvantages. The efficiency for traction purposes of polyphase working has not been sufficiently proved, but as regards the method of transmitting power to considerable distances for conversion to continuous current to be applied to tramway purposes, the three-phase system has so far held the field at pressures up to 6,500 volts. A most complete system of high-pressure polyphase traction work was inspected by many members of the Institution during a visit to Northern Italy in the spring of this year, and to those interested in this subject it will be useful to closely follow the fortunes of the electrified Valtellina, Lecco, and Milan Railway. For this line there are in course of construction electric locomotives which have been designed to exert a tractive force of from 7,500lb. to 11,000lb. at a speed of 40 miles per hour, their individual output being, I understand, from 800 h.p. to 1,200 h.p. The exceedingly interesting experiments being made on the Marienfelde-Zossen military railway have resulted so far in the attainment of a speed of 125 miles per hour. The railway from Berlin to Zossen is about 15 miles in length, and the current generating station is about eight miles from the head of the line. The car—a Siemens and Halske design—was supplied with power from the line wire at a pressure of about 14,000 volts.* The inauguration of through traffic between Liverpool and Bolton, a distance of 40 miles, marks an important epoch in the progress of the South Lancashire Tramway project, which embraces a network of more than 500 miles of track, and will serve an area whose population is about 5,000,000.

The application of electric traction to our railways is progressing. At present the sections which are being dealt with are those which have a great traffic density or a frequent service This policy is doubtless a wise one, as the railway companies limit the application of a considerable capital expenditure to the best paying division of their lines, and to those portions where the benefits to be derived are the most apparent. During the current year the first section of the Metropolitan District Railway conversion has been made, and it is expected before March of next year that the Moorgate street - Drayton Park and Drayton Park-Finsbury Park sections of the Great Northern and City Railway Company will be in operation. The Mersey Tunnel Railway has been completed, and the conversion of the Wirral Railway is under consideration. The North-Eastern Railway has had trial runs along Tyneside, and good progress is being made with the Liverpool-Southport line. The Central London Railway is completing the change from locomotive to motorcar driving. The motorcar system is generally accepted as the best form for passenger traffic for many reasons which I need not recapitulate. The direct-current system at 500 to 700 volts appears to remain as a standard for railway work of this class, as well as for tramway work, but there are signs that single-phase alternating current may prove a rival. In the United States the Washington - Annapolis Railway is being equipped with an overhead system which will deliver direct to the motors a single-phase current at 3,000 volts. The three-wire system of feeding tramways and railways, though not without examples abroad, has not been adopted in this country save on the City and South London Railway, where it seems to have proved satisfactory.

The only surface-contact system in this country is that which has had nearly a year's trial at Wolverhampton. Troubles have arisen between the Corporation and the company. It is therefore impossible to say exactly how the matter stands. It is believed that the Kingsland mechanical switch surface-contact system may be tried at Dresden shortly. Although accumulators are being extensively used for private carriages in London and elsewhere, yet this country has not seen its way to employ them for rail or tramways. In Italy and Germany some use is made of them, and it is stated that as the result of two years' working on lines running out of Bologna, the cost of battery traction has proven 28 per cent. cheaper than steam. The use of storage battery locomotives in America for shunting and mine work appears worthy of mention, as it seems to have attained considerable proportions and to have proved successful in practice.

In the provinces the great power distribution undertakings are getting to work by degrees. Besides the Midland and Newcastle concerns we can now count the Durham, Lancashire, North Metropolitan, and South Wales Companies. The advantages of electricity as a motive power seem to be readily appreciated by the industrial populations of these districts. Among some of the large schemes in project is the electrification of the national railways of Sweden, the original power being derived from water pressure or the combustion of peat. Estimates are being drawn for 2,700 miles of railway, calling for over 100,000 h.p. The official estimate shows that there will result a saving of 50 per cent. in the present working expenses, which amount to about £800,000 per annum. Switzerland again speaks of a conversion of its national lines, entailing the use of 30,000 h.p. to be obtained from water pressure.

The utilisation of the Victoria Falls of the Zambesi is a project under serious consideration, and at least a portion of the scheme may be near realisation. Some three months

* Since writing the foregoing I notice that the car designed by the Allgemeine Electricitäts-Gesellschaft has on the same line attained a speed of 130½ miles per hour.

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ago certain details of the scheme were made public, and from these it appears that whereas the Niagara Falls are equivalent to a continuous loss of 7,000,000 h.p., at the Victoria Falls of the Zambesi the loss is five times as great. In advocating the utilisation of this waste it is pointed out that tramways near San Francisco are driven by a current which has its origin in the Ubax Falls about 220 miles away, and that some American engineers estimated that power giving a steady load of 24 hours per day could be delivered 330 miles from the generating plant at about £4. 10s. per kilowatt. At Niagara six syndicates are carrying out work which, when completed, will be capable of generating over 1,000,000 h.p. Some of the generating sets will be of 10,000 h.p. working at 11,000 volts. The pressure will be converted to 60,000 volts. The highest pressure as yet made use of in Europe for power transmission is in Italy—namely, 40,000 volts. This plant is not yet completed; it is intended that water power will develop 7,500 kw. at 9,000 volts (42 cycles per second), which will be transformed to 40,000 volts for transmission. In the United States, in Montana, where a similar pressure is employed for transmission, the voltage was increased to 80,000 for a few hours with success. Consideration of these voltages recalls the experiments made in March, 1883, just 20 years ago, by Marcel Desprez, in power transmission between Paris and Creil, a distance of 57 km. at a pressure of 5,700 volts. One also thinks of the transformer of Gaulard of about that period.

I now turn to the subject which gave birth to this Institution and from which its first title was derived—I mean the subject of telegraphy. Between May 26 and July 7 of this year an international conference of the telegraph administrations was held in London at the invitation of his Majesty's Government. These meetings are, so far as may be, quinquennial, and are usually held in the capitals of the Great Powers. The last meeting in London took place in 1879. The discussions which now are carried on between the Government delegates, and with the representatives of the telegraph companies who are also invited to be present, are purely of an administrative order, and principally deal with tariffs and the rules for carrying out the international exchange of telegrams. Technical questions, such as the size of conductors and the classes of instruments to be employed in the international service, are either already agreed upon or are the subject of separate and private understandings between the administrations interested. These have been fairly well standardised during the 38 years that have elapsed since the first conference was held in Paris. Since 1879 the growth in the length of telegraph land lines has been very large, and the development of submarine telegraphy has been almost phenomenal. At that date the public were just beginning to realise what power for good or for evil was being placed at their disposal. Merchants were beginning to feel that the submarine telegraph had a centralising effect which enabled them to carry on their business with smaller stocks of goods. The large merchant had no longer the control of the foreign markets which his wealth had formerly given him, and the small merchants began to have an innings. When this state of things came home to the traders, submarine telegraphic facilities were in great demand. The cables across the Atlantic and other oceans began to multiply, and new centres of industry were connected to the chain. The men at the head of cable affairs, and notably the late Sir John Pender, were not slow to meet these developments by increasing the ramifications of the telegraphic network, and bringing the charges for telegrams to such a figure as to encourage the public to make full use of the means of intercommunication placed at their disposal. This policy was hastened by the wholesome dread of competition where such did not exist, and by competition itself. A year ago the gap in the world's telegraphic girdle was completed by the laying of the Trans-Pacific cable which now unites Canada with Australia, and this year has seen completed a second line across the Pacific from San Francisco to the Philippines and China by way of the Sandwich Islands, Midway, and Guam.

It is strange that during this development the improvements in the types of telegraph cable employed have not been great, nor has there been any great advance made in the design of the instruments used for the transmission of signals, but the administrative work has been vastly bettered. Messages which formerly took hours in transmission are now received from the public and delivered to the addressees in a few minutes. I am informed that a telegram announcing the result of the yacht race for the America Cup was carried, in August last, from London to South Australia in four minutes. This message, which was forwarded *via* South Africa, was handled by 15 operators, passed through 11 stations, and traversed 14,404 nautical miles of submarine cable and 1,515 statute miles of land lines. Ordinary commercial traffic cannot be dealt with at this speed, but the instance I quote shows what can be accomplished when special arrangements are made to carry news which is of peculiar interest. The manager of an American cable company has told me that the result of the America Cup Race reached London one minute after the termination of the race, having been transmitted through 3,400 nautical miles of submarine cable and some 200 statute miles of land wire. The record time between New York and London is 30 seconds, and messages have been sent and replies received in 1 minute 30 seconds.

During the last 25 years the engineers engaged in submarine telegraph work have devoted more care to the surveys of route than was previously the practice; to a great extent this means that the engineers have succeeded in persuading the capitalists that these surveys are of prime importance. The Atlantic cables of 1857-8, of 1865, 1866, and on to 1874 were laid on the data as to the ocean bed furnished by perhaps 30 soundings taken over a route some 1,700 nautical miles long. In 1871, Lord Kelvin furnished a means for sounding which did not exist previously, and in 1872 the Silvertown Company made a first trial. The late Sir William Siemens, in 1874, carried out the first systematic sounding in the Atlantic, and from that time forward until 1883 it was the habit to take soundings, but not to make a full and careful survey. With the results obtained from these soundings our knowledge of the ocean bed was increased to the extent of teaching us that submarine mountains, plains, and gullies exist, and that the physical conditions of the submarine floor are very similar to what one observes in travelling through Europe from Calais to Brindisi. In 1883 the first thorough preliminary survey of any cable route was made, but as this has been the subject of a paper read before the Institution on Nov. 10, 1877, I need not enter into detail further than to say that the result of this survey materially altered the original plans for laying the cable on account of unsuspected elevations and depressions of the ocean floor having been discovered. In addition to the configuration difficulties to be encountered by a submarine cable, the chemical composition of the soil is important, as it greatly affects the cable's life. A paper referring to this subject was read before the Institution on March 11, 1897. I had the pleasure of handling about a month ago a piece of submarine cable which had lain at the bottom of the sea in deep water for nearly 30 years, and its appearance was such that I was unable to say whether it could not have lain there for another 30 years without showing any deterioration. To-day there are employed in cable work 49 ships, representing 92,094 tons. The largest, the "Colonia," belongs to the Telegraph Construction and Maintenance Company, and has a dead-weight capacity of 11,000 tons. When he considers the comparative facility with which cables are now repaired, no shareholder in a submarine telegraph company needs fear for the permanency of his property. In July, 1879, there were 50,450 nautical miles of cable in operation; there are now under the sea 222,253 nautical miles, and I have every reason to believe that this mileage will continue to increase.

On wireless telegraphy I have no new developments to report. The Cantor lectures delivered by our vice-president, Prof. J. A. Fleming, before the Society of Arts in March of this year, and the description of the Lodge-Muirhead system in *Page's Magazine* for last May, give to anyone interested in the subject the latest communicated information of any value. I need only add that there seems no immediate prospect of its seriously competing with the business of the existing telegraph companies. In

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my remarks concerning the means of transmission through submarine cables, I omitted to make reference to the relay of Mr. S. G. Brown which was described by him in the paper he read before the Institution on May 1 of last year. I may also mention that since 1879 considerable improvements, though of a minor nature, have been made in duplex transmission.

The use of the telephone continues to extend, and in addition to the greater facilities offered in Great Britain there are gradually being established international wires which place in telephonic communication the principal towns of Great Britain and several of the commercial centres on the Continent. So far as I am aware, no practical use has yet been made of Poulsen's teleautograph which I had the pleasure of inspecting with our vice-president, Mr. Gavey, and of which he gave a description in a communication to the Institution on Nov. 22, 1900.

Before passing to the next portion of my subject, I should like to make a short reference to a very early investigator into the phenomena of magnetism: I mean Dr. William Gilbert. Our past-president, Dr. Silvanus Thompson, who has taken so great an interest in the bibliography connected with Gilbert, tells me that the tercentary of the death of this remarkable man will occur on Dec. 10 next (new style), and that probably some notice of the fact will be taken by his native town, Colchester, and by the Royal College of Physicians, of which body Gilbert was president at the time of his death. As you are doubtless aware, the work by Gilbert, notably his "De Magnete Magneticisque et Magno-magnete Tellure," shows a patient observation and careful recording of results, which resemble in many ways the method of Michael Faraday. Your Council have not yet decided what steps, if any, will be taken by the Institution in connection with this celebration.

Whilst reviewing the state of electrical progress, mention should be made of the work of the Engineering Standards Committee. This committee is making some progress in its work, and it is pleasing to note that the Government has recognised that the Institution of Civil Engineers, the Institution of Mechanical Engineers, the Institution of Naval Architects, the Iron and Steel Institute, and this Institution should be assisted in the useful work they are doing. A Government grant has been made which will lighten the burden of these institutions, as, until this assistance was recived, they were not only doing the work, but were also providing the funds necessary for carrying it out. Sir William Preece and Colonel Crompton, two of our past-presidents, are members of the General Committee, and represent the Institution. The former is chairman of the Electrical Plant Divisional Committee, which is most directly connected with our branch of the subject. It is to be hoped that some of the results of the deliberations of the Electrical Plant Committee may shortly be published, and should they be, I shall append them to this address by way of further publication.

While speaking of the work of the Engineering Standards Committee, I cannot resist the temptation to protest against the continual attempts which are made to apply to our weights and measures and money what is called the decimal system. However regrettable it is that scientific men should not have boldly recommended for adoption 12 instead of 10 as the place ratio of figures when so many sweeping changes were made at the time of the French Revolution, I am afraid they are too indolent to do so now, and that 10 will continue in use until another universal upheaval changes all things. Because 10 is conventionally adopted for this ratio, there appears to me no reason why the system should be extended to all the weights and measures necessary for common use, bringing about many absurdities, and in many cases establishing very inconvenient standards. The adoption of the metre, or any other measure of about its dimensions, as a unit of length matters little, but if the metre be adopted it is no reason because a millilitre of distilled water is supposed to weigh 1 grm. at 4deg. Celsius *in vacuo* that butter, coal, diamonds, and wood should be compulsorily dealt with in metres or their decimal derivatives. I am the first to admit that in physics and chemistry there are undoubted advantages in having, so far as one can, a common relation existing between the various units, but that is no reason why we should combine to force on the public a system of weights, measures, and money which is so much against nature that it hardly obtains currency in the countries of its adoption. In France, precious stones are to-day bought and sold in carats, firewood in cordes, milk in pints, gravel in toises, grain, potatoes, and charcoal in boisseaux, wine in barriques, feuillettes, demi-setiers, and chopines, wood for construction in pieds, pouces, and lignes, beer in canettes and pots, sugar and coffee among the poor people are dealt with in livres, demi-livres, etc. Cattle dealing is carried on in pistoles and écus, and not in francs. Finally, they have just issued a 25-centime piece, doubtless because it represents a quarter of a franc. In my opinion, the decimal system applied to weights and measures and money offers too limited a field for the operations of ordinary life; and I should be sorry to see it with all its disadvantages forced upon us by legislation to the exclusion of other systems, when the admitted advantages to be gained are so small.

I should now like to make a few remarks, if time will admit, on the present functions of electrochemistry. This is one of the most progressive branches of electrical industry; although striking advances are rare, constant improvements in detail are being made, and processes which have been long outlined are being developed into commercially practicable methods. Probably there has been no step so noteworthy during the year as the announcement by Mr. James Swinburne of his invention of a new process for the reduction of metallic sulphide ores, which, with the collaboration of Mr. Ashcroft, he has put to test on a commercial scale. The process consists in treating the ores with chlorine, displacing the sulphur, which is recovered—the essence of the invention being the fact that this reaction takes place without the formation of chloride of sulphur; various precipitations follow, according to the metals present, the final result, after all the other materials have been extracted, being zinc chlorine. This is electrolysed, the zinc being obtained in the metallic state, and the chlorine is ready to be utilised again. Thus the process is cyclic, and it is applicable to almost all kinds of ores, including the huge piles of waste which have accumulated as the result of less complete processes. This system may well prove of the utmost importance in metallurgy. Another valuable process which has made considerable progress during the past year is the reduction of iron ores by means of the electric furnace. At Livet, in France, the process is in practical operation, generators of 1,200 h.p. each giving single-phase current at 30,000 amperes each, and driven by water power, being employed. The output is 12 tons of steel per day. At these works ferro-silicon is also made from quartz, scrap iron, and coke at less cost than that of smelting, and copper pyrites is reduced to copper and iron sulphides rich in copper, and ready for the ordinary smelting process. Steel of high quality is similarly produced in Sweden at the rate of 1,500 tons per annum. With the Stassano process the expenditure of energy is said to be 3,000 horse-power hours per ton of iron; but with the Ruthenburg system it is said that 500 kilowatt-hours suffice, and that ores of poor quality can be treated. Large deposits of iron ore exist in Canada remote from coal mines, but within reach of Niagara Falls, and it is said that a Canadian syndicate has been formed to work the Ruthenburg system with power derived from the Canadian Niagara Falls hydro-electric works. Already in Canada the Betts process for refining lead is in operation at Trail, British Columbia, the daily production amounting to seven tons of lead. The crude lead is used as anode in a bath of lead fluosilicate and fluosilicic acid; there are 22 anodes per vat, through which 4,000 amperes are passed, and the pure metal is deposited on the cathode, leaving the impurities, including the precious metals and copper, on the anode in a skeleton of spongy lead.

In a quite different direction electricity is being used for the purification of the water supply of towns. There are two installations of this kind in Germany—Schierstein and Paderborn—where the Siemens ozonising tubes are in use; air is charged with ozone by means of these, and is passed up dripping towers, down which the water trickles, with the result that it is completely sterilised as regards all deleterious organisms. At Schierstein the capacity of the plant is nearly 50,000 gallons per hour, and the power

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required is 50 h.p., of which, however, only 27 h.p. is used for ozonising; the remainder serves for pumping, etc. The pressure used is 8,000 volts. The working cost is in all from 3½d. to 4½d. per 1,000 gallons. By the Jaruti process water is electrolysed to give pure hydrogen and oxygen, consuming 115 kilowatt-hours per 1,000 cubic feet. A solution of caustic soda is used, with a perforated iron diaphragm to separate the gases. At Stangfjorden, in Sweden, the Jebsen system is used for the manufacture of briquettes from peat. The latter is carbonised by heating with the electric current, derived from water power, and the tarry by-products are recovered. The production of nitric acid from the atmosphere has long been the subject of experimental research; it is now in active operation at Niagara Falls, where by means of electric discharges at extremely high pressures and frequencies the nitrogen and oxygen are caused to combine. The same subject has been dealt with on the Continent, where a return of 52 grm. to 55 grm. of nitric acid per kilowatt-hour has been obtained, using a current of 0·05 ampere at 50,000 volts and 6,000 to 10,000 cycles per second. As Sir William Crookes has shown, the fixation of atmospheric nitrogen may in the distant future have a most important bearing upon the existence of the vast population of the earth, when natural sources fail to furnish an adequate supply of food.

In connection with this subject, the synthesis of sugars by the electrolysis of carbonic acid, ammonium, phosphate, etc., which has been accomplished by Walther, is of no little interest. The extraordinary potency of electrolysis and the electric furnace in chemical and metallurgical processes has been most largely made use of in America, which is, in fact, the electro-chemical headquarters of the world. The various works which derive their power from Niagara Falls are producing caustic soda, chloride of lime, carbide of calcium, chlorate of potash, sodium and sodium peroxide, sodium cyanide, baryta, phosphorus, nitric acid, lead, carborundum, graphite, corundum, etc. A single American concern is producing 4,500 tons of aluminium per annum, while the United States produces 278,860 tons of electrolytic copper per annum, no less than 86·5 per cent. of the world's output. Siloxicon, a highly refractory compound of silicon, carbon, and oxygen, is one of the latest products of Niagara. The electrolytic rectifier, which depends upon the peculiar properties of aluminium in an electrolytic cell, is a device which will have many applications, especially since it has been so arranged as to ingeniously utilise both positive and negative waves of an alternating current.

One of the most important branches of electro-chemistry is that which relates to secondary batteries, and in spite of the immense amount of work which has been done in this direction in the past, remarkable progress has been made of late. The most notable invention in this department is the Edison nickel-iron cell, which appears to be on the verge of adoption on a commercial scale. Elaborate machinery has been designed and constructed at great cost for the rapid manufacture of the cells, and trial cells have been in the hands of European experts for many months, while complete sets have been exhaustively tested in America and England. There seems to be no question that the cells have fulfilled the claims made for them, and that their introduction in quantity will give an immense impetus to the electric automobile industry, and even to accumulator traction in general. The cleanliness, capacity, and seeming indestructibility of the cells, joined to their highly perfected mechanical construction, render them admirably adapted to automobilism, and the stated ability to charge them with 75 per cent. of their full capacity in one hour is a feature of the first importance. Other cells have been brought forward, notably the Elieson cell, which is an improved lead plate cell, with the property of enduring remarkably high rates of charge and discharge without injury, and the "N.S." (Niblett solid) cell, in which the whole of the positive and negative elements are packed tightly in a container. Each of these has meritorious features, but whether they will stand the test of time cannot yet be decided. Besides the foregoing examples, a vast amount of work is being done in every branch of electro-chemistry, and the recent formation of the Faraday Society, admirably named, to further the interests of the science and industry in this country—long after the birth of similar societies abroad, it is true—can well be included as one of the most important and fruitful "recent developments" in the electrical world.

I will now bring this address to a close, as I began it, with a reference to the growth of this Institution. In my opening remarks I omitted an observation which I should have made concerning this growth, and that was in reference to the source from which our members are drawn. Had not a great wave of educational fervour passed over this country some 20 years ago, had not the establishment of technical institutes all over the country taken place, had not Lord Kelvin and others educated their pupils in a way which best fitted them for the position of efficient teachers in these technical colleges, our Institution would not have attained its present importance, and the posts filled by many of its members would, perforce, have been filled by the better educated foreigner. It is a great advantage to the taught that their teachers should be concerned with the practical side of the subject they treat, and this in itself is a justification for those who teach being members of our Institution and taking an active part in its management. Teaching from text-books which are written on an undeveloped science causes the student to learn many things that he has to unlearn, and launches him into the world full of information which may have been abandoned altogether, or is at least five or six years old. If the teachers are in touch with everyday practice the taught profit immensely, and leave their colleges with knowledge which, although it may later require modifying, has at any rate the advantage of being the knowledge of the day. I believe the electrical industry in this country is almost entirely in the hands of electrical engineers educated in England. Can this be said of the chemical industry? I doubt it, and presume that it is because the latter is a much older science, and has not been favoured in possessing in this country so many educational advantages as are offered to those engaged in the electrical industry. It certainly has not, as a general body, had teachers with the same practical experience, although there are undoubted signs that the younger generation is being better taught. To cite one instance in my personal knowledge, out of the many which might be selected: I remember my father introducing into Scotland, for the purposes of calico printing and dyeing, the use of certain coal-tar dyes, the employment of which had just been practicable by Mr. W. H. Perkin. Forty-five years have elapsed since then, and although Great Britain has practically been the home of the raw material and one of the greatest consumers of these products, yet, through the application of greater knowledge and skill, Germany to-day furnishes our printers and dyers with the greater proportion of their requirements. We are being beaten in a race in which the foreigner is handicapped. Is this due to the natural incapacity of the Englishman, or is it due to the want of the opportunities which his foreign competitor possesses? Despite the opinion recently expressed by Prof. Karl Pearson, I like to accept the latter explanation, although, given the opportunities, we must always bear in mind that a chemist's work is laborious in the extreme, and this may not, as a rule, satisfy the ordinary class of English student. In adopting this illustration I do not wish to be misunderstood. I have no intention of implying, and it would be foolish to imply, that this country does not possess chemical knowledge of the very highest order, as witness the number of distinguished men whom we know by name, and the work they have done, and also the large number of chemical works established in the London, Manchester, Glasgow, and other districts. I also fully recognise that the chemical industry cannot be fairly compared with the electrical industry, as it occupies a much wider field, and is a much more difficult subject to master. I use the illustration as I do not believe the mass of the people engaged in the industry have placed at their disposal sufficient opportunity for proper instruction, or for acquiring knowledge, as is the case in Germany and some other countries.

With wisdom, we in this country open our arms to the skilled man of other countries, and through his skill we can, in certain directions, maintain supremacy in some of our productions. The pity of it is that we have not

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amongst our own countrymen men of equal education and skill. One may say that the electrical industry is also suffering, and that the signs of it are the large importation of American and German machinery into this country at the present time; but I venture to disagree. Americans and Germans are doubtless appearing on our markets, and in many cases owing to greater skill in manufacture; but the financial side of the question has a great deal to do with their incursion, and especially is this so with their competition in our colonies and in non-manufacturing countries. We must, as a policy, continue to welcome all comers, but while so doing we should equip ourselves so that by sheer skill and ability we may conquer in the end. The equipment we require is, everyone now admits, technical education, and thus we are developing in all directions. The electrical engineers as a class are better equipped than any other class I know of, thanks to the teaching received in our technical institutions from very capable men, some of whom we are proud to see numbered among the past-presidents of this Institution.

During the recess, several powerful advocacies for the furnishing of greater educational facilities to the students of this country have been published, and it is gratifying to see that these publications were made in a manner to bring them before everyone who cares to read them. Sir Norman Lockyer, in his presidential address to the British Association meeting at Stockport, made a stirring appeal, which must sink into the soul of every thinking man who has the welfare of his country at heart. Sir William Abney, as chairman of Section L—educational science—placed before the public what has been done since 1853 by the Science and Art Department with the small amount of funds at their disposal. Prof. Meldola's lecture, delivered in August last at Oxford on chemical industry and research, should also be mentioned, as it deserves careful reading. Opportunely Prof. H. E. Armstrong has just had published by Macmillan and Co. a collection of his writings on education. Sir William Ramsay, the president of the Society of Chemical Industry, and many others who are interested in industrial development, are actively forwarding the cause, and it is to be hoped that some good may be evolved from the atmosphere of public interest which has been created, and that we may thus eventually find the men of this country as well furnished as their foreign competitors with the necessary knowledge, and with the means of applying it in investigation. Our past-president, Dr. John Perry, informs me that there is under consideration the formation of a science guild, whose fundamental object will be the encouragement of the application of scientific principles to industrial and general purposes. We must all hope those engaged in the matter will succeed in founding this guild, as there doubtless exists a blank which it can fill. I am glad to see some of our members—notably my predecessor, Mr. Swinburne, and our honorary member and past-president, Mr. Swan—are interesting themselves in the formation of the Electro-Chemical Society, to which I have already referred, and I am sure we all wish them every success in their effort to specialise in Great Britain this very important subject.

For the future development of the usefulness of the Institution there appears to me to be one matter worthy of our utmost attention. The Institution membership extends all over England and the Colonies, and we have found it a useful addition to our constitution to establish local sections in different centres. Since these sections have been formed, many valuable contributions have been incorporated in the *Journal* of the Institution which might not have appeared there had the opportunity of having a meeting place in the author's neighbourhood been absent, and had there not existed an organised assembly to discuss the subject submitted by him. The local sections are growing, and must by the nature of things increase in importance. The development of the electrical industry in the provinces must advance with greater strides than in London, where manufacturers are hampered by high local rates, and sometimes obstructive legislation, which appears to be a necessity in our large metropolis, and which is, fortunately, not so essential in smaller communities. Again, in the neighbourhood of London the cost of raw material is appreciably higher; fuel is also higher, and the charges for the transport of the finished goods to their destination handicaps the London manufacturer. These, in addition to the higher scale of wages paid, are fast driving manufacturers into the provinces. Such a migration, from a general point of view, is, perhaps, advantageous, but it indirectly affects the Institution in a way which is not of advantage to the central body. If the migration continues to the same extent as took place in the case of London shipbuilding many years ago, the centre of production, so to speak, of the electrical industry will gradually gravitate northwards, and nothing but consumers will be left in the Metropolis. Many of our ablest members are already in the provinces, and it is quite a question for the Institution to consider whether the day is not fast approaching when we should extend our system of decentralisation. Is it not time that we should consider the establishing of a local section in London, similar in all respects to the local sections we have in Birmingham, Dublin, Glasgow, Leeds, Manchester, and Newcastle? In this new local section papers affecting London could be read, and be published or not in the *Journal* of the Institution in the same manner as papers in the other local sections are dealt with. London would continue to be the headquarters of the Institution, and Institution meetings could be held, say, four times a year. At these papers of general interest could be contributed. If any such scheme as this were adopted, the constitution of the Council of the Institution would be somewhat affected. The chairman and committee of the London Local Section would, of course, be all London men, but the Institution would have a larger field from which to select its President and Council, as men who have their business in the provinces, and who cannot spare the time to attend the present numerous Council and Institution meetings, might be able to attend the less numerous meetings which would be the outcome of some such rearrangement.

In conclusion, I must thank you for the kind tolerance with which you have received the remarks that I have had the pleasure of submitting for your acceptance.

A NEW COMPOUNDED THREE-PHASE GENERATOR.*

The more recent three-phase generators with the Heyland compounding winding built by Messrs. Kolben and Co, have been of the rotating radial pole magnet type. They are excited by means of a small commutator connected to the magnet winding in a similar manner to the original Heyland asynchronous generators, and the compounding under all conditions of load and power factor has been found to be extremely satisfactory. The main current generated is led directly round the magnets by means of the commutator exactly as in continuous-current compound generators. The commutator performs two distinct operations. It rectifies the main current into a uni-directional current, and also splits it up into its two components—power current and wattless current—and feeds these to the magnets in such a way that the compounding effect is practically proportional to the wattless component. The chief characteristic of the machine is the commutator. Sparkless running is, of course, of the first importance, and this is attained by an interesting arrangement explained below, and higher commutator voltages can safely be employed than were permissible in the case of the asynchronous machines. In spite of the comparatively high brush voltage, the small size of the commutator, and the fewness of the segments, the working is as satisfactory as in the best continuous-current machines.

It is well known that, in order to regulate synchronous alternators for constant voltage, the excitation must vary practically with the wattless component of the current, so that the commutator in these machines is distinguished from that in the asynchronous machines by the fact that it must pass only this component round the magnet winding. As, however, the arrangements for compounding are similar in the two types of machines, and in order to

* Translation of an article by E. Kolben in *Elektrotechnische Zeitschrift* for Oct. 8, 1903.

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point out the advantages of the newer type, it will be well to give a short description of the asynchronous machine first. Consider an asynchronous machine simply arranged for self-excitation, but not for compounding. The action can be followed by means of Figs. 1 and 2. Fig. 1 is a development of the rotor which is supposed to have a two-phase winding, slots 1, 1, 1 being the slots per pole of one phase and 2, 2, 2 those of the second phase. The instantaneous position of the poles is shown at N and S S—*i.e.*, phase 2 lies in the centre of the pole, so that the field must be produced by the current in phase 1, and the whole magnetising current must, therefore, be supplied to phase 1.

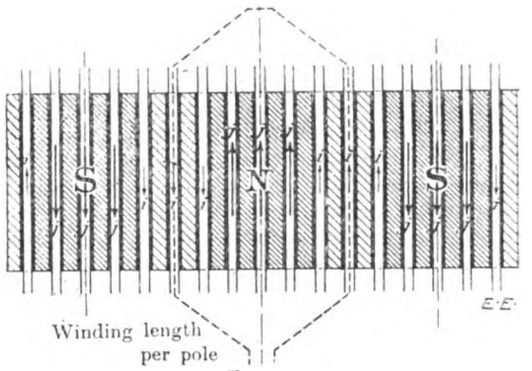

FIG. 1.

If a non-inductive load is now taken from the machine, the stator currents will divide at the pole centre—*i.e.*, they will be opposite to phase 2 of the rotor—and in consequence of the slip of the rotor field produced by the load, currents, J, will be induced in phase 2 of the rotor, and these currents will be equal and opposite to the stator currents.

It will be seen from Fig. 1 that the winding space is employed to the best possible advantage, half the winding (phase 1) carrying the magnetising current and the other half (phase 2) the power current. If the load taken from the synchronous machine is inductive, on the other hand (Fig. 2), the stator current will no longer flow at the middle of the pole, but at a point 90deg. in phase from it—*i.e.*, it will flow in those stator conductors which are opposite to phase 1. In order to counteract the armature reaction, the exciting current in phase 1 must be increased by an amount equal and opposite to J. No current

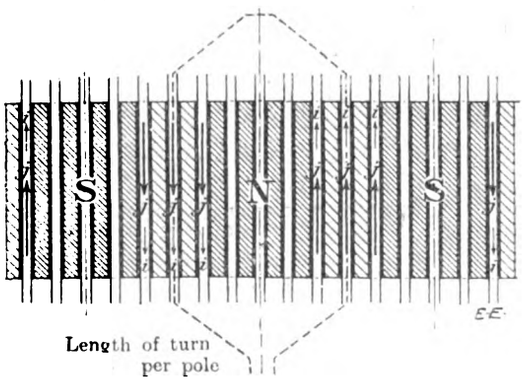

FIG. 2.

due to slip will be induced, however, so that phase 2 will carry no current. The whole rotor current, power current, as well as magnetising current must, therefore, be supplied by phase 1 alone, thus making the current division and the employment of the winding space the worst possible. This is one reason why the asynchronous machines were better suited for non-inductive loads than for inductive ones. It is obvious that if a given machine were excited by a continuous current half of the copper might be omitted, since phase 2 would carry no current on inductive load, and so would be superfluous. A purely wattless load is, however, only a limiting condition which is never quite attained in practice. On the whole, however, it is evident that the advantages of the asynchronous machine fall off as the wattless currents increase.

In order to consider the effect of replacing the asynchronous rotor (Fig. 2) by a suitably arranged ring of projecting poles, the total flux per pole, the air-gap, and the ampere-turns of the machine may be assumed to be practically alike in the two cases. Supposing the machine had six slots per pole, the iron section of each field pole would correspond to that of four teeth. Phase 2 is omitted, and the four neighbouring teeth may be combined into a single polar projection. This results in a ring of poles as shown developed in Fig. 3. Circular poles are chosen, as they are well suited for the proportions mentioned, and permit of a very decided reduction in the average length of turn per pole. With the dimensions chosen this length will hardly equal half its previous value. Supposing that the copper section per pole remains unchanged, the weight of copper, owing to the omission of phase 2 and the halving of the mean length, would be reduced to one-quarter and the copper loss in the rotor to one-half the previous values. These

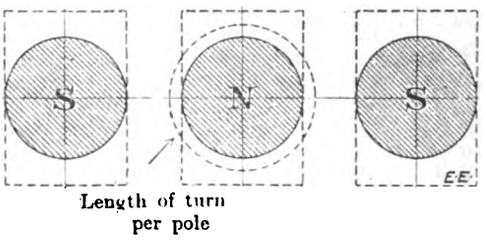

FIG. 3.

results are, however, rather too favourable, as no allowance has been made for the greater leakage which occurs in synchronous machines, and which would necessitate a slightly greater core section, length of turn, and number of ampere-turns. Still, it is always possible to reduce the rotor copper and rotor losses by at least half, as compared with the compounded asynchronous machine. This reduction relatively to the compounded asynchronous machine, is attained by the omission of phase 2 and the good use of the winding space. Relatively to ordinary synchronous machines, a saving is also attainable due to the compounding permitting smaller air-gaps, weaker fields, and greater armature reactions to be employed.

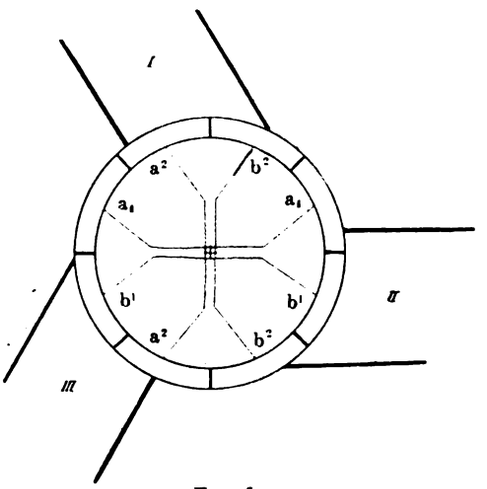

FIG. 4.

In order to explain the method of compounding these new machines, reference once more to the arrangements of the asynchronous machines will be of use. Fig. 4 shows the connections of a two-pole asynchronous machine with a two-phase rotor. The separate phases in the recent constructions consist of wires wound in parallel, in order to avoid sparking of the commutator by preventing the occurrence of appreciable magnetic leakage between them. The main current of the machine is delivered to the separate phases either at right angles to or in the same direction as the field, according as the current in the stator is power current or wattless current. In this case, for instance, in accordance with Figs. 1 and 2, phase 1 carries the wattless component and phase 2 the power component of the current at the instant shown.

(To be continued.)

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NOTES.

De Forest Wireless Experiments.—Mr. De Forest has commenced his experiments in this country under the auspices of the Post Office. They are being carried out between Howth in Ireland and Holyhead, and are reported to have so far given successful results. Messages are sent at the rate of 25 to 35 words a minute. It is stated that although there is a Marconi station at Holyhead about three miles from the De Forest station, no interference with or disturbance of the messages sent to and from Howth was noticed.

West Indian Cable Breakdown.—The West India Committee has addressed a letter to the Colonial Secretary on the subject of the constant breakdowns of the telegraphic communication with and between the British West Indian Colonies. In it they say that in the last four or five months the situation has become aggravated. On no less than five occasions during the present year the Trinidad-Demerara cable has broken down, and it is unnecessary to emphasise the serious inconvenience and loss which has thereby been incurred.

Tramways and Light Railways Association.—The members of this association and those to whom invitations have been issued will meet on Dec. 11 to hear an address by Mr. Atherley-Jones, K.C., M.P., the president of the association, on "Fiscal Policy in Special Relation to the Tramway and Light Railway Industry." Sir C. Rivers Wilson, G.C.M.G., the past-president, will take the chair at eight o'clock at the Society of Arts, John-street, Adelphi, and a discussion and vote will follow, in which several well-known gentlemen in engineering and commercial circles are expected to take part.

Obituary.—We regret to hear of the death of Colonel F. Pescetto, the local hon. secretary of the Institution of Electrical Engineers in Italy. The deceased gentleman was a prominent figure during the Italian visit last summer, and he earned the gratitude of every individual member of the party for the exceeding kindness and courtesy he displayed on that occasion. Mr. R. Kaye Gray at the last meeting of the Institution made a sympathetic reference to the late colonel, describing him as an "exceedingly kind-hearted and gentle man." In his profession Colonel Pescetto was director of the electric works at Genoa.

Yorkshire College.—A determined effort is being made to convert this institution into a university. The only difficulty in the way is the raising of the necessary funds. The Lords of the Committee of the Privy Council have had the matter under consideration, and they have agreed to recommend the grant of a charter on the understanding that the West Riding County Council makes a substantial subvention towards the university, and that the promoters undertake to raise a capital sum of at least £100,000 by the earliest possible date. There seems to be some difficulty in deciding on the name which the new institution shall bear, but doubtless this will not be allowed to stand in the way of the ultimate consummation of the scheme.

St. Louis World's Fair.—A profusely illustrated and informing handbook has been issued by the St. Louis Gottsschalk Printing Company giving a general and concise description of the arrangements for the St. Louis World's Fair to be held in 1904. Mr. Chas. M. Kurtz, Ph.D., assistant chief in the department of art, is responsible for the compilation of the book, and he is to be congratulated both on its excellent get up and the general usefulness of the information which it contains. In the section devoted to this country we find it stated that the British Government will erect a pavilion, the main hall and the principal front of which will be modelled after the orangery, or banqueting hall, of Kensington Palace. Beyond the banqueting hall will be an inner court ornamented with fountains and statuary.

The Engineers' Club. — Under this title a new association has been formed for the promotion of social intercourse between members of the engineering and allied professions. A smoking concert was held at the Westminster Palace Hotel on Friday last, and the programme at present arranged includes a children's party, followed by a cinderella dance, at the Caxton Hall, Westminster, on Saturday, Dec. 12. An attractive list of other social gatherings to follow is being gathered. The club has been founded under the auspices of the Junior Institution of Engineers, but membership is open to the profession generally upon proper introduction. It is hoped in the future to be able to engage permanent rooms, so that members may enjoy the usual advantages of a clubhouse. Mr. Fred. S. Pilling, 20, Victoria-street, Westminster, S.W., one of the joint hon. secretaries, will be pleased to answer any enquiries.

The Osmium Lamp.—Dr. W. Wedding, professor of the Technical College, Berlin, has made a report on some tests he has carried out in order to determine the life and economy of the osmium lamp. In the experiments two groups, consisting of six 37-volt lamps each, were connected in series across a 220-volt circuit. In group 1, for the first 3,132 hours the average life of the six lamps was 2,853 hours, and the average candle-power fell from 30·1 to 23·7. The mean consumption per candle-power rose from 1·46 to 1·78. After 520 hours the first lamp collapsed, and after 3,724 and 3,940 hours respectively two others gave out, the remaining three still burning after 3,973 hours. In group 2, which consisted of six 25-c.p. lamps, the report gives the average life as 1,479 hours, the candle-power dropping in 2,198 hours from 25·1 to 19 9, and the energy consumption increasing from 1·37 to 1·75 watts per candle-power. These excellent results give ground for hope that lamps of this character may be turned out before long in commercial quantities and at commercial prices.

Technical Education in London.—The Technical Education Board for the county of London have prepared a report showing the growth of technical education so far as it is connected with the five schools and institutions managed by the Council. The total number of students attending the classes at these schools was 2,053 at the end of October last, compared with 1,633 in 1902—an increase of 420. Improvers, learners, and apprentices under 21 years of age are admitted to the classes free, whereas other students pay 10s. per session, with the exception of artisans or working women earning less than 30s. a week, who pay 4s. 6d. per session. It is gratifying to notice that at each school the free students attend for a larger number of hours than the paying students, and the percentage of those who make over 20 hours' attendance per session is in each institution greater in the case of the free students. The American Ambassador has consented to present certificates to the county scholars, and the presentation will take place on Jan. 29 at the Queen's Hall. It has been arranged to hold the annual conference of teachers at the South-Western Polytechnic from Jan. 7 to 9, further particulars of which will be published in due course.

New Books.—Messrs. Whittaker and Co. will publish shortly "Electric Traction: A Practical Handbook on the Application of Electricity as a Locomotive Power," by Mr. John H. Rider, chief electrical engineer to the London

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County Council tramways. The work will deal with the various systems of construction of, and the apparatus, generating plant, etc., used in, electric railways and tramways.—"Directory and Map of Automobile Charging Stations" (The "Electrical Times," Limited. Leather, 3s. 6d.; cloth, 2s. 6d.). The directory contains particulars of upwards of 700 places in the United Kingdom where the batteries of electrically-propelled automobiles and the ignition accumulators of petrol-driven cars may be recharged, the information given including such useful details as the hours of business, the current available, price charged, and whether repairs can be carried out and garage given. The map shows clearly all the main roads, while all the places mentioned in the directory are marked in various ways according to the nature of the facilities offered. The work is of special value in the case of electric vehicles, for it is easy with the aid of the map and directory to plan out a tour and be certain of obtaining facilities for charging *en route*.

Railway Electrification.—It will be remembered that in the abstract we gave in our last issue of a long article under this title appearing in the *Times*, the hint was thrown out that if electric supply companies in London were in a position to provide the necessary electrical energy, the question of converting the suburban steam railways to electrical working would be very much simplified. Mr. R. Stewart Bain, the managing director of the London Electric Supply Corporation, has written a letter to our contemporary, in which he states that in about a month's time his corporation will be in a position to supply electrical power on a large scale for traction purposes similar to those described in the article. The Deptford power station of this corporation, one of the largest electric generating stations in the country, is situated in close proximity to three of the southern railways, and from that station it would be possible to obtain a supply of electric power to work the suburban traffic of any or all of these railways at a price less (owing to the variety and extent of the load at the station) than it could be produced by the railway companies separately or jointly. The saving effected in capital expenditure to the latter from such an arrange ment is obvious.

The Ramsgate Dilemma.—The Ramsgate Corporation have been much exercised for the past fortnight on the question of electric lighting. The Isle of Thanet Light Railways Company and the Ramsgate and District Electric Lighting Company are both applying to the Board of Trade for electric lighting provisional orders, and both have applied to the Corporation for their consent. It greatly grieved the members of the Corporation that they were not allowed to have both schemes, but they were informed by the Board of Trade that competing orders would not be granted. From the information we have received, the light railways company offered the more favourable terms for private supply, and the electric lighting company the better proposals as to purchase. We presume that it is due to this latter consideration that consent has been granted to the application of the electric lighting company. Without more detailed information, however, it is useless to criticise the decision of the Corporation, and we would only say that it seems a pity to multiply electric supply undertakings in one district. The light railway company have their works in full swing, and could with their better load factor give economically the cheaper supply promised.

Institution of Electrical Engineers.—The next meeting of the Institution in London on Thursday, the 10th inst., falls on the three hundredth anniversary of the death of William Gilbert, and the Council have decided to mark the occasion by a fitting ceremonial. The Mayor and other representatives of the borough of Colchester will attend officially at 8 p.m. to receive an historical picture (representing Dr. Gilbert in the act of showing his electrical experiments to Queen Elizabeth and her Court), which will then be presented by the Institution to the borough of Colchester, in which town Gilbert was born in 1544, and died in 1603. At the conclusion of the presentation an ordinary general meeting will be held, at which the following paper will be read: "The Slow Registration of Rapid Phenomena by Strobographic Methods: The 'Ondographe' and 'Puissancegraphe' (Wave Recorder and Power Recorder)," by E Hospitalier, president of the Société Internationale des Electriciens. M. Hospitalier will also give a demonstration of the ondographs. If time permit, the following paper will then be read: "On the Magnetic Dispersion in Induction Motors, and its Influence on the Design of these Machines," by Dr. Hans Behn Eschenburg. We would remind our readers that the annual dinner takes place the night before at the Hotel Cecil.

Electric Discharges in Gases.—The current number of the *Journal* of the Chemical Society gives a short abstract of a paper by Mr. W. R. Carr on the laws governing electric discharges in gases at low pressures. Paschen has found that with spherical electrodes and a given spark potential the gaseous pressure at which an electric discharge occurs is inversely proportional to the distance between the electrodes. The author, using parallel plate electrodes in a uniform field, extends the application of the above law to a number of gases (air, hydrogen, and carbon dioxide) for pressures at, and below, the critical pressure (this being the pressure for which the spark potential has its minimum value). The values of the spark potentials were for all pressures, independent (1) of the size of the electrodes, provided the discharge took place in a uniform field; (2) of the material of the electrodes, iron, zinc, aluminium, and brass being used in turn. Paschen's law appears to be applicable so long as the distance between the electrodes is greater than the diameter of the sphere of molecular action. The minimum spark potential varies with different gases, but is a constant for a given gas, independent alike of the gaseous pressure and of the distance between the electrodes. From the author's results it seems that the minimum spark potential is a property of the atom rather than of the molecule; for any selected gas its value may be calculated additively.

Noise of Electric Tramcars.—In a leading article a few days ago the *Times* called in question the noise made by the running of electric tramcars. We know that in some cases this trouble has positively amounted to a nuisance, which frontagers on the line of route have been powerless to prevent. It is usually during the first months of operation only, however, that complaints are made on the score of noise, as witness the case of the electric cars in West London. Mr. J. Williams-Benn has written to our contemporary inviting its leader writer to take a trip on one of the London County Council electric cars and, by practical illustration, be convinced of the error he has fallen into by assuming that trams run on the conduit system are equal offenders with cars driven by the overhead trolley in respect of noise. Mr. Benn says he will discover that the conduit system is much quieter than the overhead. In the latter case there is the grinding of the rails plus the noise of the trolley wire. Indeed, the noise of the conduit system, as now running, does not compare unfavourably with the rumble of the horse cars—*i.e.*, if the clatter of the horses' hoofs be taken into account. As to the "nuisance" to the district, Mr. Benn says the fact remains that all the boroughs in

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the south are clamouring for an extension of this "nuisance" at the earliest moment. The letter concludes: "So far as our information goes, property has perceptibly appreciated. It is difficult to understand why a beautiful and clean electric car should depreciate property more than a lumbering and dirty horse car. Anyway, our experience is that north and south the people 'want more' London County Council electric trams on the conduit system."

Rugby Engineering Society.—This is the title of a new society which has established itself in the Midlands. The scheme was promoted by the Rugby staffs of the British Thomson-Houston Company and of Messrs. Willans and Robinson, Limited, but anyone interested in engineering is eligible for membership. The society already numbers some 350 members, and has as its first president, Mr. W. J. Larke, and as vice-presidents, Messrs. C. H. Wingfield and F. Samuelson. The two hon. secretaries are Mr. E. R. Briggs and Mr. C. C. Wharton respectively. The first ordinary meeting was held on Thursday evening, Nov. 5, when an interesting paper was read by Mr. F. Samuelson on the "Curtis Steam-Turbine," the paper being illustrated by half-size sectional drawings of a 500-kw. turbo-generator running in the British Thomson-Houston power-house at Rugby, as well as by curves showing the steam consumption, etc. The paper itself is a most interesting one, and gives clearly the principles involved in the Curtis steam-turbine. A great point is made of the fact that the steam consumption per kilowatt-hour is wonderfully uniform over a wide range of load. The reason for this is that the turbine is of the impact type, and the governing over a range of load is effected by varying the number of nozzles actually in use. We hope to give a full extract from the trial figures in this paper at an early date. The second meeting on the 19th ult. was devoted to a continuation of a discussion on the paper, and a very complete reply was given by Mr. Samuelson. The third meeting was held yesterday, when a paper was read by Mr. D. P. Thomson on "The Central London Railway."

Electric Motors at Hackney.—Mr. L. L. Robinson, the electrical engineer to the metropolitan borough of Hackney, has just issued an interesting pamphlet on the application of electric motors to commercial purposes. The object of the publication is to increase the demand for electric power, which has already reached considerable dimensions in the borough. Although the supply of electricity was only commenced at the end of October, 1901, there are now 147 motors connected to the mains with an aggregate horse-power of 537. The information given in the pamphlet is interesting from many points of view, and the consumer will specially value the figures given on p. 17 of the average quarterly accounts with various classes of consumers. These are worked out as the average cost per brake horse-power per quarter, and come surprisingly low in a number of instances. Thus, one firm using electric motors for an engineering workshop with lathes, circular saws, etc., finds the average cost only £1 per horse-power per quarter, or £4 per annum. Ore-crushing plant, working longer hours, of course, costs more, and it is likely that this plant uses more regularly the rated output of the motors. The charge for electrical energy in Hackney used for driving motors has been reduced from Oct. 1 last to the following rates: 2d. per unit for all consumption up to 1,000 units per quarter, and 1½d. per unit for all electrical energy used in excess of this quantity. As the Council have not the powers to let motors out on hire, they have entered into an arrangement with the Rhodes Electrical Manufacturing Company to do this for them. The terms set forth on p. 23 give the rates charged under this hire-purchase system on one, two, or three year leases. The quarterly payments in this case include interest and repayment of capital. These terms will be of service to small users, but many firms will prefer to buy their equipment outright after reading the results that have been obtained elsewhere in Hackney. The illustrations in the pamphlet leave nothing to be desired, and show a great variety of application of electric motors.

High-Voltage Direct-Current Traction.—At a time when the application of high-voltage alternating current to traction work is being widely discussed, it is interesting to hear of an experiment which Mr. R. Thury, of Geneva, is carrying out in Southern France with a trolley system taking continuous current at 1,200 volts. The line in question extends between St. Georges de Commiers and La Mure, about 20 miles apart, near Grenoble. The main business appears to be freight, and one locomotive is in service at the present time. It weighs about 50 tons, and is of 500 h.p. capacity, there being, in fact, four motors of 125 h.p. capacity each, two on each truck. These are connected in series, and each require 185 amperes at 625 volts. The line is equipped on the three-wire system, so that the voltage between the outside wires is 2,400 volts. The road is a grade with slight slope, and the loaded train comes down with the motors arranged to run as generators and act as brakes, being connected to the resistances. For breaking the circuits, oil switches are used. Hauling 20 cars of a gross weight of 111 tons, the locomotive makes a speed of about 22 km. per hour on the 2¾ per cent. grades. The overhead construction is solid, with double contact wires and double sets of Siemens sliding bow contacts, exerting the slight upward pressure of 4½lb. The overhead line consists of two "figure 8" copper wires, 114mm. cross-section, in span on wooden poles. As already stated, the voltage is 2,400 volts between the outside wires, and 1,200 volts between each contact wire and the rail forming the neutral. The resistances employed in association with the controllers are carried in the motorman's cabin, being large enough to absorb easily the electric braking current produced by the locomotive on the descent when the motors are run as generators. The locomotive has also a hand braking system and an air system, for which the compressor is driven by a small motor of 4 h.p. at 1,200 volts. Special care has been taken with insulation in view of the high voltage used. We are indebted for the above particulars to the *Electrical World*.

Conductor Rail Steels.—Before the American Institute of Mining Engineers last month Mr. J. A. Capp read a paper in which he gave the results of tests made with the object of drafting an original specification for third-rail steel. Steels of as wide a range of composition as could be obtained were tested, and the results are given in various tables and diagrams. The T-section rail is the outcome of designs intended to present the greatest life and strength of the section with the least weight of the metal, but, on the other hand, one of the chief requirements of the third rail is an ample cross-section to carry the current without an undue drop in potential. The strength of the section is of little moment. Bearing this in mind, a section of a conductor rail has been designed by Mr. W. B. Potter which, when 2·5in. wide by 4in. high, will weigh about 98lb. to the yard. A dovetail at the bottom provides an easy means of securing the rails by fishplates of special form, and any of the common forms of bond may easily be applied. From the tests carried out by Mr. Capp on the influence of special additions to steel upon its electric conductivity, it appears that manganese preponderates in influencing the resistance of the steel, and that for lowest resistance manganese must be present in very small quantity, much smaller than is usual in merchant

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steel or structural steel. While all the usual impurities found in steel reduce this conductivity, so great is the preponderance in the influence of manganese that other elements may be tolerated in quantities which the steel-makers would consider reasonable, without unduly increasing the resistance. For a satisfactory third rail the lowest possible resistance, say from 6 to 6·5 times of copper, is not necessary. Assuming, then, that a rail made from steel having a resistance not greater than eight times that of copper is desirable, the specified analysis of maximum impurities allowable should be: carbon, 0·15 per cent.; manganese, 0·30 per cent.; phosphorus, 0·06 per cent.; sulphur, 0·06 per cent.; and silicon, 0·05 per cent. It appears that the wear and tear question is a very serious one. From the remarks with which the author concluded his paper, it seems that the wear and tear on the third rail of the Manhattan Railroad has reduced it by about $\frac{1}{10}$in. since the time of its installation.

The Royal Society.—The anniversary meeting of this society was held at Burlington House on Monday afternoon, when there was a large attendance of Fellows. A feature of the meeting was the presentation of the medals in the gift of the society. Among the recipients was M. Pirre Curie, who received the Davy medal "for the most important discovery of the year in chemistry." The discoverer of radium was accorded a most sympathetic reception. The Hughes medal was awarded to Prof. Johann Wilhelm Hittorf for his experimental researches on the electric discharge in liquids and gases, extending over a period of more than half a century into the present year. An incident of the proceedings was the formal presentation of a subscription portrait of Lord Rayleigh, painted by Sir George Reid. The president mentioned that though one of the more immediate objects of those who conceived the idea of a portrait was to commemorate the distinguished scientist's great services in connection with the foundation and administration of the National Physical Laboratory, it was also intended to mark his secretaryship of the society for 11 years and his labours on several scientific commissions. He further referred to Lord Rayleigh as one of the most eminent original workers of his generation, who had traversed the whole range of physical science, bringing to light its essential principles. Considerable division of opinion was manifested in regard to a successor to Sir Michael Foster, M.P., so long one of the secretaries of the society. The nomination of the council, however, was confirmed by ballot, and Sir Archibald Geikie was declared elected. In the course of his address Sir Wm. Huggins, the president, referred to the loss sustained by the society in the death of Sir Geo. Stokes, to whom, he mentioned, a memorial is about to be erected in Westminster Abbey. An important suggestion made by the president was for the better inter-communication of ideas between the various learned societies in the kingdom, and that the Royal Society's papers should be more speedily published. In the evening a banquet was held in the Whitehall Rooms, at which the president was supported by a large and distinguished company.

Etiquette for Electrical Contractors. — The members of the London Electrical Contractors' Association at their meeting on Tuesday evening were asked to discuss the question "Are we tradesmen?" and some of them did so in no uncertain manner. Mr. J. B. Joseph, who introduced the subject with a short paper, declared that the varied character of the work of electrical contractors entitled them to the dignity of professionals ranking with engineers, and argued that, in keeping with professional etiquette, they ought not to cut their accounts or allow discounts for electrical fittings or to consulting engineers. This led to a fairly spirited debate, and on the first point the meeting was evidently against Mr. Joseph. Mr. Rawlings, for example, bluntly declared that he preferred to be able to buy and sell than to call himself an engineer or a consulting engineer. They were business men—that was the beginning and end of it. Another member (Mr. Bedford) took a similar line, pointing out that professional men were not supposed to advertise. Mr. Rolf, a consulting engineer, argued that this was not a question of professionalism, but a personal matter. He was sure there was nothing in the business of an electrical contractor which would debar him from association with engineers. On the other part of the subject the meeting was certainly with the author in his denunciation of the practice of cutting accounts and allowing discounts, and it was agreed that, in the case of consulting engineers, allowances for professional services ought to be handed direct to them by the principals, and not be included in the contractors' estimates. Another point upon which there was general agreement was that the wiring of a building and the fixings of fittings ought to be carried out by the same contractor, as the contrary practice led to trouble and confusion. A suggestion made by Mr. Rolf, that it should be binding upon all firms who were members of the association not to fix fittings on other contractors' wiring, was rejected as impracticable, but the feeling was expressed that something of the sort ought to be done. We should, perhaps, say that during the debate both Mr. Rolf and Mr. Gaster, another consulting engineer, repudiated any suggestion that consulting engineers received discounts from contractors except such as were provided for in the estimates. We understand that the question of fusion with the Federated Ironmongers' Association is under consideration by this association, having regard to the common interest in electrical fittings of the two trades.

Storage Batteries. — The paper which Mr. W. Hibbert presented to the meeting of the Institution of Electrical Engineers last week, describing experiments conducted by himself on the new Edison secondary or storage battery, has led to an interesting communication being published in the *Times* of the 27th ult. from a correspondent signing himself "Multiple Supply." The object of the communication is to direct attention to a suggested application of Edison's battery outside of the motorcar. In brief, the proposal is that larger batteries of heavier construction than those used for road travelling should be employed as an aid and adjunct to recognised systems of long-distance electrical transmission on railways. In effect, such a system has been devised. The writer thus describes it: An electric locomotive and tender is used, the tender carrying an Edison battery weighing from 15 to 30 tons, according to the speed desired and the weight of the train. If 20 tons of the latest, or 1903, type of Edison battery should be used, then a train weighing 200 tons could be propelled from Victoria to Brighton in 45 minutes or less, or at a speed of 75 miles per hour, by battery power only. In this case, as in all others, the total weight of electric locomotive, tender, and battery would be from 10 to 15 per cent. less than that of a steam locomotive and tender able to do equal service. But as batteries take time to charge, they would be used only as an aid to other means of propulsion, and in the following manner: Current from suitably located generating stations would be conveyed to all trains by a light third rail, this current being either continuous or alternating as desired. This would be used to drive the train through suitable motors, the extra power required in starting from stations and on upward gradients being supplied by the battery current applied to other motors. If the line supply should fail from any cause, then

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the batteries alone would be called upon to propel the train to its destination or to a section of line not in difficulties. To ensure economy of construction, the third rail would be omitted at all sidings, in station yards or tunnels, on bridges, or wherever its use would be dangerous to life, battery power only being used at such points. Without going into the elaborate details which have been fully worked out by competent engineers, the writer says that the first cost of such a system is about one-fourth that of anything now in common use, and much less than that of some proposed high-voltage systems, while in security of operation it is superior to the reliable steam locomotive. Indeed, for an expenditure not exceeding £4,000 per mile of single track, trains weighing from 200 to 350 tons may be operated at intervals of from 10 to 15 minutes throughout the greater part of the day, and at a normal speed of 80 miles per hour, thus practically duplicating the train capacity of most railway lines. The question of efficiency and cost of power supplied to the motor is not treated by the writer.

The Late Sir Frederick Bramwell.—We regret to have to record the death of Sir Frederick Bramwell, F.R.S, which took place on Monday last in London. This eminent engineer completed his eighty-fifth year on March 7 last. The story of his life is one of strenuous and successful labour, and is closely bound up in the progress of engineering. He was apprenticed in 1834 to one John Hayne, who was then making steam-driven carriages to run on the roads, and it was only at the latter part of his life that such self-propelled vehicles gained a place in commercial and private life. In was thus in a "steam-locomotion-on-common-roads atmosphere" that Bramwell's apprenticeship was passed, and he made full use of his opportunities to gather facts and information which might afterwards be useful to him. At that time technical education was a thing unknown, and but few engineers could take advantage of such scientific education as was to be obtained. "Innate love of the profession" and "mother wit" were the sole educational aids available to the engineers of that date. Their success was, therefore, "in a large measure due to the fact that they became engineers literally because they could not help it: that the taste for engineering was born with them, and that their very natures compelled them to follow that taste." We quote Sir Frederick Bramwell's own words, and he was in his own person a remarkable exemplification of them. His extensive and varied information was the outcome of personal observation and experience. Study was uncongenial to him, but his retentive memory rarely lost its hold of any detail which he had seen or had described to him, and his mind became a storehouse of professional learning. Of Sir Frederick's work amongst engineering and scientific societies, it suffices to say that he occupied at one time or another the presidential chairs of all our leading institutions. His work for the Institution of Civil Engineers was most highly appreciated, and he inaugurated the benevolent fund which has done so much good amongst old engineers. Electrical engineering has received much attention from him, as instanced by the many electric works for the design which he was responsible. Of these, the pioneer electric lighting station at Derby was an example, and the inauguration ceremony in connection with the South Wales Electrical Power Distribution Company was one of the latest occasions on which Sir Frederick entertained a large audience with engineering reminiscences. He was a brilliant speaker, and his ready wit helped to enforce his arguments in a most pleasant way. Thus the Institution of Electrical Engineers in London enjoyed last session a most entertaining defence by him of our present system of weights and measures as against the decimal system. The engineering profession as a whole is poorer by the loss of Sir Frederick Bramwell, and his genial humour, clear judgment, and ready wit will be missed at the meetings of the many societies he so regularly attended. A memorial service will be held to-day at St. Margaret's Church, Westminster, at 1 o'clock. This service has been arranged by the Institution of Civil Engineers. Members of other scientific societies are invited to be present.

Radium.—Sir Wm. Ramsay's lecture before the London Institution last week on "Radium and the Periodic Law" was perhaps chiefly remarkable for his declaration that the transmutation of elements as a theory was by no means absurd. The lecturer briefly sketched the outline of the periodic law, which is beginning to suggest some root identity between the various elements, and then told of some practical results that had followed the discovery of this law. Sir William traced the various steps which led to the discovery of radium. Mendelieff, the great Russian chemist, ranged the elements—hydrogen, oxygen, carbon, nitrogen, sodium, the metals, and the other substances of which all things were composed—in the order of their atomic weight. Thus arranged, he showed that substances which came in certain classes had certain properties in common, as, for example, fluorine, chlorine, iodine, and bromine. But there were gaps in this scheme, and Mendelieff predicted that new elements would be discovered to fill the vacant spaces. The fulfilment of that prophecy was one of the greatest scientific achievements of recent years, and each new kind of atom had fallen into and fitted an empty place. In 1894 Lord Rayleigh and Sir W. Ramsay detected argon in the air. Next year Sir William discovered helium, which had been revealed in the sun by the spectroscope before it was found on earth. Two years later, in 1897, when the British Association met in Canada, Sir William Ramsay ventured on the prophecy that other elements like argon and helium would be discovered. He and a scientific colleague justified the forecast. They searched high and low, and finally by means of liquid air they isolated three new elements in the atmosphere—krypton, neon, and xenon—belonging to the same class as helium and argon, and like them inert bodies with no discoverable affinity for others. The professor showed what gases of these substances were like by sending through them an electric current. Their spectra were thrown on the screen, that of xenon, or "the stranger," showing in its entirety the remarkable number of 2,000 distinctive lines. These, it had been said, were inert elements. Their discovery had been followed by the revelation of a class of elements that were remarkably energetic. In 1896 Röntgen discovered the X-rays, and Prof. Ramsay showed a radiograph, the first he believed taken in London by the Röntgen rays. Simultaneously Becquerel, in Paris, discovered that uranium would discharge the electroscope. Madame Curie, following up the investigation, revealed the existence of polonium in pitchblende, and in the same mineral Monsieur and Madame Curie made the momentous discovery of radium—now universally known as the most energetic of all radioactive bodies. But not the only one; there seemed to be six in all—uranium (found by Becquerel), polonium and radium (Monsieur and Madame Curie), thorium (Schmidt, of Breslau), tinium, and an unnamed element (by Gresel). As to what became of radium ultimately, Sir Wm. gave it as his opinion that the infinitely small particles that it threw off eventually lost their radioactivity, and then gave the spectrum of helium. It seemed as if this intensely active element at last turned into helium—thus bearing out the theory of transmutation.

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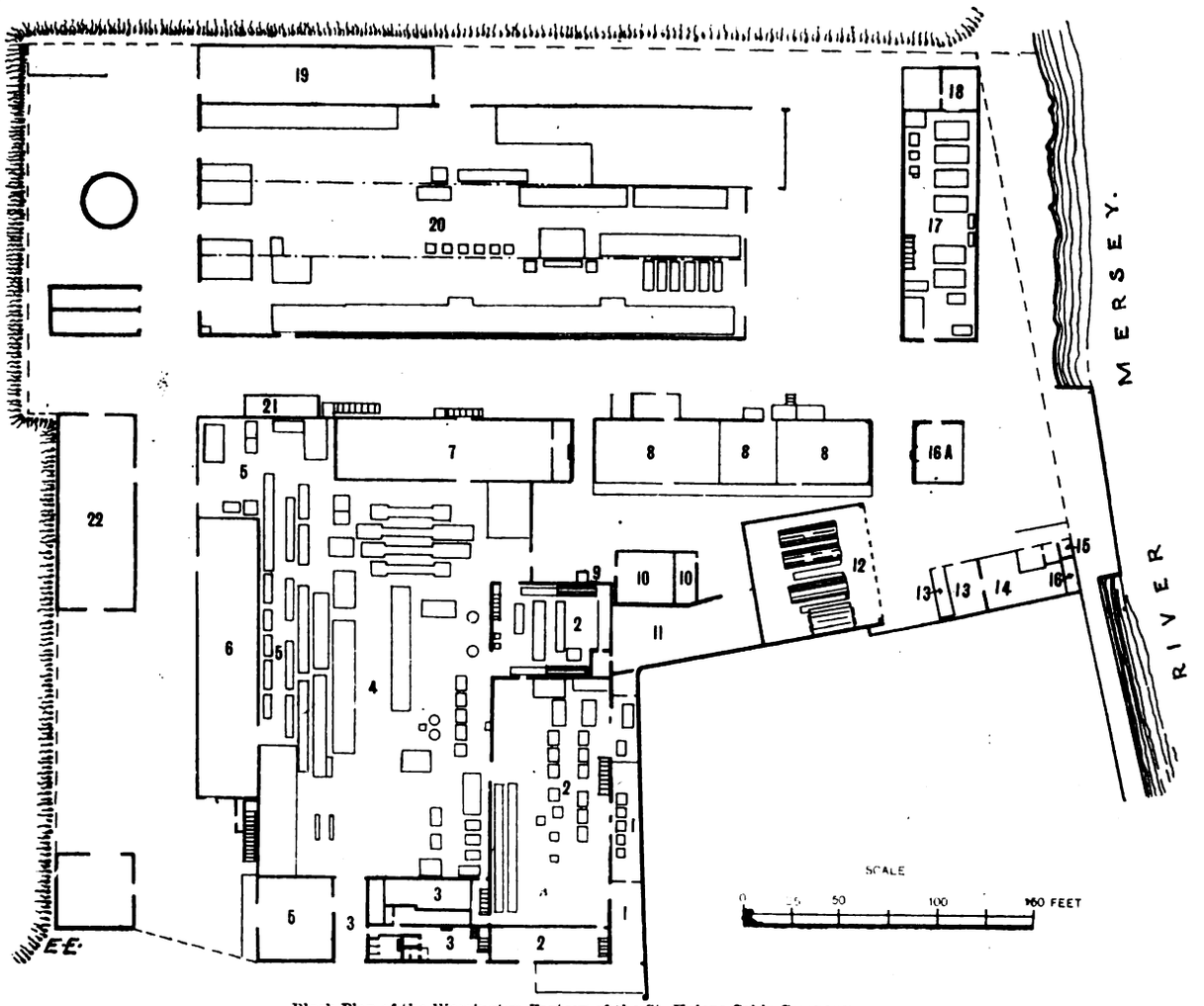
WORKS' VISITS.

I.—The St. Helens Cable Company, Limited, Warrington Factory.

It is not intended that the following article shall be an exhaustive description of the above factory. Passing reference only will be made to the departments engaged otherwise than in the manufacture of electric cables or the preparation of insulation for same. Regarded as a whole, the factory is a striking example of home progress and enterprise. The company originally established themselves at St. Helens, as the title implies, and their Warrington factory may thus be regarded as an overgrowth. Hitherto the Warrington factory has depended upon St. Helens for its wire supplies, but arrangements have now been made, we understand, to render it self-contained in this important respect by the addition of a wire-drawing plant capable of turning out 75 tons per week. The necessary accommodation for this plant is already provided. In the selection of a site for their new factory the company made a particularly happy choice, both the railway and water facilities offered being exceptional. During the past four years the factory has been quadrupled in extent, and the directors have secured 66 acres of the adjoining land with a view to further developments in the future. The company is now under new management, and the complete reorganisation has led to both economies in manufacture and improvement in details.



Block Plan of the Warrington Factory of the St. Helens Cable Company.

The general arrangement of the existing buildings is shown on the accompanying plan, the numbers on which indicate the different shops as follows: (1) raw rubber stores and rubber-washing room; (1A) rubber-buffing room; (2 and 2A) drugrooms and rubber manufacturing department; (3 and 3A) offices and cable-testing room; (4 and 5) electric cable manufacturing sheds; (5A) cotton-covering room for small wires; (6) copper and raw material stores for cable manufacture; (7) engineering department; (7A) joiners' and carpenters' (drum-makers); (8) compound shed; (8) iron and brass foundry; (11) power-house; (11A) finished rubber goods warehouse; (12) boilers; (12A) rubber-drying room; (13 and 14) cable-jointing shops; (15) pump-house; (16A) electric motor repair shop; (17) rubber-spreading shop; (17A) rubber-drying room; (18) laboratory; (19) dry-core cable-testing room; (20) dry-core cable-manufacturing shed; (22) waiting test-room. The lettered numbers refer to first-floor rooms.

Rubber Department.

Upon entering the works we were at once conducted to the rubber department—marked 1 and 2 on plan—which may be regarded as the nucleus of the whole establishment. The first room visited was the raw rubber stores, where a large stock of all the finer grades of rubber is stacked in bins. An average stock of over 50 tons is kept in these stores, representing in itself a large amount of capital. We next entered the boiling and washing section, the raw rubber being first boiled in large tanks containing a special solution, and then passed successively through a massive three-roll crushing mill, washing and sheeting mills, until thoroughly cleansed from all impurities. After this treatment the rubber is stored away in large drying chambers, kept at a constant temperature of 110deg. F., where it remains for some weeks until the sheets are matured. We then proceeded to the mixing section, where the various qualities of rubber are made up and consigned to the mixing mills. This is an important operation, and only the most skilled operatives are engaged in it; thereby ensuring the best results for the various purposes. Subsequent to the mixing process the batches of compound are rolled out, through one or other of the three large calenders available, to the required thickness. It should be mentioned that the machinery in this department is of the latest and most up-to-date kind. The calenders and mixing and washing mills are arranged on three main shafts. The first of these shafts is driven by a 200-h.p. engine, and carries six

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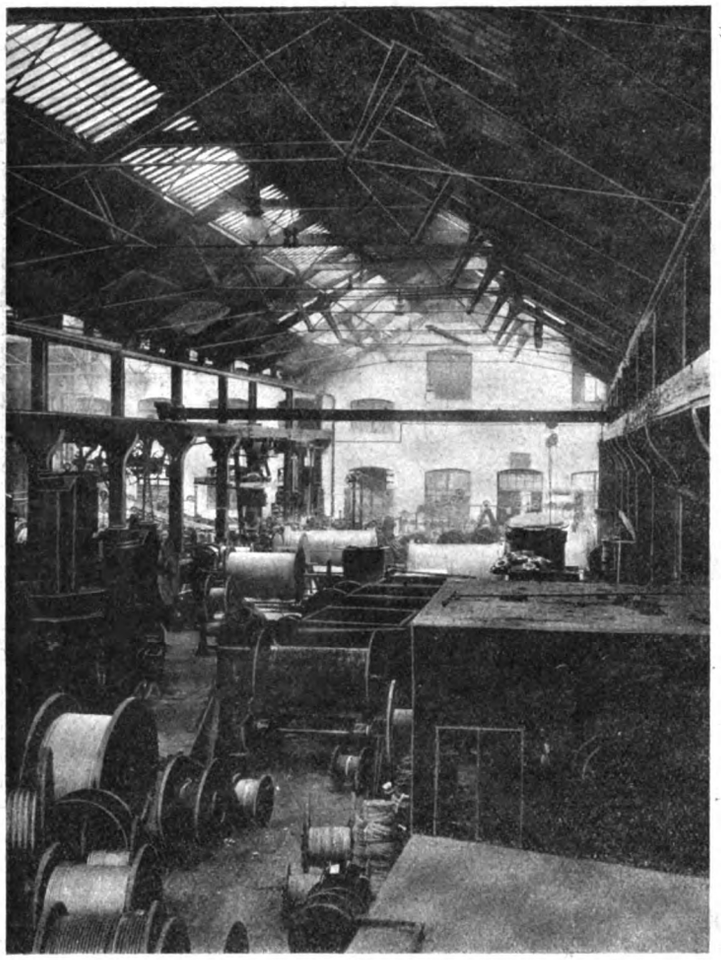
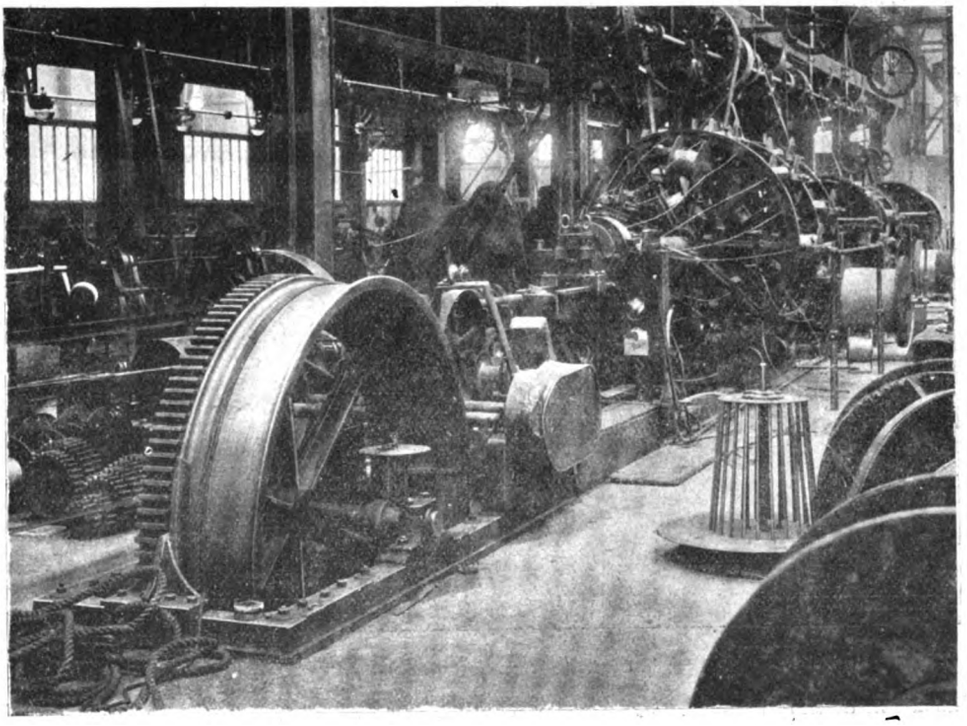
mixing mills and one three-bowl calender; the second shaft, driven by a 350-h.p. engine, carries three small



Bay in the Main Cable Shop.

washing mills, one large two-roll washing mill, one large three-roll washing mill, one mixing mill, and one three-bowl calender; while the third shaft, driven by a



Stranding Machine in Main Cable Shop.

120-h.p. electric motor, carries three mixing mills and one three-bowl calender. Although primarily intended to provide the cable branch with its requirements in compound

for the manufacture of vulcanised cables, this department has also established a reputation for mechanical and other rubber goods, of which the factory yields an enormous output. This fact has an important bearing upon the organisation of the factory, which is invariably busy in some when not in all of its branches. In the same building other machines were turning out cab tyres, tubing, etc. The manufacture of the firm's cab tyres alone keeps a large

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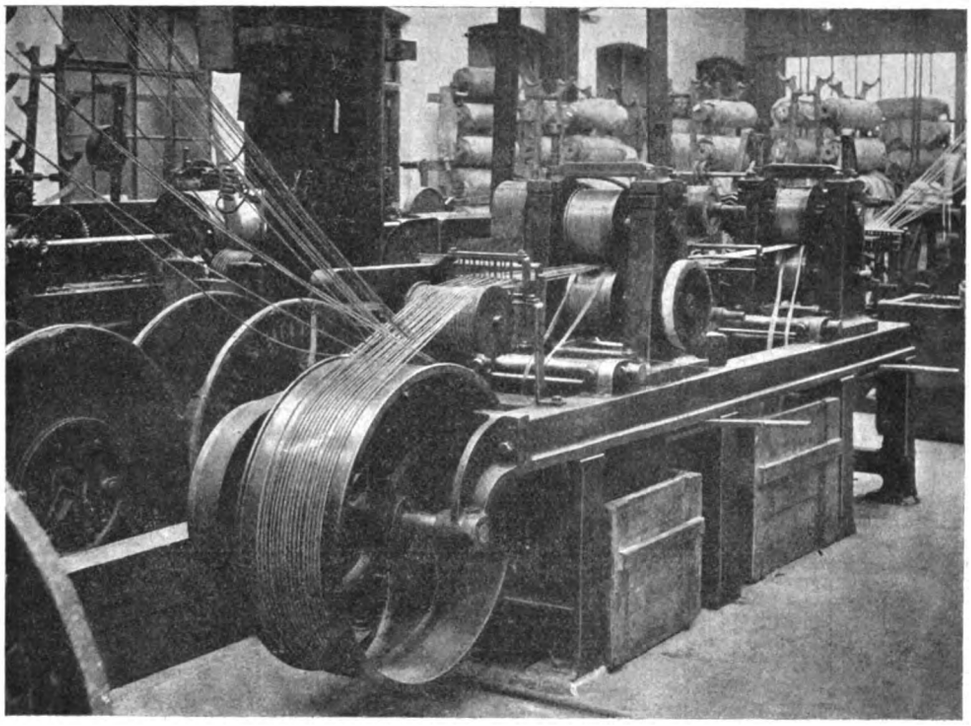
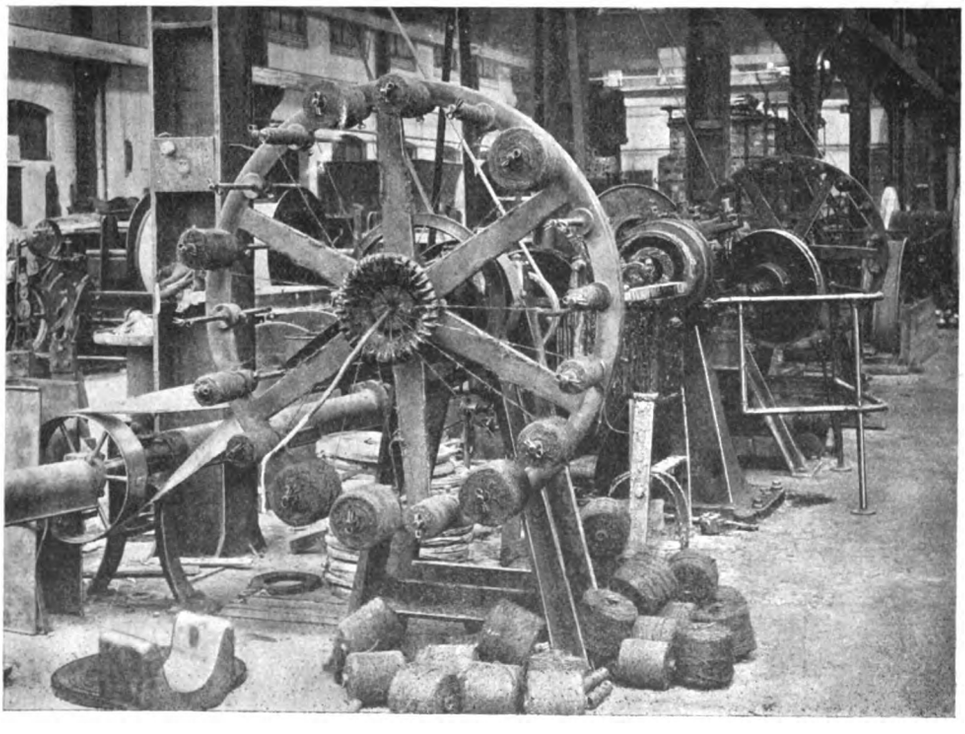
number of hands employed, several tons of these tyres being dispatched from the works weekly. Having witnessed, for our own satisfaction, the operations which the production of this class of goods entails, we passed on to the press and curing shops. Here we were surrounded by vulcanising pans, hydraulic and belt-driven presses of all shapes and sizes, accumulator and powerful hydraulic pumps, etc. Thence we proceeded to the moulding room and witnessed the manufacture of a bewildering array of rubber goods of every conceivable description—balls, buffers, pedals, blocks, insulating materials, etc. The next move was to the mechanical rubber section. Here we saw large rolls of sheets and insertion, valves, washers, cylinders, rubber gloves, mats, etc., and more vulcanising pans, together with large drums for lapping sheets. Then we came to the lathe and buffing room, with its long line of lathes of various patterns and designs, sewing machines, leather-cutting and rolling machines, packing making rolls, etc. It may be explained here that some of the rooms mentioned in the foregoing, and others of which subsequent mention will be made, are situated on the first floors of the respective branch buildings to which they belong, and are consequently not shown on the accompanying plan. From the last-mentioned room we crossed the yard to a new building—marked 17 on plan. This is the rubber-spreading shop, and contains seven splendid steam-heated spreading machines, with their necessary accompaniment of dough mills, masticators, etc, all electrically driven. Here operatives were spreading sheets of pure rubber and all kinds of insulating tapes and cloths. Overhead is a large chamber for maturing the pure sheets; also a well equipped laboratory, entered through a fire-



Longitudinal Machine in Main Cable Shop.



Armouring Machine in Main Cable Shop.

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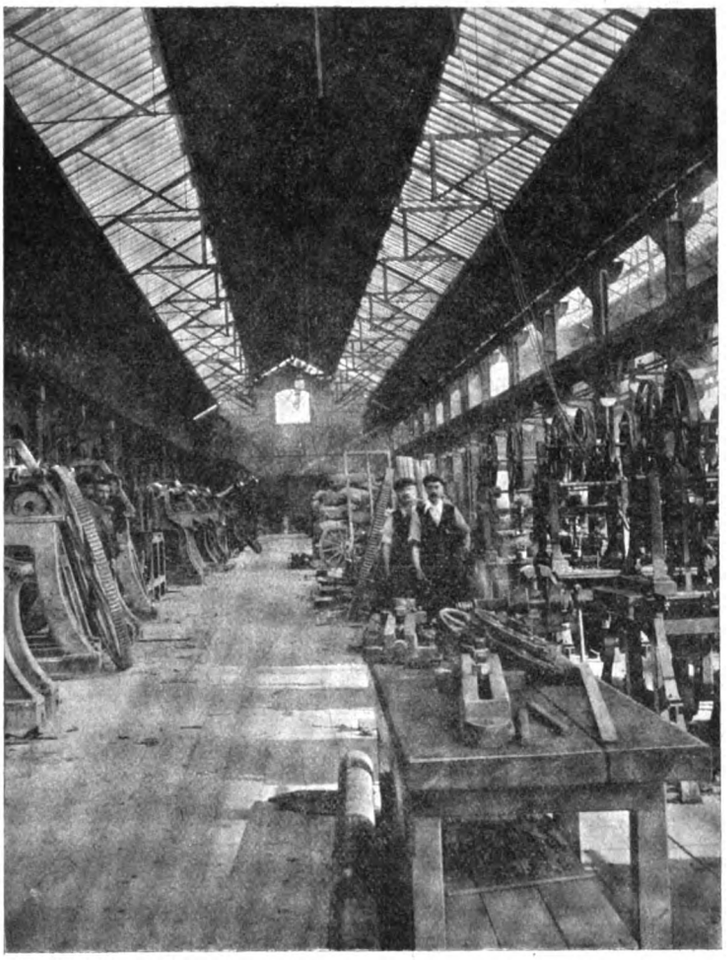
proof door. This laboratory is under the control of an expert chemist, and contains all the necessary apparatus for experimenting and testing the firm's various products and proving the quality of raw materials before these are passed into the factory. Among other apparatus we noticed delicate specific gravity balances, a powerful Zeiss microscope, experimental mixing mills, and calenders, etc. The material stores next claimed brief attention. These are extensive, and contained a large stock of fabrics—such as linen, cotton, flax, hemp, jute, etc.—for the various purposes of the factory.

Cable Department.

Proceeding, we arrived ultimately at the cable department itself. Cables are the firm's principal manufacture, and the factory has been designed with a view to the efficient and speedy handling of all sizes, ranging from the smallest instrument wire to the largest power or telephone cable. Roughly speaking, this department consists of three shops, with stores and testing-room conveniently arranged, so that delays and labour handling are reduced to a minimum. These shops may be designated respectively the main cable shop, the dry-core cable and paper insulating shop, and the cotton and silk covering shop. The two first-mentioned occupy the positions marked 4-5 and 20 on the accompanying plan, and measure 280ft. by 140ft. and 300ft. by 120ft. respectively, while the third—a first-floor shop, and consequently not shown on the plan—measures 280ft. by 40ft. As regards equipment, these shops are laid out with a complete plant of modern machinery.

The main cable shop is traversed throughout its entire length by four electric gantries, and contains plant for the manufacture of cables with single, concentric, or triple-concentric conductors, either paper, rubber, or dialite insulated, and for lead covering and armouring the same as follows: one triple-concentric Bulmer stranding machine to lay up 37 single wires in one operation; one 18-bobbin high-speed strander; one 6-bobbin high-speed strander with four heads; four longitudinal compound rubbering machines to deal with 8, 12, 18, and 24 wires respectively; seven pure rubber covering machines; one 4-headed and two 5-headed dialite insulating machines; one 3-headed paper and taping machine; one 4-headed taping machine; one 4-beaded vertical taping machine; four 24-spindle braiding machines; eight 18-spindle braiding machines; one steel-taping machine, fitted with two jute serving heads and two compounding tanks; three rubber-cutting lathes; one lead press with 20in. to 8in. diameter ram; one lead press with 26in. to 6in. diameter ram; one lead press with 26in. to 8in. diameter ram.

The lead presses enumerated in the above list are worked by electric motor-driven pumps, supplying water at a normal pressure of $1\frac{3}{4}$ tons per square inch, and each is capable of covering any cable up to 3in. diameter. Serving this shop there are also three vulcanising pans, each of which will take a 9ft. by 4ft. 6in. drum of cable; five steam-heated ozokerite tanks for impregnating purposes, each of which will take a 8ft. by 5ft. drum of cable; and four long ozokerite tanks for compounding small cables.



Bay in Dry Core Shop.

The dry-core cable and paper-insulating shop is laid out more especially for the manufacture of telephone cables and paper-insulated cables generally. It contains at present the following plant: one large telephone cable laying-up machine; 40 vertical papering heads for telephone wires; 12 telephone wire-pairing machines; four 24-spindle braiding machines for braiding telephone cables; 12 Keighley stranding and papering machines; two four-headed papering and tapering machines; one six-headed vertical high-speed strander; one four-headed vertical high-speed strander; one 12-bobbin closing juteserving and compounding machine; three vacuum drying ovens for telephone cables; one continuous hydraulic lead-covering press with 26in. to 8in. diameter rams, supplied by a set of electromotor-driven pumps.

As might be surmised on referring to the dimensions given elsewhere, this shop is not yet fully equipped. The wire-drawing plant, of which previous mention has been made, is destined to ultimately occupy one bay, while new

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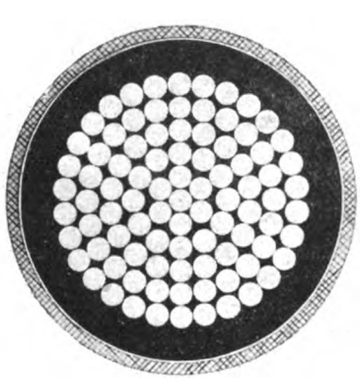
machinery is to be added, we understand, to increase the works output of rubber and dialite insulated cables. In close proximity there has just been erected a gas-producer plant, with the necessary provision for storage, designed to supply gas for heating purposes. This plant may be said to represent the latest addition to the works.

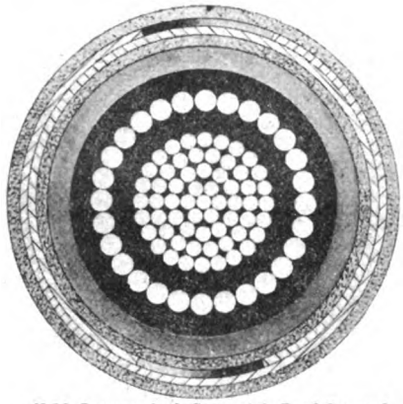
The equipment of the *cotton and silk covering shop* is as under: 32 pure rubber coating machines; 96 16-spindle, 24 24-spindle, six 20-spindle, four 32-spindle, one 60-spindle, and one 28-spindle braiding machines; 32 silk-covering machines; 80 cotton-covering machines; one 19-bobbin, one 7-bobbin, and one 4-bobbin stranding machine; three flexible stranders. As its name implies, this shop is devoted entirely to the manufacture of cotton and silk covered wire for armature winding, bells, telephones, etc. It is capable of supplying every description of cotton-covered and braided wire, strip, and cable, and has an output of many tons per week.

It is beyond the scope of this article to describe the various machines comprising the equipment of these works, but to one at least must be accorded more than passing mention. We refer to the telephone cable laying-up machine installed in the dry-core cable and paper-insulating shop. This machine consists of three sections, each capable of being driven separately, or the whole driven together by a 50-h.p. electric motor. It is designed to lay up a 306-pair telephone cable, or, if necessary, even larger cables, at one operation, and occupies the whole of one bay, 300ft. by 40ft.

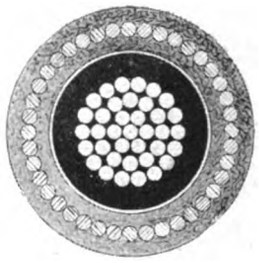
No description of this department would be complete without reference to the testing equipment provided. The galvanometers are all of the highly sensitive D'Arsonval



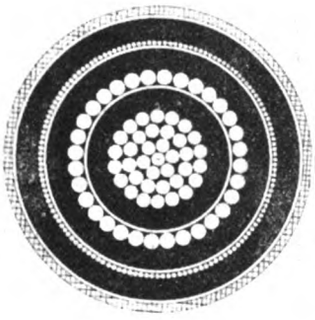
91/118 Standard Single-Core Cable.



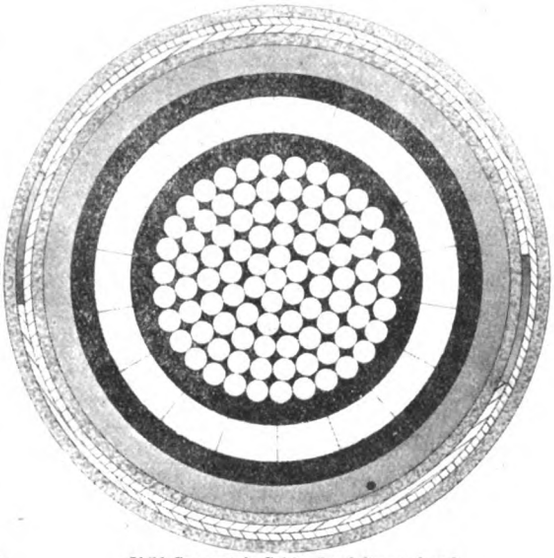
61/14 ·3 square inch Concentric Lead-Covered and Armoured Cable.



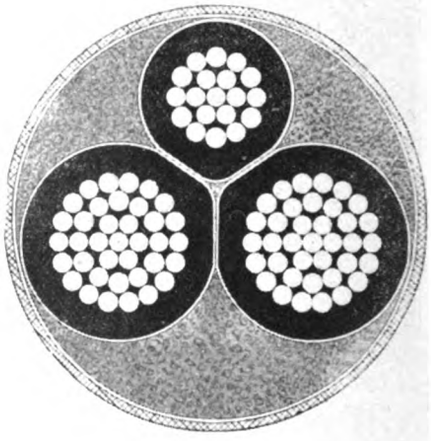
Single Conductor Armoured Cable.



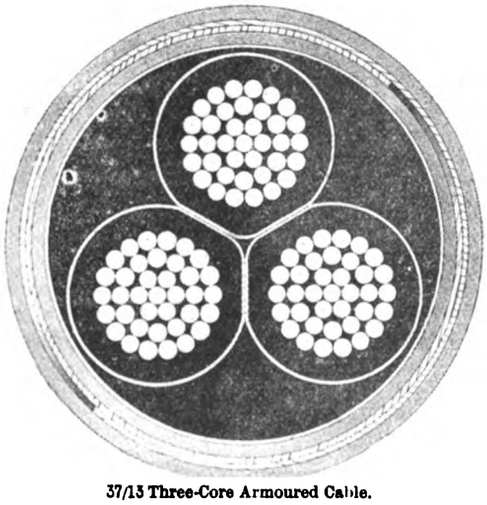
·15 square inch by ·075 square inch by ·15 square inch Triple-Concentric Cable.



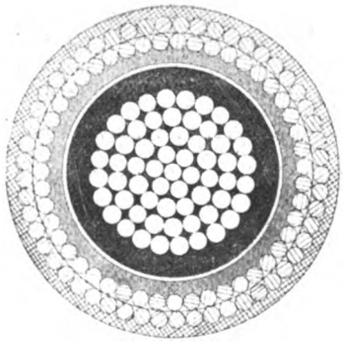
91/11 Concentric Cable, Lead-Covered and Armoured with Segmental Copper for Outer Conductor.



·3 by ·3 by ·15 Three-Core Cable.



37/13 Three-Core Armoured Cable.



61/13 Single-Core Armoured Cable.

7/15 Twin Cable with Lead Covering and Compressed Cores.

Typical Full-Size Sections of Standard Cables Manufactured by the St. Helens Cable Company at Warrington.

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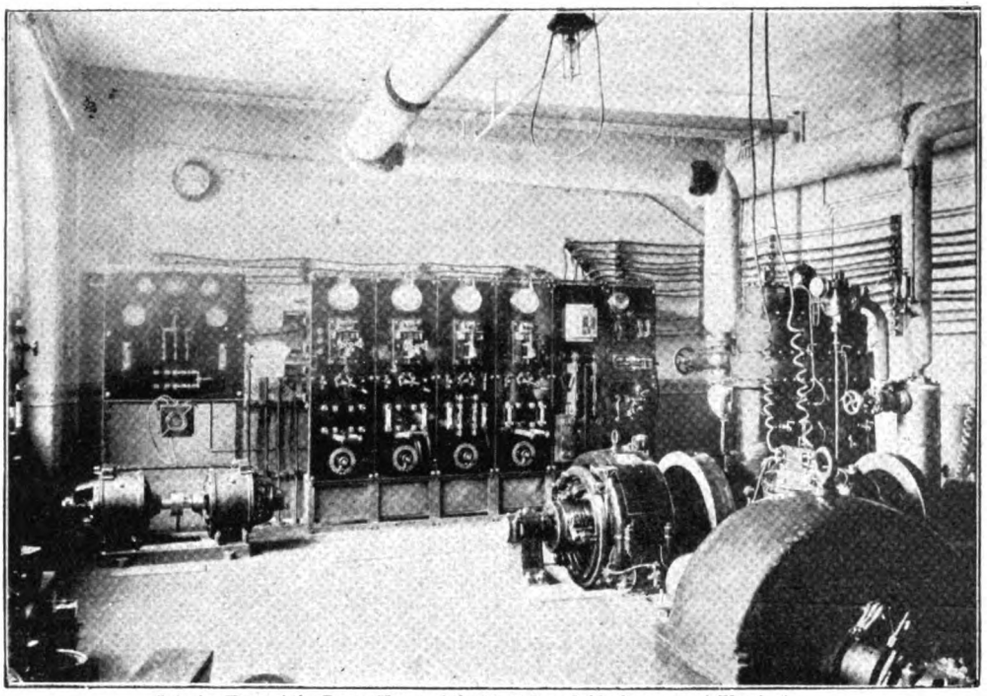
type, mounted on substantial brick pillars, the test keys being mostly of the well-known Rymer-Jones pattern. The pressure to each set is 600 volts, which may be sub-divided at will by means of elaborate battery commutators. All the tables on which the sets are mounted are of special design with a view to economising space. The high-

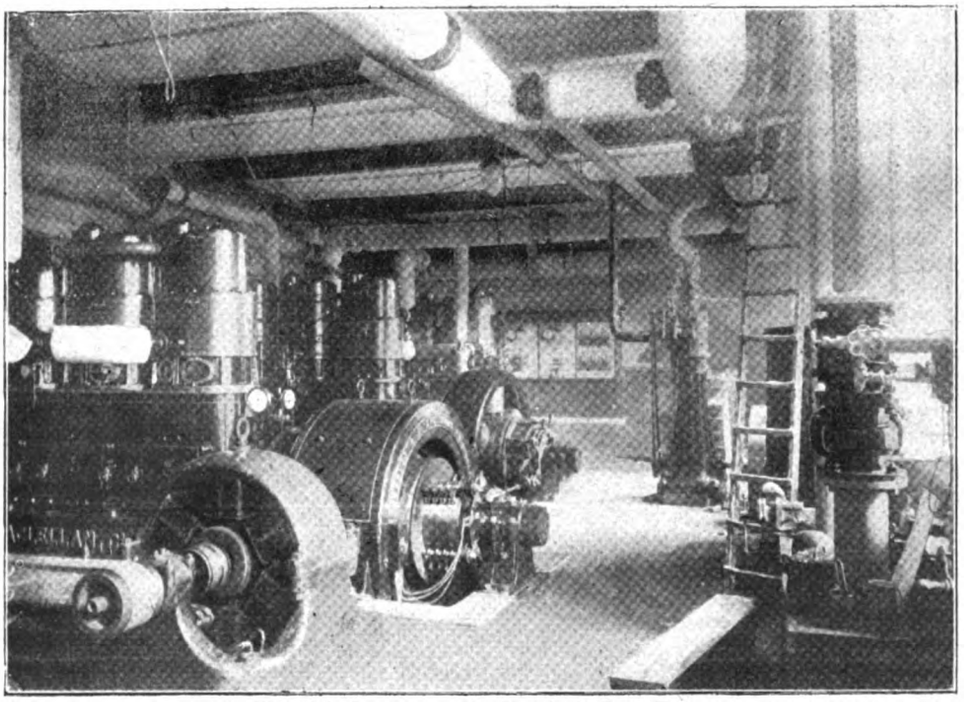


Interior View of the Power House of the St. Helens Cable Company at Warrington.

potential testing apparatus consists of a large alternator and step-up transformers, an electrostatic voltmeter for reading up to 5,000 volts, and a large Kelvin balance for still higher pressures up to 100,000 volts. There is no lack of tank room, eight large tanks being in daily use for the immersion of cables and wires. All results of tests are permanently recorded, and can at any time be quickly turned up for reference.

appreciated by many of the leading collieries in the United Kingdom. Dialite cables have also been largely used in connection with a number of public electric lighting and traction schemes. It may be explained here that dialite is bitumen vulcanised by a special process. We were shown through the rooms in which the crude materials are boiled down, also the subsequent manufacture of the product into sheets of insulation bearing a very strong resemblance in texture and mechanical properties to rubber. Among others, Mr. Wordingham and Mr. Adams, of Glasgow, have reported upon dialite insulation for cables, the results of the tests given being eminently satisfactory in every respect.

At the time of our visit to the works there were on the



View of the Larger Generating Plant in the Power House.

Of the company's various manufactures, dialite insulated cable takes the first place in importance, being a speciality which has come rapidly into prominence of late. The most important claim made in favour of this cable is that it is absolutely non-hygroscopic, thereby obviating the necessity for lead sheathing. It is, therefore, peculiarly suitable for colliery work, a fact which has been deservedly

machines, in various stages of progress, many large cables destined for ultimate use in this and other parts of the globe. Our particular attention was called to a concentric cable of one square inch sectional area, paper insulated and lead covered, made to the order of one of the Colonial Governments; also to a three-core dialite insulated cable intended for colliery work. The feature of the latter cable

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is that the interstices between the insulated cores are filled with dialite insulation instead of the usual jute or hemp worming. The result is that, after vulcanisation, the conductors are enveloped by a solid homogeneous mass of dialite. Sections are reproduced herewith of one of the cables which were going through the different shops at the time of our visit. These will convey an idea of the variety of cables made to recent order.

Auxiliary Departments.

Brief reference may be made to the engineering department of the works, marked 7 on the accompanying plan. This is laid out for the repair of any class of machinery in the factory, and the manufacture of light insulating machines generally. The smithy attached contains two hearths and a pneumatic hammer. A joiners' and carpenters' shop is provided for the manufacture of cable drums and executing general repairs. There is also an iron and brass foundry, 80ft. by 30ft., marked 8 on plan. Joint-boxes are made here, also fittings and castings used in making the machinery erected in the engineering shop, etc. Attached is a 50cwt. cupola, blown by a Root's blower, direct coupled to an electric motor; also a 3cwt. open-hearth brass furnace, six brass crucible furnaces, and a complete sand-blast plant. It now remains to deal with the power and lighting plant, which is no small item in an establishment the size of that under notice. On our way to the power-house we gave the dispatch department brief attention. This department is interesting, in that it represents the final stage in progression to which all cables, etc., manufactured in the works come, and it is here that we get a vivid idea of the amount of work turned out by the factory per day. In this connection mention may be made of the fact that the packing-room has had to be enlarged recently in order to meet growing requirements. Although a railway station practically adjoins the factory, the need has been felt of a direct railway connection, as the method of dispatch by cart to the station is, especially for large and heavy consignments, at times inconvenient. Hitherto the factory has lacked such connection, but this defect will soon be remedied, as the London and North-Western Railway Company are, concurrently with the widening of their main line to the North, putting in a private siding. When this work is accomplished, the St. Helens Cable Company will be in a position to reap the full advantage of a site inherently good. The bulk of the raw materials consumed by the factory, including coal from the neighbouring collieries, is water borne, and enters the works from the quayside.

Power and Lighting Plant.

It is on this side that the power-house is established. The steam-producing plant consists at present of three Lancashire and one Babcock-Wilcox boilers, each capable of evaporating on an average day load 8,750lb. of water per hour. Superheaters are fixed in the down-take at the back of the boilers, and two Green's economisers are in use, the scrapers being driven by electric motors. Condensing plant of the most approved type is also installed.

The engine-room equipment includes one British Thomson-Houston 230-kw. dynamo, one Bruce-Peebles 205-kw. dynamo, and one Lancashire Dynamo Company's 86-kw. dynamo, each of these dynamos being coupled direct to an Alley and Maclellan's high-speed compound single-acting engine. In addition to this plant there are two engines of the same type and make as the above, aggregating 500 h.p., driving the shafting for the rubber mills direct.

As regards the design of the electric installation a noteworthy feature is the entire separation of the power and lighting circuits, separate switchboards being used for each. The lighting current is distributed from a three-wire system at 230 volts pressure, the generators being wound for 460 volts corresponding to the pressure in the power mains. A General Electric Company's balancer is used for balancing the three-wire system. Throughout the factory there are about 80 motors in use, ranging in power from 3 h.p. to 120 h.p. These are employed for driving line shafting or cranes and machinery direct. The supply is conveyed to the different buildings by underground mains in earthenware ducts and by overhead-line conductors.

Our thanks are due to the company's secretary (Mr. F. Kenyon) for assistance rendered in the preparation of the above article, and to their energetic works manager (Mr. H. R. Garrard) for his courtesy in conducting us over the factory.

INDEPENDENT TELEPHONY IN GREAT BRITAIN.

BY GARDNER AND HOLME.

(Continued from page 803.)

(7) Junction and Trunk Lines.

As already mentioned in a previous article, in order to connect up for communication the various outside villages with the main exchange, junction wires become necessary. These junction lines generally diverge from the main exchange, as will be seen on reference to Fig. 1. It will also be seen that while two exchanges are entirely isolated, the others (two) are in the same direction, thus reducing the cost of construction and maintenance.

In the erection of the junctions for Portsmouth, which were excessively long, only two main routes were necessary to connect up six outside exchanges. Junction lines generally start at the termination of the main underground cables, and are then carried overhead on creosoted wood poles along the main turnpike roads or highways where wayleaves are accessible, the wayleaves being obtained from the county and district councils; but where engineering difficulties are experienced in the roads through obstacles and trees, application is made to the private owners of the several properties over which the line of the poles is proposed to be erected. Difficulties are seldom experienced in the obtaining of these consents if the landowners are approached in the first instance and agreement entered into. A form of application is shown in Fig. 35.

In taking up this work, the engineer-in-charge should begin by making a preliminary survey, and being provided with a complete set of Ordnance maps (6in. to the mile), he should walk or drive over the different roads along which it is proposed to erect these lines. As soon as the route to be followed is decided upon, application should be made to the local authorities at once in order to save delay. From the information collected the private wayleaves are generally ascertained, but in order to save many difficulties it is best to obtain the services of a good local man in the obtaining of these, as he will be thoroughly acquainted with the district. Following the preliminary survey, a detailed plan should be made up after the following manner: (1) the position and number of the poles as near as possible; (2) particulars of crossings; (3) methods of staying the poles; (4) private consents required; (5) the means obtainable for laying-out the poles by traction or cartage, traction being by far the best and cheapest method. The detailed plan or working survey is the key to the success of the whole operation, and if prepared thoroughly will save time, expense, and many alterations after the work has been completed, and will show the foresight and experience of the engineer by the appearance of the line.

The surveying engineer should be accompanied by the foreman who is to take charge of the work and a few labourers to mark off the proposed position of the poles and measure up the lengths of the spaces between each pole. These positions might be marked by driving in hardwood pegs into the ground painted on top with white paint. This method cannot always be relied upon, and a better one is to draw up a survey book entering all information while on the spot, such as landmarks on the road, for future guidance. Fig. 36 shows a useful form of book. A will give the number of each pole consecutively from terminal or distributing pole at cable end to the exchange pole at the village proposed to be connected; B the position of the pole in the roadway, hedge line, or bank, this being a guide to the hole diggers in case of the marks being lost; C the length of the pole in feet, extra or special poles being marked accordingly; D the distance in yards between the poles; E the number and position of the stays. F, the remarks column should be as large as possible in order to note down all special information as to consents, single and double line stays, and all such points that will be of service to the

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——— Corporation Telephones.
Town Hall,
.....190

To.....

.....

Sir,

In consideration of your permitting us to.....

.....

.....

we undertake to make good any damage which may be done to the said property, either in the execution of our work or in repairing or maintaining same, and to remove said .....within six months after receipt by us of notice in writing requiring us to remove same. We further undertake to make good any damage which may be occasioned by such removal.

.....Manager.

——— Corporation Telephones.

To the Manager,
——— Corporation Telephones.
Town Hall, ———.

Sir,

Referring to the terms of the undertaking of the corporation of date .....consent to the corporation

.....

.....

on condition that they will make good any damage which may be done to the said property, either in the execution of the work or in repairing or maintaining the same, and that they undertake to remove the said .....within six months after receipt by you of notice in writing from.....requiring such removal, and that they further undertake to make good any damage occasioned by such removal.

Signature .....
Address .....
Date .....

Fig. 35.

foreman when carrying out the work. The survey should be so complete that anyone would be able to follow without difficulty the proposed route. In selecting the side of a road, the line should be kept as straight as possible, and the side chosen clear of obstacles and trees, preventing as much as possible the overhanging of the centre of the road in long spans with the wires. An

Survey Book.

A No. of pole.	B Position.	C Height.	D Spans.	E Stays, if any.	F Remarks.

Fig. 36.

necessary to the fitting of struts. Consents should be obtained on the printed forms, signed and dated, verbal consents not being legal and always leading to disputes and trouble. The license granted to the authority by the Postmaster-General generally confers with it wayleave powers, but it is important that accurate information be obtained as to the owners and occupiers whose consent is necessary to the erection of a line. All information of the local authorities controlling the highway should also be recorded, and the Telegraph Acts of 1863 to 1892 understood before taking any risks. The consents and survey being made up, a schedule should be prepared from the details and plan, showing the stores and materials necessary to carry out the junction work, and also an estimate of the cost.

Hole Digging.—This part of the work might be let out to contract at a price per hole, under the supervision of the foreman, who could mark off the holes, giving instructions as to position of digging and depth, and so arrange the works as to keep the hole diggers well in advance of the erecting gang. The holes generally are dug in line with the wires so as to get the solid earth on both sides of the pole. Poles should be buried to the usual depths, and the

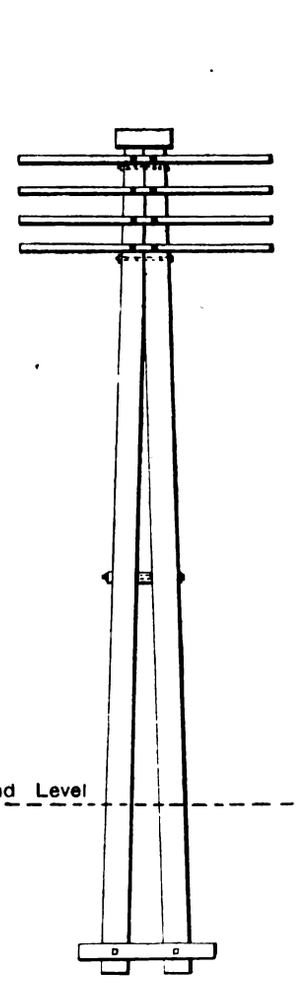

Fig. 37.—A Pole.

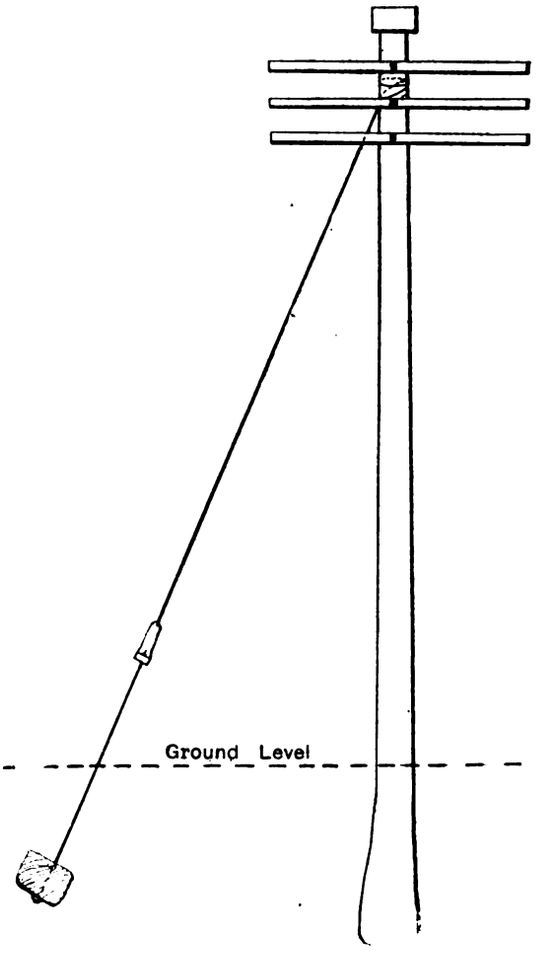

Fig. 38.—Pole, showing stay and method of fixing.

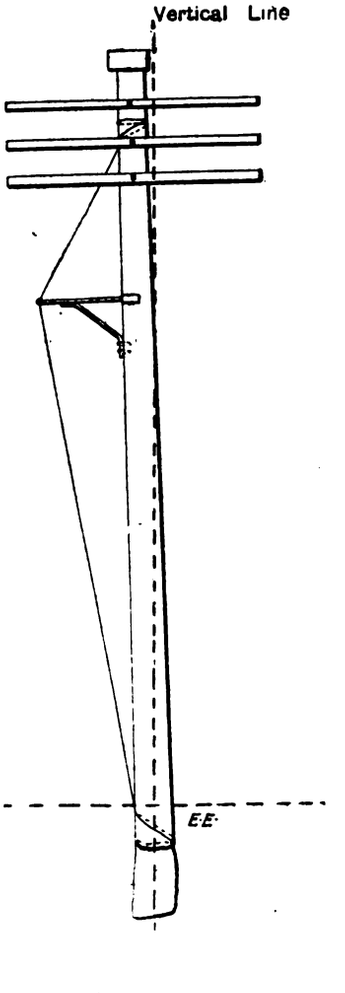

Fig. 40.—Pole with Outrigger.

irregular line of poles is unsightly, and always leads to comment. Poles should be kept regular both in height and distance apart, well stayed, strutting being avoided. It is often better to cross the road and stay back the poles to avoid strutting, as workmen do not give the attention

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foreman given a written copy in order that he can check each pole, the poles being marked and dated 10ft. from the butt. For creosoted poles in ordinary soil the following depths for planting will be found adequate for junction lines:

DEPTHS FOR PLANTING WOOD POLES.

Length of pole.	Depth in ground.	Length of pole.	Depth in ground.	Length of pole.	Depth in ground.
26ft. ...	4ft. 0in.	... 36ft. ...	5ft. 0in.	... 50ft. ...	6ft. 0in.
28ft. ...	4ft. 3in.	... 40ft. ...	5ft. 3in.	... 55ft. ...	6ft. 6in.
30ft. ...	4ft. 6in.	... 42ft. ...	5ft. 6in.	... 60ft. ...	7ft. 0in.
32ft. ...	4ft. 9in.	... 46ft. ...	5ft. 9in.	... 65ft. ...	7ft 3in.
34ft. ...	4ft. 9in.	... 48ft. ...	5ft. 9in.	... 70ft. ...	7ft. 6in.

Erecting.—For junction lines creosoted poles of from 26ft. to 45ft. will be found ample in height, the local circumstances, clearance, and number of wires governing each individual case. For this class and size of pole ladders will be found the best for erecting, the ladders being made specially for the work. The poles should be set well against the pull of the wires; 12in. on the head of the pole from the vertical line will be found none too much on sharp angles, and in special cases poles might be blocked with timber 4ft. by 6in. by 6in., to keep them from coming over with the pull, about 12in. or 18in. below the ground line and also at the base. This method should be adopted in soft marshy soil and bog land. The soil around the poles should be thoroughly rammed and punned during the filling in, and all surplus soil removed. Holes should never be left open unguarded or during the night, and the work should be organised so that all poles are erected for the number of holes dug out during each day. On very sharp angles and where staying powers are impracticable A poles are best, and form a very rigid structure, as shown in Fig. 37.

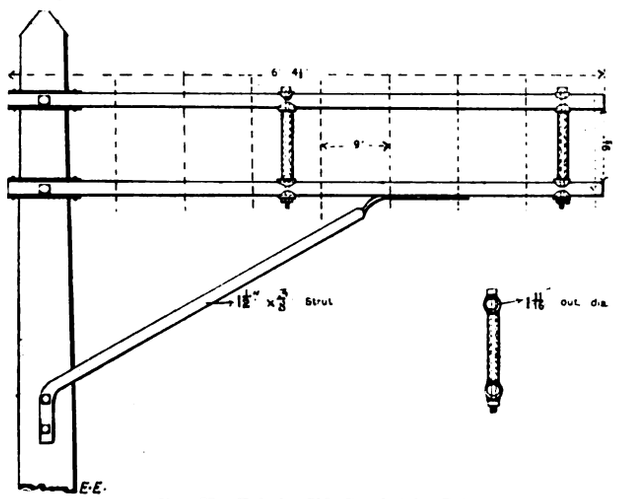

FIG. 39.—Tubular Side Bracket for Pole.

Mounting.—The mounting of the poles is generally done by a gang of men in advance of the hole diggers and erectors, as it requires care and time to fit and mount poles correctly, and none but good men accustomed to the work should be employed. Immediately following the laying-out the mounting gang ought to follow up and fit the poles with roof, earth wire, and arm. The mounting gang should be given instructions as to the fitting—that is, in the fitting of the galvanised iron roofs or finials, the side of the pole to earth wire for the protection against lightning, the number of slots to cut out for the arms, and the number of holes to bore out for bolting the arms to the pole. It has always been found good practice to cut and bore out more slots than are necessary for present use, while the poles are on the ground. Fig. 38 shows the necessary fittings with stay fixed ready for wiring. Fig. 39 shows the method of wiring a pole to clear trees where it is impossible to get through with open wires in the ordinary way. Where this method is adopted the poles should be set well back and rigidly stayed against the weight of the arm and wires.

Staying.—As already mentioned, this is done to prevent a pole being pulled over with the angle of the wires. Special stranded galvanised wire is used for this purpose either of iron or steel, $\frac{5}{8}$ or $\frac{7}{8}$ wires, being twisted together. Iron is better and more suitable for the work. In the fixing of stays on a pole they should always be clear of the arms, so that the arms are free for removal at any time. The following table gives the relative properties of galvanised iron and steel wires for staying purposes:

S.W.G.	Breaking strain.
No. 8	1,600lb.
,, $\frac{5}{8}$ strand	5,800lb.
,, $\frac{7}{14}$,, ...	5,820lb.

Poles should be stayed at every angle and line stayed every quarter of a mile, the most efficient position for fixing being the middle point between the upper and lower arms. The lower end of the stay should be attached to a stay tightening rod, these rods generally running 6ft. to 8ft. in length, and from $\frac{5}{8}$in. to 1in. in diameter. They ought to be buried in the ground 3ft. 6in. to 6ft., a large block of timber being used and fitted to the stay rod, acting as an anchor to the stay, the hole being undercut so as to get the block of timber well under the solid earth. The stay should be given as large an angle as possible, the base being a half to two-thirds the height of the resultant point above ground. Where this distance of base is not obtainable a stay bracket might be used and fitted, as shown in Fig. 40. Care should be exercised in the fitting of all stays to see that they will not come in contact with the wires, and at the base or ground line they ought to be protected by a blind post well painted.

(To be continued.)

A NEW COMPOUNDED THREE-PHASE GENERATOR.*

(Concluded from page 832.)

In the synchronous machine the pole winding is single phase, phase 2 being omitted. The current supplied to the

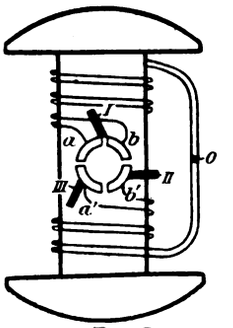

FIG. 5.

commutator is the whole main current, and the connections of the pole winding to the commutator must be such that, on the one hand, the separate brush circuits are never interrupted and, on the other hand, the current in the pole

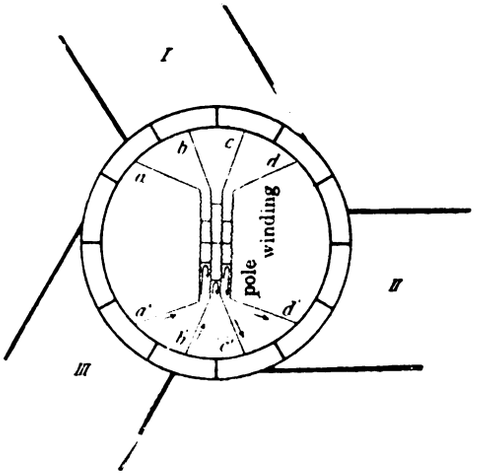

FIG. 7.

winding rises and falls proportionally to the wattless component of the main current. This is attained in the following manner: the pole winding consists, not of a single

* Translation of an article by E. Kolben in *Elektrotechnische Zeitschrift* for Oct. 8, 1903.

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wire, but of two or more wires wound in parallel throughout their whole length, and these are connected to a commutator having a number of segments per pole corresponding to the number of parallel windings, interspersed, however, with

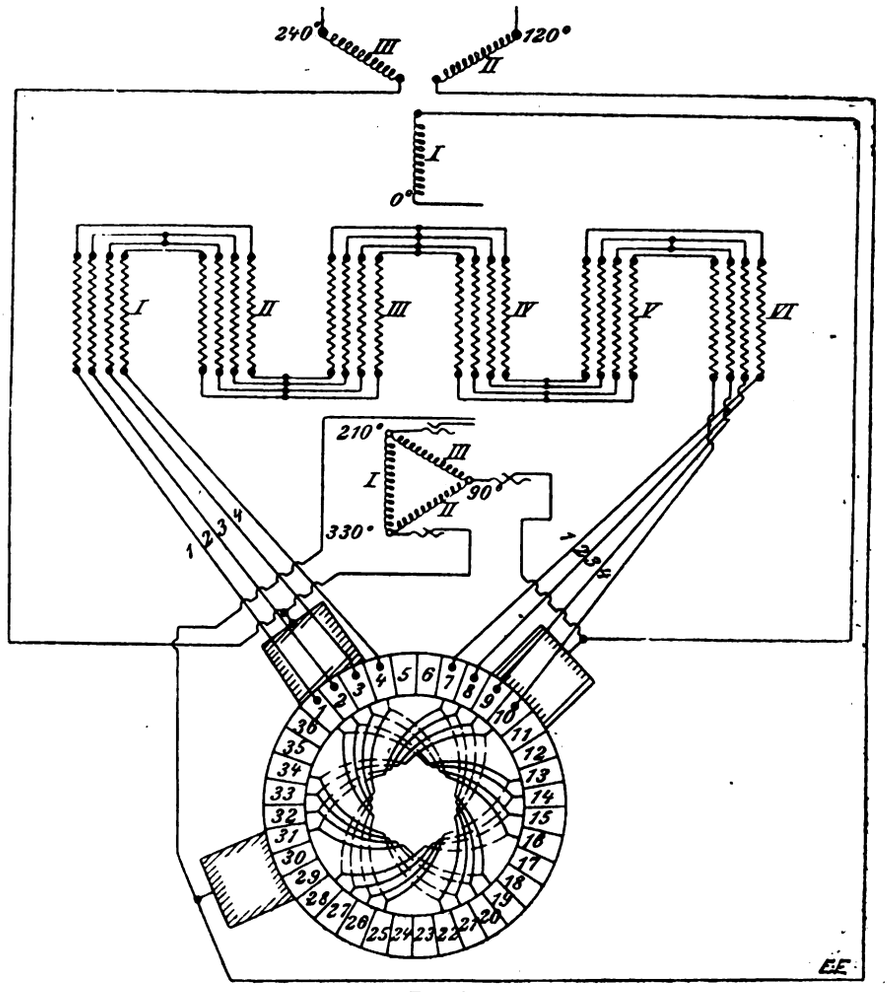

FIG. 6.

dummy contacts not connected to the windings at all. The simplest case is that shown in Fig. 5. The pole winding here consists of two parallel wires which are connected to the commutator, and also connected together in the middle at the point 0. The brushes are so set that the wattless currents

brush I, through the two wires, *a* and *b*, to the two ends, *a'* *b'*, and back through brushes II. and III. A power current may at the same time flow through the commutator, but would not produce any magnetising effect on the pole,

for it would flow from brush III. through *a'* to 0, and *b'*, and back through brush II.—*i.e*, it would flow in both the wires, *a'* 0 and *b'* 0, in opposite directions, and so produce no effect

Sparking is prevented at this commutator by the fact

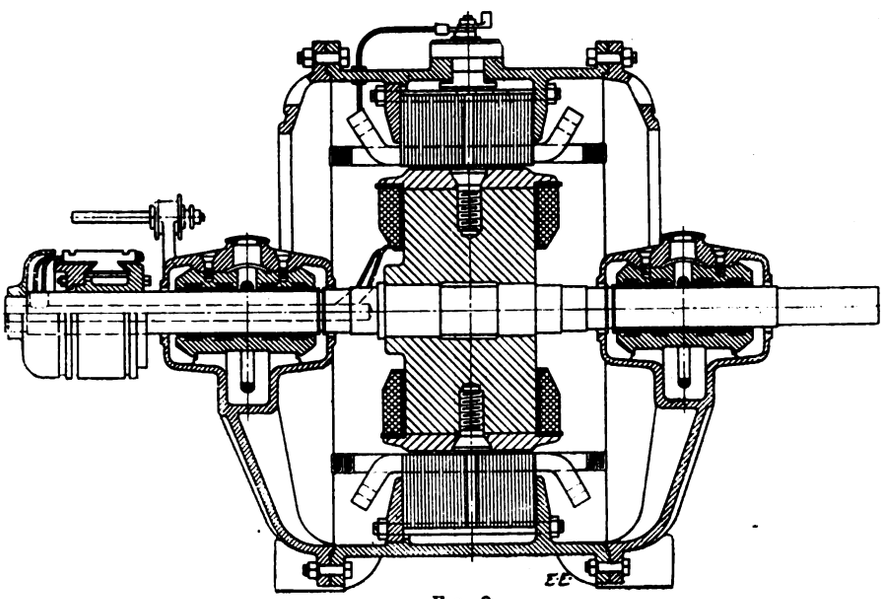

FIG. 8.

coincide with the direction of the magnetic axis, the power currents being at right angles to it. A wattless current will, therefore, always flow in one or the other winding, or in both in parallel in the same direction. In the position shown, for instance, a wattless current would flow from

that, the two wires being wound in parallel, whenever one is momentarily cut out of circuit the other remains in circuit and cancels the self-inductive effect of the disconnected wire. In actual practice the winding consists of more than two wires in parallel. Fig. 6, for instance,

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TABLE I.

—	Main circuit. Voltage. E_H	Current. J_H	Watts. A_H	Cos ϕ.	Commutator. Voltage. e_K	Current. i_K	Watts. d_K	Cos ϕ_K	Exciting circuit. e_E	i	Revolutions.
Test No. 1	247	0	0	—	12·3	24	416	·81	—	24	1,000
	270	39	2,100	·11	21·5	46	1,620	·94	—	—	1,000
	255	30	13,300	1	15 5	35	350	1	—	—	1,000
Test No. 2	204	0	0	—	9·3	18	—	—	19	37·5	1,000
	212	51	4,500	·24	15	31	600	·74	20·5	18	1,000
	220	52	20,500	1	13·4	28	—	—	22	43·4	1,000

TABLE II.

—	Nature of load.	Main output. E	J	Cos ϕ	Watts.	Input supplied to commutator. e	i	Cos ϕ	Current in regulating resistance (exciting circuit).	Revolutions.
Test No. 3	72 per cent. inductive load	223	41·5	·35	3,400	12·7	32	1	31	1,000
	Full inductive load	205	57	·46	9,400	13·5	33	·88	38	1,000
	36 per cent. non-inductive load	225	21	1	8,200	—	25	—	40	1,000
	81 per cent. non-inductive load	220	48	·93	1,700	12	31	12	40	1,000
	Open circuit	208	—	—	—	7·3	17·2	7·3	38·5	1,000

shows the connections for a six-pole generator having four wires in parallel in each of the six magnet coils. The larger number of wires have the advantage that higher

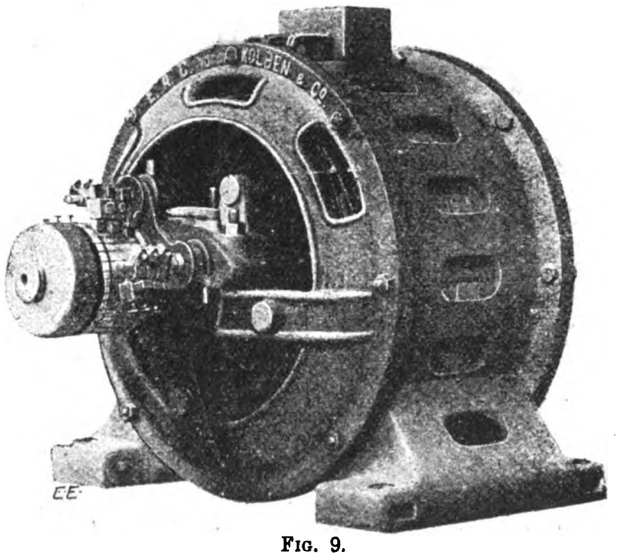

FIG. 9.

brush voltages and lower currents can be employed without sparking. Absolutely sparkless running is attained by an interesting arrangement also shown in Fig. 6. The

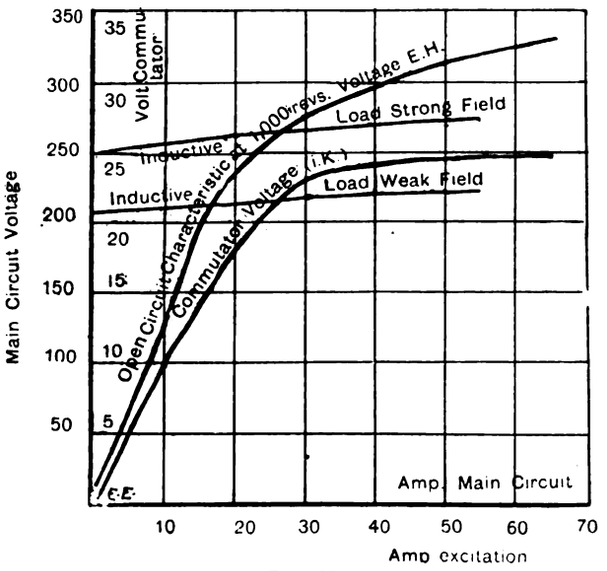

FIG. 11.

separate wires are interconnected at symmetrically arranged points starting from the centre point. In this way the voltage differences between neighbouring segments form a smaller fraction of the total brush voltage the greater the number of wires in parallel, so that higher brush voltages can be employed the greater the number of parallel wires. The arrangement has the further advantage that only a

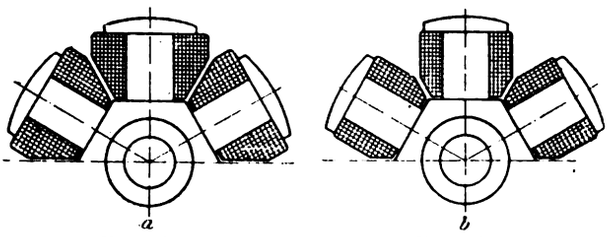

FIG. 10A. FIG. 10B.

comparatively small proportion of the power currents flow through the magnet winding, thus reducing the losses. In Fig. 7 the path of the power current is show diagrammatically by means of the arrows.

Figs. 8 and 9 show a section and general view of an ordinary three-phase machine fitted with the compounding commutator and radial poles. In consequence of the

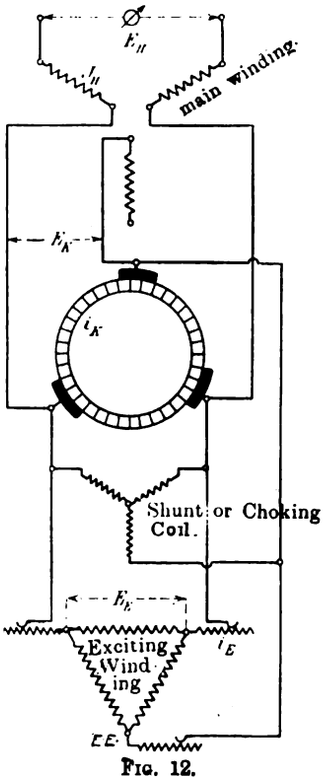

FIG. 12.

permissible reduction in air-gap, the weight of copper on the poles was reduced from 70 kg. to 50 kg. This reduction can be seen by a comparison of Figs. 10A and 10B. At the same time, in spite of the reduction in copper, the copper

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loss in the poles with cos $\phi = \cdot 8$ fell from 4 per cent. in the ordinary machine to 2 per cent. in the compounded machine In the first experiments carbon brushes were employed to prevent sparking, but in order to reduce the brush losses these were replaced later by sheet-metal brushes without any sign of sparking. It was found best to employ several narrow brushes per brush spindle, so that by setting one behind the other the required number of segments could be covered.

The test results for a 20-kw. six-pole, 50 ⁓, 250-volt machine are given in Tables I. and II. It was an ordinary standard three-phase generator with its exciter replaced by a commutator, and its six magnet coils altered to suit the arrangement shown in Fig. 6. The open circuit and load characteristics are shown in Fig. 11. The regulation of the exciting circuit is carried out as shown in Fig. 12. A three-step resistance is employed for the voltage excitation, whilst for the adjustment of the main current excitation a shunt was employed in the one case (Table I.), and a three-phase adjustable choking coil in the other case (Table II.). The decided over-compounding which is seen to occur at one particular inductive load in Table II. is due to the magnetic saturation of the choking coil employed. The tests show that the machine also compounds with a weak field—*i.e.*, at about 200 volts—and shows an over-pounding of as much as 10 per cent. on inductive load.

As the compounding method described is applicable, with little alteration, to standard three-phase machines, the many advantages of compounded over separately excited machines are likely to lead to the rapid introduction of the method. Many such compounded generators, including some of 1,500 kw., are at present under construction in Messrs. Kolben's workshops.

DEPRECIATION ON ELECTRICITY UNDERTAKINGS.

The *Bolton Daily Chronicle* of Nov. 26 has the following:

Councillor Dr. J. E. Panton, chairman of the Bolton Corporation Electricity Committee, writes a lengthy letter to the current number of the *Journal of Gas Lighting* with reference to Bolton's position in the matter of depreciating its electrical undertakings. Bolton is compared with Scotch concerns, and Councillor Dr. Panton emphasises the fact that whilst Glasgow's sinking fund is only 1 per cent., that of Bolton is 3½ times that percentage. He goes on to say: It is usual for the Local Government Board to allow the English municipalities (outside London) for their electricity works at the most only a life of 25 years. Now the bulk of the Glasgow electricity debt is repaid either one-fortieth or one-fiftieth annually, while Bolton has only been allowed 23 or 25 years, and a more recent and larger sanction reduces this period still further—to only 22 years. This difference cuts into the very marrow of the question of depreciation. Evidently the Scotch Office is guided by experts of very different views from those of the Local Government Board, and I quite agree with you it is very desirable a commission should be appointed to consider the whole question. Our Electricity Committee is working on very nearly identical lines with those of Glasgow and Aberdeen as regards the year's result, as the following table will show:

Town.	Electricity capital.	Depreciation and sinking fund.	Percentage on outlay.
Glasgow	£1,041,746	£41,130	3·948
Aberdeen	194,079	8,537	4·398
Bolton	207,481	9,222	4·444

So that Bolton pays a higher percentage for depreciation and sinking fund together on its electricity capital account yearly than either Glasgow or Aberdeen. The errors published to the contrary are occasioned by the working out of the totals by the cost per unit sold. It seems that the electrical engineers in Glasgow and Aberdeen have had a freer hand than in Bolton. At all events, we in Bolton have not over-weighted the capital account of our undertaking for the units produced. When comparison is made per unit sold, the figures of depreciation and sinking fund come out: Glasgow, 0·859d. per unit; Aberdeen, 0·795d. per unit. Bolton only seems to put away 0·582d. per unit, while, as I have shown you above, Bolton really provides more than either of these towns. I sympathise largely with the remark of Mr. Donald Mackenzie, of Edinburgh, that the "sinking fund contributions profoundly affect the financial position when contrasting the various municipal undertakings in reference to depreciation"; and that is why we have not in fixing our depreciation taken any note of the sinking fund requirements. I admit that we make the sinking fund payments out of this full depreciation, and I don't see any particular reason why we should not do so. I think it likely, when it is legally practicable, that I should agree with Councillor Walmsley (chairman of the Finance Committee), whose paper is entirely based on the idea of a 50 or 60 years repayment period, which ought to be kept independently of the depreciation charged—for the latter can be reduced accordingly. It is to be hoped this last opinion will take off some of the keen edge of your "startling discovery," for I take it we now, in effect, do what Mr. Walmsley would have us adopt under his two separate headings."

The Bolton paper also gives a quotation from the *Journal of Gas Lighting*, but with this we will not trouble our readers, inasmuch as, in our opinion, no journal is more conspicuous for selecting its phrases with regard to technical undertakings than the one quoted—it is merely an advocate.

INSTITUTION OF ELECTRICAL ENGINEERS.

At the ordinary general meeting of the Institution on Nov. 26 the following were the candidates balloted for:

Members.—R. W. Frazer, Anglo-Portuguese Telephone Company, Lisbon, Portugal; W. M. Horsfall, 22, Hackins Hey, Liverpool; J. F. Kelly, Ph.D., 284, West Housatonic-street, Pittsfield, Mass., U.S.A.; F. A. C. Perrine, Pittsfield, Mass., U.S.A.

Associate Members.—W. J. Abel, 99, Waterloo-crescent, Nottingham; S. F. Blyth, Electricity Works, Great Yarmouth; F. B. Cramer, 17, De Vere-gardens, Kensington; E. N. Greaves, Corporation Electricity Department, Bradford; H. H. R. Green, Engineer's Department, St. James's-gate Brewery, Dublin; E. Heitmann, Stanley Instrument Company, Great Barrington, Mass., U.S.A.; T. P. Pask, Natal Government Railways, Pietermaritzburg; F. S. Robertson, Siemens Laboratory, King's College, W.C.; E. T. Steinthal, 1B, Cooper-street, Manchester; J. J S. Stuart-Fox, Western Telegraph Company, Rio de Janeiro, Brazil; G. E. Unbehaun, 61, Booth-street, Balmain, Sydney, N.S.W.; C. J. Wawn, care of Municipal Council, Shanghai, China; L. B. Woodworth, P.O., Cleveland, near Johannesburg, Transvaal; A. Wunderlich, 21, Coleraine-road, Blackheath, S.E.

Associates.—F. I. Bennett, Foden Bank, Macclesfield; J. Bradwell, 37, Park-avenue, Southport; A. E. Carr, P.O. Box 84, Germiston, Transvaal; G. E. Ensor, C.S.A.R. Telegraph Department, Pretoria, Transvaal; A. Innes, 24, Butterfield-street, Richmond Hill, Leeds; R. W. Newman, Government Irrigation Works, Thebus, Cape Colony; J. Purvis, 120, Durants-road, Ponders End, N.; J. Stavers, 24, Willow-road, Hampstead, N.W.; C. White, 24, Wolseley-road, St. Helens, Lancashire; A. Wright, Corporation Electricity Department, Barnsley, Yorkshire.

Students.—A. Clark, care of Messrs. Robey and Co., Lincoln; S. J. Eardley, The Grove, Alfreton, Derbyshire; C. K. Fitzherbert, Faraday House, Charing Cross-road, W.C.; C. H. Fox, The Quarry, Ilfracombe, Devon; J. A. Galiano, 34, Cranley-gardens, Kensington, S.W.; W. L. Harliss, The Gables, Boston, Lincolnshire; W. E. Hean, 64, Clifford-street, Glasgow; A. H. Huddart, Penrith House, Breakspears-road, Brockley, S.E.; N. Neill, 26, Byron-road, Sheffield; G. E. Newill, 48, Wheeleys-road, Edgbaston, Birmingham; C. M. Pletts, Chester House, Brockley, S.E.; G. F. Sills, 44, Burnt Ash-hill, Lee, S.E.; F. H. A. Thoday, Langtons, Hornchurch, Essex; C. F. Waddington, Lindum House, Armley, Leeds.

APPOINTMENTS VACANT.

Engineering Assistant, used to tramway work, Finchley Urban District Council, £175 per annum. Application by Dec. 3.

Shift Engineer, Tunbridge Wells, £100 per annum.

Assistant Electrical Engineer, Sanitary Commissioners, Gibraltar. Salary, £200 per annum. Applications by Dec. 16. See advertisement in former issue.

Engine-Room Attendant. Salary 35s., rising to £2 per week. Particulars from the Secretary, South-Western Polytechnic, Manresa road, Chelsea, S.W.

Tramways General Manager, Bolton. Salary, £500 per annum. Dec. 4.

Traveller with connection amongst buyers of arc lamps and switchboards, Box 808, *Electrical Engineer* Office.

Junction Box Fitter, used to fitting house fuse boxes, Box No. 909, *Electrical Engineer* Office.

Cable Jointer, York Electric Lighting Station, Dec. 7. See advertisement in last issue.

Electrical Draughtsman (temporary), Metropolitan Asylums Board. Salary, £2. 10s. per week. Dec. 5.

Surveyor and Electrical Engineer, Boston. Salary, £300. Dec. 18.

Switchboard Attendant, Motherwell. Salary, 25s. per week.

Draughtsman. Apply to Box 519, G.P.O., Manchester. See advertisement.

Engineer. Apply to Box 402, *Electrical Engineer* Office. See advertisement.

Shift Engineer. Salary, 30s. per week of 56 hours. Apply to the Borough Electrical Engineer, Electricity Works, Gillingham, Kent, by Dec. 7. See advertisement.

Works Superintendent, Dublin; salary, £200 per annum. Shift Engineer; salary, £117 per annum. Sub-Station Foreman; wages, 45s per week. Dec. 9 See advertisement.

Shift Engineer, Fulham. Salary, £104 per annum. Dec. 12. See advertisement.

Clerk and Accountant, Portsmouth Telephone Department. Salary, £90 per annum. Dec. 14. See advertisement.

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TO CORRESPONDENTS.

All Rights Reserved. Secretaries and Managers of Companies are invited to furnish Notices of Meetings, Issues of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration.

All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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PRINCIPLES—LAWS.

We are living in a world of changing ideas. Quite recently, so to speak, our seemingly settled opinions have been knocked on the head by the introduction of the concept electricised corpuscles. The *Engineer* in its last issue gravely attacks the doctrine of the conservation of energy. Of course, in this attack the most is made of the peculiar properties of radium, many of which cannot well be explained by ruling theories. Mr. Cowan in his presidential address at Manchester said: "It is a matter of great regret that the principles—does he mean laws?—of economic science have not been only ignored, but rejected by the large majority of those who have contributed during the last few months to this discussion." Certainly, we are often struck by the exceedingly great dogmatism shown by the lesser lights of science, who usually speak of "laws" as if the laws ordinarily known to science are infallible and beyond the realms of discussion. On the other hand, the most advanced thinkers more often speak of these laws as promulgated as the best working hypotheses at present known. They are not averse to change, or to put aside a so-called law, if investigation proves that that law does not cover all known cases. All they ask is that before one law is put aside a better working hypothesis shall be formulated. There seems to be a very great tendency in recent years to devise theories rather than to pile up facts. A new investigation gives a funny result, and, of course, the investigator imagines he has done all that is to be done in that particular direction, and found out all that is to be found out; so he, or probably his interpreters, desire to modify some law which has hitherto been accepted. The probability often is that further investigations may tend to introduce new facts, and in the end the whole of the results obtained may be found to conform to recognised laws. On the other hand, they may not. But whichever be the case, there is not the slightest reason to hurry. It would take far more to break down the very excellent working hypothesis, conservation of energy, than the few facts hitherto determined with regard to radium.

When we come to discuss Mr. Cowan's statements we are on still more ticklish ground. We absolutely deny that any principles of "economic science" have been broken, because, in our opinion, none exist. Adam Smith, Bentham, Mill, Rogers, etc., each and all made certain premises, which, thrown into the syllogistic form, give logical and true conclusions These premises, however, were founded upon conditions they knew or imagined, hence applied to those conditions, and none other. Change the conditions you change the premises, and must inevitably change the conclusions. Will Mr. Cowan deny altered conditions? If not, he may be consistent, but his opinions are not worth much. Let us take one statement which perhaps shows his consistency, but which also shows his lack of real investigation into the matter. He says: "It is well known, and, so far as I know, universally accepted, that the relation between imports and exports is normally simply that of an equation."

That statement is incorrect as stated, and never has been universally accepted, and will not be because of its incorrectness. The one point not dealt with by Mr. Cowan, nor, we may say, by any single individual of all the so-called free fooders (not free traders—a thing which they are not), is that there is no trading business which ever existed, or will ever exist, be it of a nation, company, or individual, which does not have to account for savings or losses. An equation to denote this without an unknown and constantly varying factor to represent losses or savings is an absurdity, and it is

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a simple disgrace to the intelligence of this country that such wild assertions can be made. That the masses take these assertions as gospel truth, thinking the speakers have really considered the question, is unfortunately a fact; hence the tendency to be governed not by truth, but by blatant dogmatism. Will Mr. Cowan tell us where a business exists that does not have to consider profits or losses, and tell us is it possible for any business not to have recourse—periodically, or, it may be, systematically, till all are gone and the business ruined—to savings in order to buy what is wanted. We are not now appealing to the intelligence of the land for or against Mr. Chamberlain's projects; we want to appeal to scientific men, who ought to be deep thinkers, to look more closely into a question of surpassing importance before they dogmatise on the subject.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

COMPOUND MOTOR.

SIR,—In the first answer to Question No. 632 of this week's issue I see the following: "For the same result can be obtained with a plain shunt motor of good design, by setting the brushes with such a forward lead as to maintain a constant speed through the influence of armature reaction." If such a remark as this is not a mistake, surely the answer should not be credited with full marks; or, if not an error in "A. D.'s" answer, it must be a printer's mistake, which I now beg to correct to "by setting the brushes with such a backward lead as to maintain," etc., as I am afraid a motor of 550 volts would not hesitate to flash across with forward lead; but, apart from this, the speed would be diminished as the load increased, and not raised.—Yours, etc., C. Y.

Nov. 30, 1903.

LIMITED LIABILITY, ITS ADVANTAGES, ETC.

SIR,—Referring to our pamphlet which you were kind enough to notice in a recent issue, will you please allow us to remind your readers who are sending for a copy of the same that full name and address should be enclosed. This has not been done in several letters, so that we are unable to forward on to them.

The pamphlet is sent, post free, on receipt of three stamps, to anyone enquiring for it.—Yours, etc.,

THE LANCASHIRE TRADERS' ASSOCIATION,
Central-buildings, 41, North John-street, Liverpool.

STEAM TURBO-GENERATORS.

SIR,—It would be an interesting contribution to the controversy at present proceeding in your columns on the relative merits of steam-turbines and reciprocating engines, if someone would explain the reasons which have induced the authorities at Blackpool to go in for reciprocating engines of the "high-speed self-lubricating" type for their present extensions, after using steam-turbines exclusively for so many years.—Yours, etc., TRUTH SEEKER.

ELECTRICAL PROSPECTS IN SOUTH AFRICA.

Probably no more opportune time than the present could have been selected for the issue of the voluminous and valuable report which has been prepared by Mr. Henry Birchenough, the special commissioner appointed by the Board of Trade to enquire into the present position and future prospects of British trade in South Africa. The exact position of electrical engineering in Cape Colony and the new dependencies of the British Crown in that country is to-day uncertain in the sense that the amount of work likely to be obtained by English manufactures and the prospects of expansion in this particular field in the future are a practically unknown quantity. The present report supplies much of this important information, and we think the following notes which we have abstracted from its pages will go a long way to help manufacturers to realise the really excellent prospects they have in South Africa, which offers what is at present practically an undeveloped and profitable market for their wares. In certain localities, notably in the Johannesburg district, England is already doing well in the obtaining of large and valuable orders for electrical machinery and plant of all descriptions. In others she is lamentably behind both the Continent and America. This should not deter, but should rather spur on British manufacturers to enter into competition with their pushing foreign contemporaries. How this may best be done is shown in the document under review, and home firms will be well advised to closely study the points set out in the report wherein it is believed British manufacturers more often than not fail in their rivalry with firms of Continental and American origin.

Mr. Henry Birchenough, the special commissioner appointed by the Board of Trade, arrived in Cape Town from England on Jan. 20 this year, his stay in South Africa extending over a period of 15 weeks, during which time he had the opportunity of visiting practically all the important industrial and commercial centres of the Colonies, including Johannesburg, Bloemfontein, Durban, Kimberley, and Port Elizabeth. It must be remembered that at this time the commercial situation in South Africa was still in an abnormal and transitional state, but this temporary depression is now rapidly giving place to a more normal and healthy condition of affairs. But to keep to our subject, we find that among the list of new openings for trade the commissioner mentions electric lighting and traction, particularly in connection with municipal enterprise, while the substitution of central electrical power stations upon each mine or group of mines in place of the present scattered plant will largely increase the demand for electrical machinery—such as generators, motors, electrically-driven pumps, etc. The use of electrical power, especially in the deep-level mines, where it possesses many advantages over compressed air, is quite certain to take an enormous extension during the next few years, and deserves the closest attention on the part of British manufacturers. In this connection it is the general opinion of engineers upon the Rand that the future belongs to the three-phase alternating system because of its greater flexibility, and not to the continuous-current system. The commissioner was repeatedly informed that one of the principal reasons why British engineers have fallen behind in the competition for electrical work on the Rand is their conservative adhesion to the continuous-current system. Commenting on the activity of municipal enterprise in the country, the report mentions the large scheme for electric lighting, power, and tramways which has been decided upon by the Johannesburg Corporation, the estimated outlay on which is about £1,240,000, but it will probably exceed that sum. In regard to private enterprise, it is shown that the total estimated value of the electric light and power generating plant installed by companies is about £315,000, representing 37 steam-engines, eight other prime movers, and 31 boilers. It appears that imports of merchandise into South Africa are largely made by Americans. In 1901 the total value of American imports was £2,640,193, as compared with £4,429,839 in 1902, an increase of 67 per cent. Among the principal imports was electrical machinery of all kinds.

A few points in American or foreign business methods which are said to give those who adopt them an advantage in the market may be conveniently noted here. First, Americans adapt their manufactures to the precise use and work which is demanded of them; then they understand how large and important a part freight plays in the landed cost of machinery, especially upon distant inland mining fields, so whenever they can they lighten weights. It is impossible to insist too strongly upon the fact that the question of a close and untiring study of the special circumstances and requirements of a market which is constantly changing and developing, goes down to the very root of efficiency in competition. It is the one point of all others

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to which British manufacturers ought to give their closest attention.

Another point in favour of foreign firms is that wherever they have reasonable expectations of being able to build up a trade, both Americans and Germans readily incur large preliminary expenditure; in other words, they are willing to sow liberally in order that they may reap. Again, Americans furnish their customers with far more information than British manufacturers. Their idea is that manufacturers should create a demand in order to supply it. As an instance, we may quote the following passage: "The borough electrical engineer of the city of Durban showed me quite a library of pamphlets upon all the new developments of electrical science sent to him by American firms, cleverly illustrated with their own apparatus, and giving all kinds of useful information as to working costs, results of the experience of users, and so on. Such information is invaluable to engineers in sparsely-populated colonies, who have only the opportunities which books afford them of keeping abreast of scientific progress in their own departments. This is no isolated case, nor is it confined to electrical companies. The heads of other public departments in all the Colonies showed me proofs of the remarkable and highly intelligent enterprise of American manufacturers in this direction. It is easy to imagine how great the temptation is to engineers to place orders with firms which render them so much assistance, and, in a sense, relieve them of so much responsibility."

In the drawing up of specifications, in prompt delivery, in standardisation, in better finish, in superior packing, in producing on a large scale in order to sell cheaply, in representation, and in price—in all these points the American competitor is said to greatly excel his British *confrère*. One other point may be mentioned—viz., foreign traders do not give their customers in the Colonies better terms than British traders except in the mining industry, where they appear to be more accommodating and liberal. The following suggestions as to the means by which foreign competition may be effectively met have been gathered from various sources, and are offered for what they are worth: A clearer realisation of the great and expansive future of the market; the employment of far more energetic and less conservative methods of business; a careful study of local conditions and requirements with a view to the closer adaptation of machinery to the particular work that is demanded of it; direct representation in Johannesburg; wide discretion being given to representatives in quoting prices for competitive tenders; British firms should be represented by British agents; the ordinary mines' terms should be frankly accepted, and business should be financed from the British side; prompter delivery and a closer adherence to contract dates; larger local stocks of standard types of machinery, of fittings, and spare parts should be kept; standardisation, wherever possible, and an extension of the practice of working to gauge should be effected; more attention should be paid to details and to "selling points"; cheapening of production; more brain work should be put into designs; the high standard of British workmanship and British material should be carefully maintained; and British engineers should be trained to fill a larger number of the "order giving" posts on the mines.

We now come to the supplementary reports, which follow the general information and deal with the prospects of trade in certain specified districts. The first that arrests our attention is that by Mr. William Tosh, inspector of machinery in the Johannesburg district, where, as we have stated, British manufacturers have succeeded in obtaining the greater bulk of the work. Thus, in electrical machinery Great Britain supplied 83 per cent. of the generators in use, as against 14 per cent. by Germany and Belgium and 3 per cent. by America. Again, 72 per cent. of the motors came from this country, against 14 per cent. from Germany and Belgium and the same proportion from America. Arguing from the point of view, presumably, that England should have the whole of the business in her own hands, the reporter gives the following principal reasons for the success in obtaining orders of the other countries mentioned: First, on account of the large stocks held by German representatives; and, secondly, because the efficiency of the foreign-made article is slightly higher than the British; and he urges British manufacturers to augment their local stocks and increase their energy. Another report, by Mr. C. B. Pattrick, inspector of machinery in the Krugersdorp district, deals extensively with electrical machinery. In this district this business is principally in the hands of the Germans and Americans. Mr. Pattrick states that the big three-phase generators and motors of leading Continental make leave nothing to be desired. Explaining the advantages of a three-phase, high-pressure plant, he says that three men can run a large plant, which, if continuous current low tension, would require from seven to nine men to keep it in order. On one mine in the Krugersdorp district the three-phase current (2,000 volts) for the mine pumps and lights is conveyed down the shaft by naked wires, encased in a wooden cupboard which extends the full length of that portion of the shaft which is traversed by the cable, and effectually prevents any person from coming into contact with them. This is found to be more satisfactory than the lead-sheathed cable in general use. In passing, the reporter calls attention to the importance of good insulation. As the three-phase high-tension machinery is, doubtless, the plant of the future for South African mines, the following points are instructive: 'Bus bars should be about 10in. apart and not 6in., as frequently placed, because in damp weather the current will arc over a 6in. space. Fuses should be well out from the board, and in a horizontal position, as otherwise they set up arc between overhead 'bus bars. In this country, where thunderstorms are so extremely severe, a space of at least 6ft. to 8ft. clear should be allowed behind the board. The Siemens high-tension glass-enclosed fuses are the most satisfactory, as they are all made to absolute standard. Insulated pincers for drawing them should always be at hand. Mine motors and others in damp places should have liquid starting resistances, as ordinary rheostat switch coils corrode with damp. The horn lightning arrester is beyond all comparison the best. For shop motors, those starting with a resistance work more satisfactorily than those with short-circuiting clutch, as the clutch is liable to get worn and not make good contact, often causing the rotor to burn.

In concluding this article, we cannot do better than reproduce a statement supplied by Mr. Holtby, consulting electrical engineer, upon the present state of the electrical machinery market upon the Witwatersrand. His remarks, although dealing with a specified locality, may be taken as applying to British South Africa generally, and are of great importance. The following is the report in question: "The supply of electrical machinery for gold-mining purposes is at the present mainly in the hand of American and Continental firms with perhaps one or two slight exceptions, and is due probably to the following reasons: (*a*) America and Germany in the order named were the first to realise the extensive field for their electrical manufacturers in this country, and the case of America was greatly helped by the fact that many of the consulting mining engineers on the Rand were Americans or men who had worked on the American goldfields and had become accustomed to American machinery and appliances. Germany was mainly successful through one large firm, which established a direct representative in Johannesburg, and also carried stocks of appliances. This firm also obtained control of the Brakpan power line, which put them in a strong position, and it was natural that machinery suited for this power line should be supplied by them; especially so in cases where mines used power from the line. This firm also rented suitable motors and apparatus, etc., to the mines. Another strong reason was that the Continental and American manufacturers were the first to see the general suitability of three-phase alternating-current machinery for mining purposes, and consequently were in a position to meet the first demand from the Witwatersrand, and when once a particular system of transmission is installed, there is a tendency to continue it. Machinery used on a group of mines can thus be interchangeable, less spares are required, etc. Another reason was that the price of American electrical machinery was lower than that of any other country before the war, also the time asked for delivery was in many cases only two-thirds of that asked by British firms, this being, no doubt, due to

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the better standardisation of their patterns. In passing, we may note the importance of standardisation. It is undoubtedly of great importance to be able to cable for spare parts of machinery, and it is only where standardisation is carried to considerable perfection that this can be done. British manufacturers have been, with a very few exceptions, very feebly represented here, and, instead of opening a branch, have been quite content to allow general engineering firms to represent them. In many cases the engineers of the firms in question have had little or no electrical knowledge, the result of which has been the success of the more pushing representation. (*b*) I would suggest that British firms open branches and not mere agencies in Johannesburg, carrying stocks of cables, motors, and general fittings for same. Samples of large pieces of machinery might, perhaps, also be carried. This would mean that special men able to explain technicalities would be in charge. Great care should be taken that the goods offered are suitable for mining operations. A considerable amount of electrical machinery has been sold that is totally unsuited for underground work. This is due to want of proper attention to the conditions under which mining is carried on here, and to the fact that electrical mining machinery has only comparatively recently been made in England. Further, instead of making new patterns developed by mining specialists, stock patterns have been slightly altered, and then considered at suitable, which is a very grave mistake, for in mining reliability in use is of utmost importance. Much of the trouble experienced in the past with electrical machinery underground can be traced to apparatus only suitable for above-ground purposes. (1) I should say that the actual workmanship bestowed upon English machinery is better than either American or Continental, but this avails nothing if the fundamental principles are missed and the types sold are unsuitable and not specially adapted for the work to be done; (2) prices are higher in the cases of British and Continental electrical machinery than in those of American, probably for the reasons mentioned under (*a*)—namely, standardisation; (3) I do not think there is much superiority of one country over another in efficiency. Probably American is lower in some instances than either that of England or the Continent. No doubt deep-level mining will bring about many changes in machinery used. In all probability in many deep shafts there will be intermediate hoists, which will probably be electrically driven. Manufacturers will do well to pay close attention to these hoists. Probably the power required will range from, say, 250 h.p. to 1,000 h.p."

Mr. Holtby concludes by presenting two general specifications—one for an electric hoist to be used in the incline at the bottom of a vertical shaft, and the other for a combined motor and pump. They are worthy of study.

THE TESTING OF ELECTRIC GENERATORS BY AIR CALORIMETRY.

BY RICHARD THRELFALL, M.A., F.R.S.

The following is an abstract of a most interesting paper read before the Institution of Electrical Engineers in London on Thursday, Nov. 26. It describes a method of measuring the actual losses in an alternator which is coupled to an engine. The author points out that in a number of cases it is impossible to measure the brake horse-power of engines driving alternators. For this reason he devised and experimented with a means of directly measuring the heat losses in the alternator. To do this he enclosed an alternator of 300 kw. capacity in an air-tight non-conducting casing and passed air through at a measured rate. He then ascertained the temperature of the air entering the case and that of the air leaving. The difference between these temperatures, together with the quantity of air passed in a second and the specific heat of the air, enabled him to determine the rate at which power was being wasted in the alternator. In the first part of the paper Prof. Threlfall describes in detail the way in which he measured the volume of air which was passing out of the air-tight case. The velocity at various parts of the tube was determined by Pitot gauges. In order to keep down radiation losses from the case, the air inside was kept at about the same temperature as the air in the engine-room. After the alternator experimented on had been encased, the incoming air duct was connected through the wall of the engine-room to the atmosphere. A fan in the outlet driven by an electric motor then was set to work, and it was found that a steady condition of affairs was reached in a few hours. In the first experiment a resistance frame was used as the source of heat inside the case, but the alternator was kept running in order to give the same circulation of air as in the later trials. When by electrical measurement 37·8 kw. were being wasted in the resistance frames, the heat carried out by the air stream was equivalent to 40·865 kw. Another test proved that the heat due to windage and conduction along the engine shaft was 2·066 kw. This reduced the error in the determination of the power to 2·51 per cent. In a subsequent trial under the same conditions a negative error of 1·77 per cent. was found. Tests were then made on the alternator, with the results given in the following table:

Date. 1902.	Kilowatts.	Magnetising current.	T.C.° Inlet.	T.C.° Outlet.	Inlet + Outlet / 2.	Mean temperature of casing, back and front.	Heat supply measured. Kilowatts.
Aug. 13..	301·43	65·9	16 186	32·19	24·2	24·25	38·01
,, 19...	0	51 83	19·44	30·35	24·9	28·2	25·04
,, 20..	0	66·2	15·415	26·83	21·12	24·75	27·20
,, 20...	0	0	24·42	25 97	25·20	24 4	2·066
,, 21....	249·2	57·5	20·17	33·54	26·87	30·8	34·16
,, 26...	37·8	—	17·99	36·80	27·4	29·4	39·27
,, 28..	37·8	—	20·28	38·51	29·39	31·15	40 865
,, 29...	262·4	61·2	20·95	36·35	28·65	33·10	34·07

From these figures the efficiency of the dynamo works out at full load to be 89·05 per cent., excluding the loss of heat in the exciter itself, which was outside the case. As the author points out at the conclusion of his paper, this method also allows certain of the losses to be independently determined. His experiments show that it can be depended upon to give the losses accurately to within 2 or 3 per cent., which means that the efficiency can be determined with a very high degree of accuracy. The casing used to surround the alternator was built up of ½in. grooved and tongued boarding, which was afterwards covered over with tinfoil. It is interesting to know that the total works cost for labour and material for setting up the testing apparatus was only £19. 9s The information given as to the best methods of measuring the flow of air, etc., will be of great service to any engineer adopting the method for future tests.

Discussion.

Mr. W. B. Esson, who opened the discussion on the above paper, said that, so far as he knew, the method of testing therein described was quite novel, and he was glad to see that it gave results which might have been expected. It, however, required a good deal of expert knowledge to get accurate results with it, and personally he had regarded with some suspicion the results he had obtained until he had had a great deal of experience in this way of testing. He thought it tested the experimenter just as much as it tested the apparatus. Coming to the question of the iron loss at no load and at full load, he found that the author gave the iron loss at full load to be something like 10 per cent. of the output of the generator, while at no load it was approximately 7 per cent. From some previous work on the subject he was inclined to believe that this loss was in the field poles of the generator and not in the armature core, and that the difficulty could be got over by completely laminating the poles.

Prof. Threlfall interposed to say that in the machine used by him the poles were only partly laminated, and that the loss was in the poles.

Mr. Esson said it would seem to show that merely laminating the tips of the poles was not sufficient to get a very high efficiency. He would point out, in conclusion, that Mr. Blathy, some time after he (Mr. Esson) had made his experiments, found the very same thing in testing continuous-current machines.

Dr. R. T. Glazebrook announced that they were working with the Pitot-tube method of measuring at the National Physical Laboratory. Prof. Threlfall's statement, that the momentum of the impinging air was reduced very nearly half, bore out the theory of Lord Rayleigh; and Dr. Stanton, at the National Physical Laboratory, has arrived at practically the same

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result. The important point was that it had been shown by these experiments—which were soon to be described elsewhere—that the Pitot tube was a very accurate instrument for measuring streams of air. With regard to the calorimetrical result, he gathered that the efficiency of the dynamo used by the author was measured with a considerable stream of cool air coming in. He therefore assumed that the temperature of the whole machine was lower than would obtain in actual practice. This might have an important bearing on the results.

Mr. W. M. Mordey pointed out that some of the old methods of working, even if correct, required at least as much expert attention as the method described by Prof. Threlfall. He was particularly interested in the author's references to the measurement of the air, because he was just now considering the question of the measurement of the quantity of gas passing through very large pipes for the supply of big gas-engines. He would ask the author whether the curve of air velocities was taken on a vertical cross-section or a horizontal? There was a considerable difference, he noted, between the values of the upper half of the curve and the lower half. He also asked what precautions were taken to see that the inside surface of the pipes to which this method was applied did not vary the result? The Pitot method would probably find its greatest usefulness in works, but the principal objection to it was that it must necessarily take a considerable time to get any reliable observations. He wanted to know how long it would take to ascertain the efficiency at various loads of a large machine taking from 10 to 12 hours to reach its full temperature, and again, was it possible to measure the indicated horse-power accurately with small loads when the engine was running light?

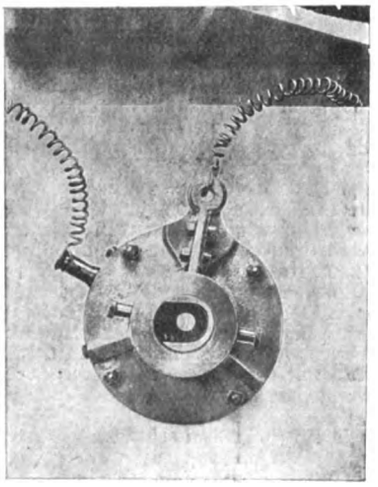
Prof Threlfall, in his reply, said a great deal had been said in the discussion about the results of the tests, but he would point out that the first object of the paper was to bring to the notice of the Institution the method itself. He hoped at some future time to be able to present the results to the society. Mr. Esson seemed to be scared by appearances of difficulty in using this method, but the clear presentation of the subject rendered this unavoidable. He could assure them that it was not necessary to be so minute as appeared from the account given in the paper. The chief difficulty with the method was in measuring the electric output with accuracy. The measurement of the air was not he thought difficult. He should be extremely sorry if they were to go away with the idea that this method was a complicated one, or that it contained pitfalls for engineers. As to the time occupied in taking measurements, it would be about four to six hours in the case of a 300-kw. machine after steadying the load. This allowance of time would give consistent and accurate results within 1 per cent. But with the sacrifice of about 2 per cent. accuracy the measurements could be made with this system in something like an hour. Replying to Dr. Glazebrook, he stated that the air was heated up to the temperature obtaining in actual practice. The diagram of air velocity distribution was through a horizontal diameter, and was only correct for the velocities given. The temperature of the air leaving the generator was estimated while in turbulence. He never detected the slightest difference in temperature. With regard to Lord Rayleigh's results, he cordially agreed with all Dr. Glazebrook had said. He would reserve his remarks on the question of the measurement of air and gases for another occasion, when he should have an opportunity of dealing entirely with that part of the subject.

A hearty vote of thanks was accorded the author.

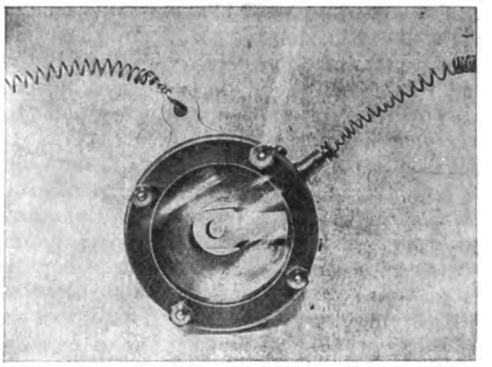
TRADE NOTICES AND NOVELTIES.

Electric Ignition.

Electrical apparatus for exploding the compressed charges in automobile engines has been largely developed during recent



years. One step in advance is the substitution of mechanical interrupters for the magnetic trembler previously used with induction coils. The mechanical apparatus for making and interrupting the circuit is more reliable and more under control. It allows also of the time of ignition being regulated easily. The illustrations herewith are of a new wipe contact circuit breaker put on the market by Messrs. L. Rene and Co., of 6, Snow-hill, E.C., and exhibited by them at the recent National Cycle Show at the Crystal Palace. Besides being adapted to motor cycles, the contact breaker is standardised



for two and four cylinder motorcars. The apparatus is made both in steel and aluminium.

Catalogues and Pamphlets, Etc.

VIEWS AND USES OF WILLESDEN PAPER AND CANVAS. Willesden Paper and Canvas Works, Limited, Willesden Junction, London, N.W.—These products are waterproof, rot-proof, and time-resisting, and we are informed that the firm have drain-pipes in use at their works (made from this paper) which were put into the ground 30 years ago. The pamphlet is illustrated with fine views of important buildings where this material is used as roofing or under slating.

VULCANISED FIBRE. Mosses and Mitchell, 68-71, Chiswell-street, E.C.—The advantages claimed for these valves are that their immersion in cold or boiling water only gives them more flexibility. They resist the action of oils, so destructive to rubber, and they do not expand in diameter, so require no cutting round the edges to free them from nuts, guards, etc.; also that they work equally well with a slow as with a fast action pump, and are as efficacious with a dead lift as with a bending or cup guard.

LABOUR AND TIME-SAVERS Illustrated. Beanland, Perkin, and Co., School Close Works, Leeds.—Describes several patterns of new single and double hack saws, a portable electric hack saw for shipyards, engineers, iron, and girder merchants, portable rail saws, the Britannia trimming and mitreing machine, a new improved hand screwing machine for engineers, smiths, wheelwrights, etc.

CABLES. W. T. Glover and Co., Limited, Manchester.—An illustrated post card showing the cable-laying at Stalybridge.

EIGHT-POLE DYNAMOS AND MOTORS. Union Electric Company, Limited, 151, Queen Victoria-street, London, E.C.—These machines cover a range from 100 h.p. to 500 h.p. at the usual standard voltages, and they are constructed with a large range in speed to suit the various requirements of dynamos and motors of such large power. Each size of magnet frame and armature can be completed in five different mechanical outfits, the simplest being suitable for forcing on to the engine, pump, or other shaft, and the most complete being that with three bearings mounted on a box bed-plate, and arranged for either rope or belt driving. The armature windings consist all of shaped bars sunk in accurately fitted and smooth surfaced slots in the cores. This type of machine allows for ample ventilation, and therefore large output weight for weight.

AUTOMATIC TIME SWITCHES. Illustrated. Vandam, Marsh, and Co., Limited, London, Birmingham, Manchester.—Fully describes a large variety of these instruments.

HOWARD TROUGHING. The Howard Conduit Company, Trafford Park, Manchester.—The company have chosen an illustrated postcard to draw attention to the advisability of relaying old rubber cables in their troughing instead of scrapping them.

PATENT AUTOMATIC FUEL-SAVING APPARATUS (CO_2 RECORDER) "Ados." Sanders, Rehders, and Co., London and Manchester.—We are informed that during the last 12 months this ingenious apparatus has found great favour amongst central electricity stations and other large works, several having now installed as many as five and six recorders. This proves the great usefulness of this recorder as a means of checking combustion in boiler furnaces, and thus effecting considerable economy in the coal bill.

PERSONAL.

The Eastern Telegraph Company, Limited, and the Eastern and South African Telegraph Company, Limited, announce that Mr. George Draper, who has been secretary of the two companies since their formation, retires from office with a pension on 1st prox. Mr. A. R. Hardie formerly the accountant, has been appointed secretary.

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The Exeter Council have granted £105 to Mr. H. D. Munro, the city electrical engineer, in respect of his special services in connection with the extension, designing, erecting, and equipping the new power station, and have increased his salary to £350 per annum.

The Sunderland Tramways Committee have appointed Mr. A. M. Dayson, at present assistant manager and engineer of the Sunderland system, as manager to succeed Mr. Harry England, subject to the approval of the Council.

The Newcastle Tramways Committee have resolved to increase the salary of Mr. Rossignol, general manager, from £750 to £850, and rising £50 per year to £1,000. The salaries of the car-sheds manager and the chief clerk are also to be increased.

FORTHCOMING EVENTS.

FRIDAY, DEC. 4.

Institution of Civil Engineers (Students' Section).—At 8 p.m., ordinary meeting. Paper: "Artificial Draught as applied by Fans to Steam Boilers," by Mr. W. H. A. Robertson.

Junior Institution of Engineers.—At 8 p.m., ordinary meeting. Paper: "Recent Developments in the Construction and Working of Gas-Engines," by Prof. D. S. Capper.

SATURDAY, DEC. 5.

Glasgow Scientific Society.—At 7.30 p.m., ordinary meeting. Paper: "Superheat," by Mr. W. H. Booth.

MONDAY, DEC. 7.

Society of Arts. — At 8 p.m., Cantor lecture: "The Mining of Non-Metallic Minerals," by Mr. Bennett H. Brough. (Lecture III.)

TUESDAY, DEC. 8.

Faraday Society.—At 8 p.m., ordinary meeting. Papers: "Total and Free Energy of the Lead Accumulator," by Mr. R. A. Lehfeldt, D.Sc. (discussion adjourned); "Bitumen in Insulating Compositions," Part I., by Mr. D. A. Sutherland, F.I.C., F.C.S.; "Notes on Aluminium Welding" (illustrated), by Mr. Sherard Cowper-Coles; "Electrochemical Installation at the Borough Polytechnic Institute," by Mr. F. M. Perkin, Ph.D.

Institution of Electrical Engineers (Glasgow Section).—At 8 p.m., ordinary meeting. Paper: "The Education of an Electrical Engineer," by Prof. F. G. Baily.

Institution of Civil Engineers.—At 8 p.m., ordinary meeting. Paper to be further discussed: "On the Distribution of Mean and Extreme Annual Rainfall over the British Isles," by Mr. Hugh Robert Mill, D.Sc., LL.D. Succeeding papers: "Deposits in Pipes and other Channels Conveying Potable Water," by Prof. J. C. Brown, D.Sc.; "The Purification of Water Highly Charged with Vegetable Matter, with special reference to the Effect of Aeration," by Messrs. O. Chadwick, C.M.G., and B. Blount.

WEDNESDAY, DEC. 9.

Institution of Electrical Engineers.—At 7 for 7.30 p.m., annual dinner, Grand Hall, Hotel Cecil.

Institution of Civil Engineers.—At 2.15 p.m., students' visit to the locomotive works of the North London Railway at Bow-road. Train, 1.40 p.m. from Westminster Bridge Station.

Society of Arts.—At 8 p.m., ordinary meeting. Paper: "Furnaces for Jewellers' Work," by Mr. H. H. Cunynghame, C.B.

THURSDAY, DEC. 10.

Institution of Electrical Engineers.—At 8.p.m., Gilbert Tercentenary Commemoration. Presentation to the Borough of Colchester. At 8.15 p.m., ordinary meeting. Papers: The Slow Registration of Rapid Phenomena by Strobographic Methods"; "'The Ondographe' and 'Puissancegraphe'" by Mr. E. Hospitalier; and (time permitting) "On the Magnetic Dispersion in Induction Motors, and its Influence on the Design of these Machines," by Dr. Hans Behn-Eschenburg. (Dublin Section).—At 8 p.m., ordinary meeting. Paper: An Experimental Study of Stationary Electric Waves, with special reference to the Phenomena of Electric Resonance," by the Very Rev. Monsignor Molloy, D.D. (Students'-Section).—At 2 p.m., visit to the Incandescent Lamp Company's Brook Green Works, Hammersmith.

FRIDAY, DEC. 11.

Tramways and Light Railways Association.—At 8 p.m., inaugural meeting. Address by Mr. Atherley-Jones, K.C., M.P., on "Protection in Special Relation to Tramway and Light Railway Enterprise."

North-East Coast Institution.—General meeting at Newcastle-on-Tyne.

Physical Society.—At 8 p.m., at the Royal College of Science. Papers: "A Method of Mechanically Reinforcing Sounds," by Rev. T. C. Porter; "The Simmance-Abady 'Flicker' Photometry," by Messrs. Simmance and Abady; "Exhibition of a Conductometer," by Mr. M. R. Appleyard; and "A Model to Illustrate Various Properties of Wave Motion," by Prof. L. R. Wilberforce.

SATURDAY, DEC. 12.

West Hartlepool Scientific Society.—At 7.30 p.m., ordinary meeting. Paper: "Mr. D. B. Morrison's Scheme for the Advancement of Apprentices." by Mr. Wm. Kennedy.

Glasgow Scientific Society.—At 7.30 p.m., ordinary meeting. Paper: "Steam-Turbine Machinery," by Mr. Arthur A. Wynne, M.A.

QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any questions should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

641. Show clearly how to calculate from the indicator card the water used per stroke per indicated horse-power in condensing and non-condensing engines.—G. W. S.

642. A battery of Tudor accumulators is connected in sections to the cell board by single-strand conductors No. 6 S.W.G., covered with hemp braiding. These conductors are burned into the leaden lugs of the accumulators, and are bare for about 1in. above them. Much trouble has been experienced through a very active corrosion which takes place in some cases even under the braiding. The bare parts have been scraped and repainted with "asphaltic black," but after a few weeks corrosion has again broken out. How can this be remedied?—A. B D.

ANSWERS.

Question No. 633.—Several car axles of an electric tramway have broken lately, all *exactly* in the same place—viz., ½in. inside keyway of gear wheel. Upon examination of these and other axles they show signs of being eaten away by electrolysis. Describe a remedy for this, also the action of the electric current upon the axles. The motor box is used for the earth return.

Answer to No. 633 (*awarded* 10*s.*).—This effect is very largely owing to the mud and other wet dirt which accumulates on the axle of the car, because this dirt would contain a good deal of mineral matter—composed of acids and bases—and known as salts in chemical language. These would not decompose electrolytically unless some circumstance gives rise to a difference of potential, which, however, need not be more than about three volts. We must, therefore, seek a resistance to the current in or near the axle and gear wheel, and as the current is large the resistance may be small, because the difference of potential it will cause, in volts, is the product of the resistance multiplied by the current in amperes, or $C \times R = E.M.F.$ The question seems to suggest that a large proportion of the current goes from the motor through the gear wheels, and that the gear wheel is not well fitted on to the axle of the car. If so, the whole of the trouble is accounted for in this way. Water and whatever it may hold in solution gets into the space between the gear wheel and the axle; probably a good deal lies in the keyway. This occasions rust, which is a non-conductor, and insinuates itself further and further, and so reduces the amount of clean surface of the body of the gear wheel and axle in actual contact. Now, considering the large current employed, we can easily understand that the decrease of conductive area between the wheel and axle occasions a difference of potential which would be quite enough to act electrolytically on the salts contained in the mud. The natural result of this would be to set free the acids, and these would immediately act upon the iron by dissolving it and so removing it. It will, of course, be readily understood that, although the gear wheel may be firmly fixed on the axle, there is a great difference between a good fit and a bad fit, and that whereas a really good fit would leave no room for liquid to creep in, a bad fit would leave a good deal of empty space, and mere capillary action would soon fill it with liquid. We have now only to remember that the keyway is the weakest part of the axle, and would, therefore, be the most likely to give way under a strain even if not weakened by the above electrolytic action. If the gear wheel is at all likely to be part of the electric circuit, it should be thoroughly and very closely fitted to the axle before the key is driven in, and the key should also be most carefully fitted for its entire length. After

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being thoroughly well fitted the whole of the axle and the sides of the gear wheel might be well tarred with advantage to exclude moisture, and, if necessary, a further path might be provided for the electricity by placing a rubbing brush, similar to a dynamo brush, on the top of the car wheel rims and connecting this to the motor box so as to make electrical contact. This would reduce any difference of potential formed on or about the car axle, and so would almost for certain stop the tendency to electrolytic action there altogether with or without the suggested tarring; but the tarring would be an additional safeguard in any case, and well worth putting on. The suggested brush on the top of the wheels should not be put unless as a last resource, because, of course, it adds to wear and tear and maintenance troubles.—F. G. A.

Question No. 634.—Describe the theory and working of the Diesel oil-engine, and state wherein its advantages lie over a good make of ordinary oil or gas engine.

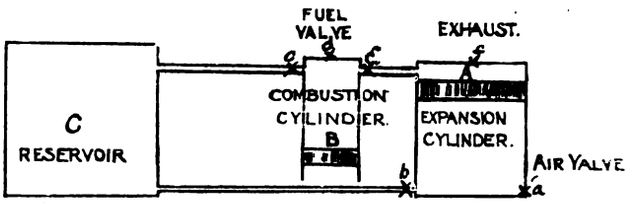
Best Answer to No. 634 (*awarded* 10*s.*).—The Diesel engine (not necessarily *oil* engine) is still so new that in any article on the subject a word as to its history cannot be amiss. Rudolph Diesel, of Munich, investigated the thermo-dynamics of the gas-engine, and from his purely theoretical and mathematical investigations was led to the conclusion that any great increase in efficiency in gas-engines working on the Otto cycle was physically impossible Continuing his investigations he was led to the theory of the ideal heat engine, and in his book, "The Rational Heat Motor" (Englished by Bryan Donkin, 1893), he develops this theory and designs an engine of 100 h.p. on this principle. This book was written and the engine designed before any attempts had been made to build a Diesel engine, as it is now called. The publication of the book led to much discussion. Many professors disagreed with the results obtained, but practical men were attracted by the possibilities of the new heat motor, and money was found to put theory into practice. By the energy of the Augsburger Maschinenfabrik, Sulzer Bros., Krupp, and others a laboratory was built in Augsburg, and experimental researches under the direction of Herr Diesel were started. The experiments, not unattended with physical danger, extended over several years ere a motor was built that could be put on the market. The perseverance and courage employed in these researches places them on a par with the greatest achievements of the fathers of engineering. The Diesel engine resembles ordinary oil and gas engines in that combustion takes place in the cylinder, but here the resemblance ceases. The ordinary internal-combustion engine fires the charge in the cylinder by external means (a gas flame or electric spark), whereas the temperature required for combustion in the Diesel engine is produced in the cylinder of the engine by the compression of air, and the combustible is not introduced until this temperature has been reached.

Diesel has laid down the following conditions for perfect combustion: 1. "The highest temperature of the cycle (temperature of combustion) must be produced before and independently of combustion by the compression of ordinary air, and not by and during combustion." It is well known that any gas is heated by being compressed. If the gas is compressed so quickly that it has no time to cool—*i.e.*, adiabatically—it naturally gets very hot, and any required temperature can thus be produced.

2. "Finely-divided combustible must be gradually introduced into the air when it is in the condition described above (very hot and at a high pressure) during the return stroke of the piston that has brought it into this condition. The combustible is added in such a way that its combustion causes no increase of temperature—*i e*, the heat caused by its burning just balances the heat lost by expansion. The process therefore takes place at a constant temperature—*i.e.*, isothermically. The combustion, after ignition, must be regulated by an external arrangement, so as to maintain the right proportions between pressure, volume, and temperature." In this condition, again, there is a considerable difference from the ordinary gas-engine, in which the combustible and air are mixed, compressed, and then fired, instead of (as in the Diesel engine) the air being compressed, and the combustible added and gradually burnt, being ignited by the heat of the compressed air.

3. "The third condition is that a proper weight of air must be chosen in proportion to the heat value of the combustible, the maximum temperature due to compression being so calculated that no artificial cooling of the cylinder walls is necessary to work and lubricate the engine." Here, again, is a departure from what was previously assumed correct. The amount of air required according to the above condition is much greater than the least quantity necessary for complete combustion. In gas-engines it has been considered that this latter quantity (the least amount required for complete combustion) gives the right mixture.

Though the Diesel engine is on the market, and many horse-power are in use and being built, the mechanical details of design are, of course, by no means fixed. A description of valve details, cams, etc., would, therefore, be out of place, and in describing the method of working only the successive operations will be given. Consider a simple engine of two cylinders—one for compression and combustion and one for expansion. (The sketch is merely diagrammatic, valves are indicated by crosses.) The piston, A, moves up and draws in air through the valve *a*; on the down stroke this is compressed and goes through the valve *b* to the reservoir, C. This is merely precompression, and must not be carried so far as to heat the air



unduly. The piston, B, during the down stroke draws in precompressed air, and on the up stroke (valve *c* being now closed) compresses it to the limit. The piston now moves downwards, fuel being admitted through valve *d* and burnt as described above. After moving down a small distance, the fuel supply is cut off, and expansion takes place. When B gets to the bottom of its stroke, A is at the top. The valve E is now opened, and the expansion continued in the larger cylinder, A moving down and B up. When A is at the bottom of its stroke, valve E shuts again, and on the next upstroke of A, the exhaust valve, *f*, opens, and the burnt gases are expelled. By having two cylinders, B, a combustion at each revolution is effected, instead of once in two revolutions.

As to the advantages of the Diesel engine over an ordinary oil or gas engine, first, the thermal efficiency is far higher than in any gas-engine. Though this high thermal efficiency is counteracted to some extent by low mechanical efficiency, due to the high degree of compression produced, the over-all efficiency is still greater than that of ordinary oil-engines, and may be expected to increase as experience is gained in construction. The engine is also cheap, as the cylinders are small, about one-third the size of cylinders of steam-engines of the same horse-power. Prof. W. C. Unwin, F.R.S., M.I.C.E., etc., in a report on the Diesel engine, says: "The Diesel petroleum motor is much better than any other petroleum motor. It has especially the following advantages: (1) Much greater economy of fuel, and, therefore, of the cost of working. It works with about five-eighths as much oil as petroleum engines hitherto constructed. (2) Much better regulation for varying load, and relatively to other engines, an increased economy of oil at loads less than full load. This is a very important point. (3) Greater facility for using oils of different qualities. (4) The diagrams (indicator) are of a better type than has been obtained before. (5) Nothing can be more convenient than the starting arrangements for the Diesel motor. (6) The two-stroke type has the very great advantage that nearly twice as much power is obtained as from a similar four-stroke engine of the same size and power. (7) I examined the exhaust of the engines, which is very clear and free from unburned oil. The Diesel engine can do with a lighter flywheel than explosion engines, and is therefore cheaper to construct in this respect. The two-stroke Diesel motor will have equal uniformity with a lighter flywheel."

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The following table, which shows the cost per brake horse-power of various oil-engines and the Diesel engine, shows the cheapness of the Diesel motor. The figures are for cost at full load, and are taken from the oil-engine trials of the Highland Agricultural Society of Scotland, 1899, with the exception of the Diesel motor figures.

Name.	Horse-power.	Cost in pence per brake horse-power.
Crossley	16	0·650
Campbell	20	0·940
Stephenson	5	1·330
Blackstone	8	0·658
Tangye	17·5	0·636
Pollock	10	0·938
Cundall	8	0·782
Diesel	Any power	0·226

Much more might be written on the subject, but further information can be found in Diesel's book, "Rational Heat Motor" (Spon), and Diesel's paper in the *Zeitschrift Ver. Deut. Ingen.*, 1897, published also in the *Progressive Age*, December, 1897, and January, 1898. The pamphlets of the Diesel Engine Company also contain much information. I am indebted to all the above sources.—A. C. G. I.

Answer to No. 634 (*awarded* 7*s.* 6*d.*).—The Diesel engine was invented some eight years ago by Herr Rudolph Diesel. At first it could not be considered a success. Indeed, prophecy was of its ultimate failure, which prophecy has, however, proved entirely wrong. Subsequent to 1898 progress in improvement has been very rapid. Structural simplifications made in 1901, which increased the mechanical efficiency of the mechanism, but which at the same time reduced the cost of construction, have brought the design to something like finality in respect of the one type now chiefly built—viz., the vertical inverted marine type. One reason why the Diesel engine has suddenly become an important industrial factor is the discovery that the rawest and crudest oils and naphthas can be utilised in it with as great facility as can paraffin or other refined oils. The crude oils are as rich in heat of combustion as are the refined oils, and it only remained to discover the proper way to use them in order to reduce in a very large ratio the cost of generating mechanical horse-power from liquid fuel. The Diesel engine, which can consume petroleum refuse with little or no trouble, reduces the cost of a horse-power to less than that obtained by any but the best triple-expansion superheat steam-engine.

Theory.—Herr Diesel, after careful analytical and experimental study of the present forms of heat engines, and after comparing their cycles of operation with the ideal Carnot cycle, concluded that all existing engines were worked on defective principles, and that no radical improvement in their efficiencies could result until the principles of working were altered. Rationally following up this destructive criticism, he then proceed to construct a new process for utilising the heat of a combustible in the internal-combustion engine, and finally laid down the following conditions as being essential for the utilisation of the maximum amount of heat in the combustible. The following is the cycle of operations: first stroke takes in air alone; second stroke compresses this air to a high pressure (35 atmospheres = 500lb. on the square inch and a temperature of about 1,000deg. F); third stroke is the working stroke, during the first part of which the combustion of the fuel is carried on at constant pressure, which is determined by the amount of oil to be sprayed in, which quantity is controlled by the governor—the second part of this stroke is approximately an adiabatic expansion; fourth stroke exhausts the gases.

It will be seen that the leading feature of this engine is (as Herr Diesel describes it) that of compressing the air to incandescence. No such temperature, however, really appears. The temperature reached at the end of the compression is lower than that developed later towards the end of the period of combustion, and this latter is only what occurs inevitably in explosion oil and gas engines worked under similar conditions. The temperature after purely adiabatic compression would according to theoretic calculation be about 1,000deg. F., but as the cylinder lining is thoroughly water jacketed, and, therefore, considerable cooling takes place during the compression, the actual temperature must be a good deal below this level.

There are four leading features of the Diesel engine that distinguish it from all other oil and gas engines: (1) The attainment of the temperature necessary for ignition by mechanical compression alone, so that all injected flame, or incandescent tube, or electric spark, or any other extraneous igniting devices are abolished. (2) The injection of the fuel takes place only after compression has been completed, and only during the first part of the working stroke; the compression in the working cylinder being that of air alone, therefore no explosive mixture exists in the cylinder before the beginning of the working stroke, and no premature ignition is ever possible. (3) The third feature is that the fuel is injected gradually into the highly-heated air, each drop of the spray burning immediately and quietly, so that no explosion takes place, while the period of injection and the quantity injected are delicately regulated by the governor in accordance with the demand for power. (4) The fourth feature is that the governing is effected within the four-stroke cycle period of thermodynamic action, and every such period has its working stroke. Most, if not all, other gas and oil engines are governed by the total cut out of the fuel injections during one or several such periods. Thus, with equal flywheel power the running is much steadier, and its speed uniformity coefficient is such as makes it very suitable for direct coupling to electric light dynamos.

Advantages.—(1) Being an internal-combustion engine, and not an explosion engine, it can at any time, without previous heating, be started from rest, and after a few revolutions take up the full load without further trouble. The operation is as follows: The engine is started by compressed air stored in what is known as the starting reservoir under a pressure of 800lb. upon the square inch, the said reservoir being charged by the air-pump during the previous run of the engine. (In the case of a new engine the makers send out these reservoirs ready charged. There is little or no danger of these vessels losing a charge; they have been known to stand from eight weeks to four months before the engine was started from them.) Assuming the engine to be left standing from the previous day's run, then with oil tanks charged and lubricators in order the engine is set just past the top dead centre. The screw-down valves on blast and starting reservoirs are opened. The engine now starts off as an air-driven engine. After five or six revolutions under these conditions the lever is thrown back. The engine will then start on its normal cycle as an oil-engine. The starting of the engine is very simple and quite certain, whether it has been stopped for a few minutes or for days, or, as before stated, even for weeks. (2) There is absolutely no smell, and the exhaust is free from unburnt gases; indeed, the gases are perfectly colourless and invisible when the engine is loaded, and upon test was found not to brown or discolour a sheet of pure white paper held close over the end of exhaust pipe for three minutes. When the engine is running without load, light wreaths of visible vapour come from the exhaust. (3) The combustion being complete, there is no carbon deposit to interfere with the working of valves or piston. After numerous examinations and prolonged running, the inside of cylinder, valve faces, and seats have been found perfectly clean and free from deposit, this deposit being one of the weak spots in all other gas or oil engines. (4) Small floor space being of the inverted marine type. (5) The ignition taking place inside the cylinder, and there being no external flame, hot tube, or electric spark, reduces the risks from fire to a minimum, and from an insurance point of view it is the safest engine imaginable.—E. FIELD.

Answer to No. 634 (*awarded* 5*s.*).—A fairly average estimate of the way in which the heat delivered to any ordinary internal-combustion engine is used is as follows: Heat converted into work, 20 per cent.; heat lost by radiation and conduction, 40 per cent.; heat lost in exhaust gases, 40 per cent. This gives a thermal efficiency of only 20 per cent. The theoretical maximum with a Carnot cycle is slightly over 72 per cent. Diesel set himself the task of devising means whereby the practical efficiency of 20 per cent. might be brought much nearer the theoretical efficiency of 70 per cent. The system of working common

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to most internal-combustion engines—viz. (1) turning the fuel into gas, (2) mixing the gas with air, (3) compressing the mixture to about 80lb. pressure per square inch, and then igniting it by means of an extraneous igniting device—he condemned as being radically wrong. After making numerous experiments in order to discover the most economical method of utilising the fuel in an internal-combustion engine, Diesel came to the conclusion that he could not do better than to use the fuel in conjunction with air. He then laid down the following conditions for the most efficient working of an internal-combustion engine: (1) The temperature of combustion must not be produced by and during combustion, but independently of it and before its commencement, by the compression of pure air. (2) The combustible must be introduced gradually into the air thus brought up to the temperature of combustion by compression in such a manner that as heat is produced it is entirely absorbed by expansion of the gases, so that no internal work (as a rise of temperature would indicate) is produced, but only external mechanical work. If this condition were realised in practice, there would be no radiation losses, and no cooling jacket would be required. (3) A considerable surplus of air should be present beyond that theoretically required for complete combustion.

The Diesel engine works on a four-stroke cycle, which takes place as follows: (1) Fresh air is drawn into the cylinder during the outward stroke of the piston. (2) The air is compressed during the inward stroke to a high pressure, and consequently to a high temperature. (3) Fuel is admitted to the cylinder during the first part of the next outward stroke, combustion taking place as the fuel comes into contact with the highly-heated air. After the supply of fuel is cut off, the piston continues the rest of the outward stroke under the expansion of the gases, as usual. (4) The piston then returns, expelling the contents of the cylinder: this completes the cycle.

The advantages of the Diesel engine over a good make of ordinary oil or gas engine are as follows: (1) A thermal efficiency of nearly 40 per cent. has been obtained—this renders the engine very much more economical than the ordinary internal-combustion engine. (2) The attainment of the temperature necessary for ignition by mechanical compression alone, so that all extraneous igniting devices are abolished. (3) The injection of the fuel only after compression has been completed, and only during the first part of the working stroke; the compression in the cylinder being that of air alone, no explosive mixture exists in the cylinder before the beginning of the working stroke—premature ignition is thus impossible. (4) The fuel is injected gradually into the highly-heated air, each drop of the spray burning immediately and quietly, so that no explosion takes place, while the period of injection and the quantity injected are delicately regulated by the governor in accordance with the demand for power. It will thus be noticed that the governing is effected within the cycle, and every cycle has its working stroke. A large number of gas and oil engines are governed by the complete cutting out of the impulse from one or more cycles; the Diesel engine gives much steadier running with the same flywheel power than engines governed on the hit-or-miss principle. The engine is thus very suitable for connecting directly to dynamos. (5) The consumption of fuel per indicated horse-power is less at partial than at full loads, due mostly to the increased ratio of expansion. (6) The quantity of cylinder oil required by the Diesel engine is considerably less than that required by the ordinary gas or oil engine. The Diesel engine can also be adapted to work with coal dust or gas.—W. T. W.

PROVISIONAL ORDERS.

The additional following notices of intended application for provisional orders appear in the *Gazette*:

ELECTRIC LIGHT AND POWER.

Tamworth Corporation, electric light; Manchester Corporation, general powers (including electrical sub-station); Hampton-in-Arden Gas Company, electric powers; Skipton Urban District Council, supply of electric fittings; North Staffordshire Railway Company, electric power; Epsom (Surrey), Electrical Power Distribution Company, electric lighting; Acton, Metropolitan Electric Supply Company, lighting; Sutton-in-Ashfield Urban District Council, electric light; Brentwood Urban District Council, electric lighting; Ashford (Kent) and District Electric Supply Company, lighting; Milford-on-Sea Electric Supply Company, lighting; Devizes Urban District Council, electric lighting; Tavistock and District Electric Supply Company, lighting; Swindon Corporation, electric power; Derbyshire and Nottingham Electric Power Company; Chippenham Corporation, electric lighting; Doncaster Corporation, electricity supply extension; Widnes Corporation, electric light; Heysham Urban District Council, electric light; Stroud, Nailsworth, and Duraley (Gloucestershire Electric Power Company), lighting; Clevedon, Portishead, and Long Ashton (Western Electric Distributing Corporation, Limited), lighting; Ramsgate District Electric Supply Company, lighting; Bath Rural District Council, electric lighting; Walton-upon-Thames Urban Electric Supply Company, lighting; East London and Lower Thames Electric Power Company; Wanstead (Empire Electric Light and Power Company), lighting; Kirby-in-Ashfield Urban District Council, electric lighting; Kettering Urban District Council, electric power and light; Hampton Wick (Twickenham and Teddington Electric Supply Company), lighting; Sunderland (Durham Electrical Power Distribution Company, Limited), lighting; Newton Abbot (Urban Electric Supply Company), lighting extensions; Melksham Urban District Council, electric lighting; Maldens, Coombe, and Ham (Twickenham and Teddington Electric Supply Company), lighting: Bristol Corporation, electric lighting; North Worcestershire Electric Power Company, lighting; Brentford (Empire Electric Light and Power Company, lighting; Brynmawr Urban District Council, electric lighting; Southgate Urban District Council, electric lighting; Trowbridge (Western Electric Distributing Corporation), lighting and power; Mid-Shropshire (Worcestershire Electric Power Company), lighting and power, Acton (Empire Electric Light and Power Company), electric lighting and power; Brighton Corporation; Dewsbury Corporation; Dundee and Broughty Ferry and District; Folkestone Corporation; Glasgow Corporation; Leith Corporation; Liverpool Corporation (extensions); Ossett Corporation; Plymouth Corporation; Rochdale Corporation; Abercarn; Andover; Barhead; Beddington, Coulsdon, and Sanderstead; Bothwell District; Caerphilly Urban District Council; Cannock and District; Crediton; Dunfermline; Eastleigh and Bishopstoke; Eastwood and Cathcart; Glastonbury Corporation; Hanwell; Houghton-le-Spring and District; Johnstone; Kilpatrick; Kingswood; Lanark; Lothians; Maidenhead (extension); The Maldens and Coombe and Ham; Musselburgh; Penzance; Portpatrick; Renfrew; Rutherglen; Shettlestone; Sunderland Districts; Bradford-on-Avon Urban and Bradford-on-Avon Rural; Vale of Leven; Walton-le-Dale.

TRAMWAYS.

Aldershot and Farnborough Light Railway Commissioners: Newcastle-on-Tyne Corporation; Watford and District Tramways Company; Leeds Corporation; Isle of Thanet Light Railway Company; East Ham Urban District Council; Barrow-in-Furness Corporation; Stretford Urban District Council; Bristol Tramways Company, extensions; North and South Woolwich Electric Railway Company; Penarth Tramways Company; Soothill Nether Urban District Council; Llanelly Urban District Council; Bishop Auckland, Shildon, and Spennymoor (United Tramways, Light Railways, and Electrical Syndicate, Limited); Calverley Urban District Council; London, Camberwell, and Dulwich Tramways Company; Southport and Lytham Tramroad Company; London County Council; Ilford Urban District Council; Radcliffe Urban District Council; Tyneside Tramways and Tramroads Company; Dewsbury Corporation; Coulsdon (Croydon Rural District Council); Preston and Blackburn Tramways Company; Preston, Chorley, and Horwich Tramways Company; Manchester Corporation; Romford (Empire Electric Light and Power Company); Hope and Castleton Light Railway Commissioners; Liverpool Corporation; Morley and District Light Railway Commissioners; Sunderland Corporation; Middlesbrough, Stockton-on-Tees, and Thornaby (Imperial Tramways Company); Chesterfield Corporation; Belfast Corporation; Harrogate Waterworks Tramroads; Holywood; Mid-Cheshire; Preston and Lytham; Torquay; West Riding.

The total provisional orders of all kinds applied for is 272, as compared with 294 deposits for the session of 1903.

NEW COMMITTEES.

BEDFORD.—*Electricity*—Revised list: Alderman Kilpin, chairman; Councillor Talbot, vice-chairman; the Mayor (Alderman E. L. Moulton); Aldermen Carruthers and Walker; Councillors Black, Carter, Howard, Hockliffe, Jarvis, and Halliley.

CARDIFF.—*Electrical and Lighting*—Mr. P. Carey, chairman; Mr. Alfred Good, vice-chairman.

CROYDON.—*Lighting and Electricity*—Alderman Miller, chairman; Councillor Rogers, vice-chairman.

GRAVESEND.—*Electricity*—Councillor Enfield, chairman.

ISLINGTON.—*Lighting*—Alderman Mills, chairman; Alderman Walkley, vice-chairman.

MAIDSTONE.—*Light Railways*—The Mayor; Deputy Mayor; Aldermen McVitie and Brownscombe; Councillors Vaughan, Baker, Britt, Elmore, Tomlin, Wallond, Manning, and Styles.

Agency.—Messrs. Plutte, Scheele, and Co., 18 and 19, Queenhithe, E.C., have been appointed agents for the United Kingdom for Messrs. Schmahl and Schulz, of Barmen, manufacturers of electric light accessories.

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LONDON TRAFFIC ENQUIRY.

On the 26th ult. the Royal Commission on London Locomotion held a further sitting, when **Mr. J. H. Brown,** representing the Battersea Borough Council, gave evidence as to the views expressed at a conference of borough councils Witness referred to the congestion at present existing at Clapham Junction, and suggested the extension of the South London Electric Railway from Clapham to the neighbourhood of Battersea Rise. His Council was strongly in favour of the appointment of a traffic tribunal by the Government which would bring into line the various schemes of communication of all kinds.

By the Chairman: His Council would willingly surrender their tramway veto to the tribunal, but they objected to surrender it to the London County Council. He felt that the County Council should be the tramway authority of London, rather than private companies. He did not know how they could induce the South London Electric Railway to extend their undertaking. He could not say whether they ought to be subsidised.

Sir George Trout Bartley: Would not the South London Electric Railway extend their line if it was thought to be profitable?—If it would pay a good dividend.

Why is it not done?—I do not know.

By the Chairman: He would allow the tribunal to hear proposals from private promoters, and allow them to approve of schemes.

Mr. H. G. Hills, town clerk of Wandsworth, gave evidence of a somewhat similar character. He suggested the extension of the tube railway from Clapham to Tooting and to Streatham Common. He also thought that a transit system should be formed on the loop line between the London and South-Western Railway and the London, Brighton, and South Coast Railway, and that a quick and frequent service of trains should be run from Waterloo *viâ* Clapham Junction, Wandsworth, East Putney, Southfields, Wimbledon, Merton, Tooting Junction, Streatham, Tulse-hill, Ludgate-hill, or London Bridge, or branching off from Tooting Junction to Balham, Wandsworth Common, Clapham Junction, and Victoria.

On the following day **Mr. J. H. Robinson** gave evidence on behalf of the Stepney Borough Council. With regard to the view expressed by Mr. G. L. Gomme, on behalf of the London County Council, that the supervision of the breaking up of streets by private companies should be transferred from the borough councils to a central authority, witness said that presumably the central authority was intended to be the London County Council. The Stepney Borough Council strongly opposed that suggestion, on the ground that the borough councils had in the past discharged their duties with efficiency.

Mr. James Rush Dixon, the surveyor to the metropolitan borough of Shoreditch, said that in the opinion of his Council it would relieve congestion if passenger subways were provided under such places as the intersection of Old-street and Kingsland-road, Shoreditch High-street and Great Eastern-street and Commercial-street. Owing to the exceptionally heavy debt of Shoreditch and the recent immense increase of rates, some new source of income would have to be found if the necessary street improvements were to be undertaken.

Mr. F. S. Robinson, town clerk of the metropolitan borough of Greenwich, gave similar evidence, and the Commission adjourned.

LEGAL INTELLIGENCE.

THE SPEED OF ELECTRIC TRAMCARS.

At the South-Western Police Court on Tuesday morning, Mr. Moffat Ford attended before Mr. Garrett in the matter of the 10 summonses he had issued against the drivers of the London County Council electric tramcars for exceeding the legal speed limit.

Mr. Ford stated that the Highways Committee of the County Council had now reported upon the Motorcar Act of 1903, and in their report the committee professed entire agreement with the Local Government Board that "the expedients provided by the Act for the reduction of the speed limit of motorcars to 10 miles an hour should not be resorted to." He (Mr. Ford) had been led to believe that his efforts in showing the absurdity of the 10-miles-an-hour speed limit had not been entirely without effect in the decision the committee had arrived at. The full committee of the Council were meeting that afternoon, and he should not like them to be under the impression that, in spite of the recommendations of the committee, the summonses were inevitably to be heard on Thursday next. Under the circumstances he did not feel justified in carrying the matter to any further extreme than necessary, and he suggested that, pending the final decision of the full Council, the summonses might be adjourned *sine die*. A representative of the Council was in attendance, and he understood that this gentleman was prepared to agree to the course he suggested.

The **Magistrate,** in reply, said that he considered Mr. Ford's suggestion a very proper one.

The summonses were accordingly adjourned *sine die*.

IN BANKRUPTCY.

In the matter of William Henry Hooley and John William Talbot, carrying on business, in co-partnership, under the style of Hooley, Talbot, and Co., at Regent-street, Rugby, as electrical engineers and contractors, the official receiver (Mr. E. T. Peirson) has issued a summary of the debtors' statement of affairs. This shows gross liabilities of £339. 13s., of which £271. 8s. 4d. is expected to rank. The assets, after deducting preferential creditors' claims, are estimated to produce £106. 15s. 4d., leaving a deficiency of £164. 13s. In the separate estate of William Henry Hooley the deficiency is put down at £2. 16s., and in that of John William Talbot of £1. 1s. 11d. Debtors give as the cause of failure "insufficient capital, delay of the urban district council in supplying electric light, and loss upon a contract owing to the action of one of our customers."

COMPANIES' MEETINGS AND REPORTS.

ARON ELECTRICITY METER.

In their report for the year ending Sept. 30, 1903, the directors state that the profit and loss account for the year, after providing for depreciation and the share of expenses and discount on the issue of debentures, show a net profit of £2,125 18s. 8d., which has been carried to the debenture sinking fund in accordance with the provisions of the trust deed. The directors are pleased to record a considerable change for the better in the affairs of the Company, which may be ascribed to the following causes: the apparent revival of the electrical industry on the Continent has created a proportionately larger demand for Aron meters, especially in Germany; the completion of the factory at Schweidnitz has enabled the Company to manufacture both cheaper and more advantageously; the manifest advantages of the Aron meter have created a reaction in its favour, which is distinctly noticeable in quarters where other instruments were afforded encouragement in recent years. The increased sales during the last year led your directors to expect better results than have actually been attained; the economies effected in the manufacture have, however, so far not been sufficiently large to compensate for the required reduction in the selling prices. The directors have persevered in their efforts to stimulate business in England, and the expenditure incurred thereby has materially reduced the profits for the year. Prof. Aron has successfully completed his experiments in connection with the production of a new and cheap meter for alternating currents, which will shortly be placed on the market. Two of the directors, Messrs. S. Barclay Heward and Mr. R. W. Wallace, K.C., retire from office by rotation this year, but being eligible, offer themselves for re-election.

NEW COMPANIES REGISTERED.

Kingswood Electric Supply Company, Limited.—Capital, £1,000. Object: to adopt an agreement with the Bristol Trust, Limited, to carry on the business of suppliers of electric light, heat, motive power, or otherwise, electrical engineers, etc. Registered office: 46, Newman-street, Oxford-street, London.

Archibald J. Wright, Limited.—Capital, £3,000. Object: to acquire and carry on the business of A. J. Wright, 318, Upper-street, Islington, of electrical and mechanical engineers, dealers in electric, magnetic, telegraphic, telephonic, other appliances, cycle and motorcar manufacturers, etc.

CONTRACTS FOR ELECTRICAL SUPPLIES.

Maidstone.—The Corporation invite tenders for the construction and equipment of light railways. Tenders by Dec. 7.

Preston.—The Corporation invite tenders for a traction switchboard and accessories. Tenders by Dec. 12. See advertisement in last issue.

London, N.—The Hornsey Borough Council invite tenders for the supply of 100 cast-iron lamp columns. Specifications from the Surveyor. Tenders by 14th inst.

Pontypridd.—The Urban District Council invite tenders for free wiring, and for Section O, the supply of tramcars. Tenders by 24th inst. See advertisement.

Stockton-on-Tees.—The Corporation invite offers for hiring or hire-purchase system for motors to be fixed on their mains. Tenders by 15th inst. See advertisement.

Govan.—The Corporation invite tenders for the supply, delivery, and erection of coal bunkers, conveyor, and electric capstan. Tenders by 28th inst. See advertisement.

Birmingham.—The Birmingham Tame and Rea District Drainage Board, 9, Bennett's-hill, Birmingham, invite tenders for three steel Lancashire boilers. Tenders by Dec. 8.

Greenwich.—The London County Council invite tenders for the supply, delivery, and erection of four 3,000-kw. generators with exciters. Tenders by 10 a.m. on Dec. 8.

York.—The North-Eastern Railway Company invite tenders for telegraph apparatus, telegraph wire, and line stores. Forms of tender from Mr. C. H. Ellison, superintendent, York. Tenders by Dec. 7.

Greenwich.—The London County Council invite tenders for six electrically-driven three-throw boiler feed pumps. Specifications, etc., at the County Hall, Spring-gardens, S.W. Tenders by Jan. 19.

Stockport.—The Corporation invite tenders for supply and laying of about 1¾ miles of distributing cable. Specifications from Mr. A. J. H. Carter, Electricity Works, Stockport. Tenders by 10th inst.

Cape Town (South Africa).—The Directors of the Cape Town Industrial Exhibition (International) invite offers for lighting the

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grounds, etc. Tenders to Palmerston House, Old Broad-street, London, E.C.

Sydney (N.S.W.).—Tenders are asked for the supply of continuous and alternating current meters. Specifications, conditions, and forms of tender are obtainable from Messrs. Preece and Cardew, 8, Queen Anne's-gate, S.W.

London, W.—The Great Western Railway Company invite tenders for the supply, delivery, and erection of water-tube boilers, engines, three-phase generators, and auxiliary plant at Park Royal, near Acton. Tenders by Dec. 7.

North-Eastern Railway.—The Directors invite tenders for arc lamp carbons and electric wires and cables, etc., for the first half of 1904. Specifications, etc., from Mr. E. H. Clark, Stores, Gateshead. Tenders by Dec. 7.

Warrington.—The Electricity Committee invite tenders for the supply of earthenware ducts for the drawing-in system of mains. Specifications from the Electrical Engineer, Howley, Warrington. Tenders by 14th inst.

Glasgow.—The Corporation invite tenders for (1) 2in., 4in., and 6in. cast-iron pipes, with trough ends for cables; and (2) cast-iron fuse-boxes. Specification from Mr. W. A. Chamen, 75, Waterloo-street, Glasgow. Tenders by 7th inst.

King's Norton (Birmingham).—The Urban District Council invite tenders for about two miles of electric cable for tramways, including laying. Specifications from Mr. C. H. Gadsby, 20, Victoria-street, Westminster, S.W. Tenders by 10th inst.

London County Council Tramways.—The Council invite tenders for the wiring and fitting for electric lighting of five sub-stations and three car-sheds in connection with the tramways. Tenders by Dec. 5. See advertisement in former issue.

Brighton.—The Council invite tenders for six water-tube boilers; a system of steam, exhaust, feed, blow-off, and suction pipes; and cast-iron storage tanks. Specifications, etc., may be obtained from Mr. Francis J. Tillstone, Town Hall, Brighton. Tenders by Dec. 7.

Christchurch (New Zealand).—Tenders are invited for the complete installation of electrical tramways, other than buildings. Specifications, etc., may be obtained from the Agent-General for New Zealand, Victoria-street, S.W. Tenders by March 17. See advertisement.

Manchester.—The Electricity Committee invite tenders for the supply, delivery, and erection at the Stuart-street station of cast-iron plates for tops of flues, dampers, and opening apparatus. Specifications from the Secretary, Electricity Department, Town Hall. Tenders by 11th inst.

Belfast.—The Committee invite tenders for the supply and erection of a complete heating and ventilating system, including steam boilers, heaters, etc., engines, blowers, and electric fans. Tenders by Dec. 4 to Messrs. Young and Mackenzie, architects, Scottish Amicable Buildings, Belfast.

Culiacan (Mexico).—Tenders are invited for lighting the town by electricity: 60 arc lamps of 1,200 c.p. and 110 incandescents of 50, 30, and 16 c.p. will be required. Propositions will be received by letter until Dec. 31 in the Secretaria del Ayuntamiento, Culiacan, where further information may be obtained.

West Ham.—The Education Committee invite tenders for the electric wiring and fittings and for the hot-water heating apparatus required at the Whalebone-lane Higher Elementary School, Stratford, E., and Shipman-road School, Custom House, E., now in course of erection. Tenders by Dec. 14. See advertisement in former issue.

London, S.W.—The London County Council invite tenders for the supply and delivery of about 6,850 tons of steel girder tramway rails, fishplates, and bolts and nuts, and for 4,100 tons of steel slot rails, and 1,490 tons of steel conductor tee rails required for electric traction on the Council's tramways. Specifications, etc., from Engineers' Department, and tenders to the Clerk, County Hall, Spring-gardens, by Dec. 15.

Sydney (New South Wales).—Tenders will be received at the office of the Deputy Postmaster-General, Sydney, New South Wales, up to 2.30 p.m. on Dec. 30, for the supply and delivery at the departmental stores, Sydney, of telegraph, telephone, and electric light material. Specifications, etc., may be seen and tender forms obtained at the General Post Offices, Sydney, Melbourne, Brisbane, Adelaide, Hobart, and Perth.

Italian Arsenals.—Tenders are invited for the supply of electric lamps for the lighting of Italian warships, and will be received simultaneously at the Directorates-General of Royal Arsenals at Spezia, Naples, and Venice, at 11 a.m. on Dec. 1. The electric lamps to a total value of 40,000 lire (about £1,600) are to be delivered at the Royal Arsenals at Spezia, Naples, Venice, and Taranto. Particulars may be obtained from the Admiralty, Rome.

RESULTS OF TENDERS.

Paisley.—Messrs. Bruce Peebles and Co., Limited, Edinburgh, have obtained the tender for a 1,600-kw. traction and lighting generator for the Corporation.

Newport (Mon.).—The Borough Council have accepted the tender of Messrs. Johnson and Phillips, who were the lowest of 36 tenderers, for three 50-h.p. motors, etc.

Oldham.—The tender of H. A. Jackson and Co., Standish-street, Burnley, has been accepted for arc and incandescent lighting and power circuits in Greenhill station.

Croydon.—A tender has been accepted of Mirrlees, Watson, and Co., Limited, for condenser, air-pumps, etc., for a capacity of 36,000lb. of steam per hour, piping, and Koppel cooling tower, at £2,709.

Johannesburg.—Messrs. A. W. Penrose and Co., 109, Farringdon-road, E.C., have secured the entire order for generating plant, including engine, dynamos, etc., and also that for the two passenger and one goods lifts, for the new building of Messrs. Harvey, Greenacre, and Co., of Johannesburg.

Coventry.—The Electric Lighting Committee have accepted the following tenders: for the construction of turbine and condenser foundations, E. Morley, £834; and for turbine steam-piping, George Fletcher and Co., £167.

Sunderland and District Tramways.—Messrs. Bruce Peebles and Co. have obtained the contract for the complete equipment of 1,000-h.p. power-house, complete overhead equipment for 19 miles of track, and 60 complete electric equipments for double-deck tramcars, including cars, for the Sunderland and District Tramways. The contract amounts to about £81,000.

Gravesend.—The British Westinghouse Company have secured the contract for the supply of a 100-kw. steam dynamo for the Gravesend Corporation. The set will consist of a Westinghouse generator driven by a Belliss and Morcom steam-engine of standard pattern, running at 475 revolutions per minute. It will be shunt-compound wound, and will give 460 to 550 volts, according to the arrangement of the windings.

Dartford.—The Metropolitan Asylums Board have received the following tenders for installing a complete system of telephones at the Darenth Asylum, Dartford, Kent:

P. Dewhurst, 24, Birley-street, Blackpool (accepted)	£245 10 0
E. T. Mackrill and Sons, Aylesbury, Bucks	247 13 7
F. Hodgson and Co., 24, Queen Victoria-street, E.C.	257 18 0
Cox-Walkers, Darlington	263 0 0
Private Wire and Telephone Installation Company, Limited, 5, Palmer-street, Westminster, S.W.	284 17 0
W. Defries, 146-7, Houndsditch, E.C.	289 0 0
New System Private Telephone Company, Limited, 36, King William-street, E.C.	298 18 10
Western Electric Company, 171, Queen Victoria-street, E.C.	319 4 0
Wippell Bros. and Row, 243-4, High-street, Exeter	340 0 0
G. Weston and Sons, 153, Fenchurch-street, E.C.	344 0 0
J. Sax and Co., Limited, 51, Rupert-street, W.	345 0 0
Ward Bros., Bevois House, 28A, Basinghall-street, E.C.	345 12 9
H. G. Rider and Co., 27, Chancery lane, W.C.	349 0 0
British Home and Office Telephone Company, 49, Finsbury-pavement, E.C.	364 0 0
W. H. Saunders and Co., 1, Palmer-street, Westminster, S.W.	369 0 0
Comyn Ching and Co., Limited, 54, 56, 58, Castle-street, Long-acre, W.C.	374 0 0
B. and R. Durant, Chapeltown, Sheffield	413 13 5
Fuller, Macleod, and Co., Limited, 9, Red Lion-court, Cannon-street, E.C.	420 0 0
Jackson Bros., The Broadway, Plaistow	440 0 0
Donnison, Sillem, and Co., 116, Great Portland-street, W.	450 0 0
A. Smith, 54 Hounds-gate, Nottingham	566 0 0
National Telephone Company, Limited, Salisbury House, London-wall, E.C.	620 0 0
F. J. Coleby and Co., 7, Thayer-street, Manchester-square, W.	750 0 0

Bermondsey.—The Council have received the following tenders for Contracts Nos. 14, 15, and 16. Contract 14 is for the feeder cables required in connection with the extension of the supply system; Contract 15 for the extension of arc lighting; and Contract 16 for that portion of the cable work involved in supplying and laying cables through the Surrey and Lavender Dock locks:

Contract 14.

Western Electric Company	£4,967 10 0
Johnson and Phillips	5,071 14 10
Siemens Bros.	5,278 18 0
Callender's Cable Company	5,371 8 4
Alternative, £5,280. 0s. 2d., lead less than specified.	
British Insulated and Helsby Cables, Limited (accepted)	5,285 4 2
Messrs. Glovers	5,331 16 6
St. Helens Cable Company	5,542 10 3
Alternative, £5,393. 1s. 8d., not to specification.	
Land und Seekabelwerke Aktiengesellschaft	5,732 13 7

Contract No. 16.—(Section A) Cables.

British Insulated and Helsby Cables (accepted)	463 10 10
Henley's Telegraph Works Company	547 2 6
Alternative	611 15 10
Callender's Cable Company	579 7 6
Siemens Bros. and Co.	629 1 8

(Section B) Work in Laying.

British Insulated and Helsby Cables (accepted)	206 10 0
Henley's Telegraph Works Company	498 4 0
Alternative	498 4 0
Callender's Cable Company	1,000 0 0
Siemens Bros. and Co., 10 per cent. over cost price.	

Contract No. 15.

Gilbert Arc Lamp Company, Limited	981 14 6
Crompton and Co. (accepted)	983 5 0
Sir Hiram Maxim Electric and Engineering Company	994 19 10
Drake and Gorham	1,013 13 6
Johnson and Phillips	1,018 19 6
Brockie-Pell Arc Lamp Company	1,051 15 0
Improved Electric Glow Lamp Company	1,060 4 9
Oliver and Co.	1,170 14 0
Brush Company	1,105 6 0
(a) Alternative	1,035 15 0
(b) Alternative	1,361 6 0
Western Electric Company	1,117 10 0

London.—The City of London Electric Lighting Company has recently placed with the British Westinghouse Electric and Manufacturing Company an order for another 1,800-kw. direct-current,

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shunt-wound generator, to be mounted direct on the shaft of the driving engine. This machine will run at 75 revolutions per minute, and will be practically a duplicate of several other 1,800-kw. machines which the British Westinghouse Company has supplied to the same station.

BUSINESS NOTES.

TRACTION.

Leicester.—Major Pringle, R.E., one of the inspectors of the Board of Trade, has made an official inspection of the permanent way of the completed tramway.

Battersea.—The Borough Council have approved the London County Council's scheme for tramways from Clapham Common to East-hill, Wandsworth.

Blackpool.—A new traction generating set will shortly be required for the electricity works in order to supply the Lytham and St. Annes Tramway with energy.

Snowdon.—Notice of an intended application to the Light Railway Commissioners for an order has been given in the case of the proposed Snowdon and Bettws-y-coed Light Railway.

Durham.—The British Electric Traction Company have informed the Town Council that they intend shortly to begin the construction of the authorised tramway from Durham to Brandon.

Electric Railway for Woolwich.—The *London Gazette* contains notice of a Bill seeking power to construct an electric (underground) railway between North Woolwich and South Woolwich.

Brighton.—A public meeting was held this week, when a resolution was carried condemning the action of a minority in obstructing on the Town Council the extension of the tram system to Preston.

Dewsbury.—It is stated that the Corporation are considering the question of purchasing the tramways within the borough. Notice of intention to do this must be given before the end of the year.

Rowley Regis.—At a meeting of the District Council on Monday it was reported that special efforts are being made to secure improved tramway facilities on the Halesowen and Oldbury main roads.

Wigan.—The question of tramway extension from Wigan to Standish has been pending for a considerable time, and there is reason to believe that before long a satisfactory result will be arrived at in the matter.

Liverpool.—The Tramways Committee have decided that the proposed Lodge-lane and Aigburth tramway is not wanted, but it was stated at Wednesday's meeting of the City Council that the matter was entirely in the Council's hands.

Municipal Motors at East Ham.—It is proposed to run municipal motor omnibuses in East Ham. The Tramways Committee of the Urban District Council report being about to visit Hastings to inspect the double-decked vehicles plying there.

Flintshire.—The promoters of the Flintshire tramways scheme have resolved not to seek powers from Parliament next session, but to defer their application till 1905, so as to have the benefit of a more strongly organised and concentrated local support.

District Railway.—It is stated that, owing to a subsidence on the electric section of the District Railway between Park Royal and Alperton, single-line working has been resorted to, the service on the section consisting for the present of one train an hour.

Wandsworth.—The question of the construction of new tramways at Streatham is still under consideration by the Borough Council, who cannot make up their minds to make a contribution towards the cost of the street widenings in spite of popular sympathy with the scheme.

Lambeth.—The Borough Council are going to send a deputation to the County Council to see if the latter will accept £20,000 in respect of street widenings for the tramways instead of £40,000, which is the one-third share of the estimated cost required by the County Council.

Belfast.—The City Council, at their meeting on Tuesday, approved the draft Tramways Bill to be promoted in the next parliamentary session. It was agreed to insert a proviso that the leasing power shall not be exercised without a *plébiscite* of the electors being taken on the question.

Electric Tramways for Minerals.—An electric tramway for the carriage of minerals has been opened from East Pool and Agar United Mines to Tolvaddon stamps. The line has been put down by the Urban Electric Supply Company, Limited, under contract with the mine company.

Swansea.—A movement is on foot amongst Oxford-street and Temple street tradesmen with the object of seeing if the Corporation cannot be induced to abandon the scheme for running the new tramway system through those streets. Major Druitt, of the Board of Trade, has made an enquiry into the objection.

Provincial Tramways Co.—The accounts of the company for the year ended Sept. 30, after setting aside £6,000 for depreciation at Plymouth and Grimsby, admit of the payment of a dividend on the ordinary shares of 3s. per share, making 6s. per share, or 3 per cent. for the year. The balance carried forward will be about £2,700.

Bradford.—A trial trip was run on Monday over the new tramway which has been laid in Church Bank, which provides the steepest gradient on the Bradford tramways—viz., 1 in 9. Mr. C. J. Spencer, the general manager, drove the trial car, and the run was satisfactorily accomplished, the car being pulled up whilst travelling at a fair speed in half its own length.

Poplar.—The General Purposes Committee reported to the Borough Council on Wednesday that, being of opinion that the north and south of London should be better connected, they had approved the proposals of the London County Council to seek powers to construct tramways from East India-road, through the Blackwall Tunnel, to Greenwich.

Glasgow.—The Corporation have agreed to fit covers to the upper decks of one or two cars by way of experiment. The Kirkintilloch Town Council intend to send a deputation to the City Tramways Committee urging an extension of the lines to that town. The extension from Partick to Cambuslang was opened for traffic on Wednesday. The distance is 8½ miles.

Beckenham.—At the last meeting of the Town Council, the question of the system of traction to be adopted on the proposed tramways was debated at length. The committee advocated the overhead trolley, but eventually it was decided to entertain the conduit system as an alternative system, and it was agreed to communicate with the British Electric Traction Company in the matter.

Devonport.—A sub-committee of the Corporation Tramways Committee has received a report from the borough surveyor as to the probable cost of certain road widenings and improvements required by the Devon County Council as a condition to their consent to the proposal to construct a light railway from the borough boundary to Crownhill. The report was afterwards accepted by the Tramways Committee.

Wakefield.—The Leeds Corporation Tramways Committee at their meeting on Monday received an application from the Wakefield and District Tramways Company for permission to run cars over the Leeds Corporation lines from Thwaite Gate into the centre of the city. It is the intention of the Corporation to establish connection with the Wakefield tramways in the manner suggested, but the matter was postponed for further consideration.

Withington.—The Council at their last meeting decided that, after considering the memorials and correspondence for and against the proposed tramway extension to Chorlton-cum-Hardy, the construction of a double line of tramways along the Wilbraham-road and Alexandra-road South to the boundary of Moss Side be carried out. A sub-committee was authorised to conclude the negotiations with the Manchester Corporation as to the terms of the lease.

Woolwich.—The consent of the Borough Council has been given to the proposed doubling by the London County Council of the existing tramway from Beresford-square to High-street, Plumstead, to the county boundary. Upon condition that the London County Council grant a loan for the purpose, a contribution is to be made by the Borough Council of one-third of the cost of the necessary street widening, such contribution not exceeding the sum of £4,800.

Paddington.—The Borough Council on Tuesday considered a letter from the London County Council asking for consent to a proposed tramway from the Marble Arch to Cricklewood and for a contribution of one-third of the cost of the necessary street widenings. The recommendation of the special committee was against the proposal, but an amendment that the Borough Council would consider the scheme provided that the County Council agreed to bear the entire cost of the street widenings was carried by a large majority.

Leith.—The Town Council have published notices of their intention to apply for a provisional order in next session of Parliament for power to acquire from the Edinburgh Street Tramways Company the existing tramways in Leith, to construct new tramways, and make agreements for promoting through traffic between the Leith lines and the Edinburgh lines. They ask power to acquire the existing tramways, and to have any agreement entered into, or that may be entered into by them, with the Edinburgh Street Tramway Company confirmed.

Aberdeen.—On Saturday morning Colonel P. G. von Donop made his official inspection of the Ferryhill and Torry sections of the Corporation tramways. The inspector expressed himself as perfectly satisfied with the manner in which the lines had been constructed, and commented favourably on the smoothness of the running. He was asked that on this section the maximum speed of 14 miles per hour should be allowed, but Colonel von Donop said that he never granted the maximum speed within a municipal boundary. He fixed the speed at 12 miles an hour.

Islington.—Having regard to the difficulty of dealing with certain bridges, the London County Council asked the Borough Council to consent to the adoption of the overhead trolley as against the conduit system in the electrification of portions of their northern tramways. The Works Committee of the local Council now report, however, that they are strongly in favour of the conduit system, and find that Finsbury, Hackney, Shoreditch, and Stoke Newington all agree with them that "the overhead trolley system is totally unsuited to the needs of London north of the Thames."

Seaham.—The District Council have passed a resolution to the effect that a committee be appointed for the purpose of considering and ascertaining what steps can advantageously be taken by the Council, either alone or by co-operation with any other public authority, company, or persons, with a view to bringing the Council's district into more convenient or direct communication with Seaham, Murton, Easington, and Horden Collieries and the surrounding districts, and more particularly as to the desirability of the construction of a coast road uniting Seaham Harbour to the collieries to the south and a light railway or tramway to Murton Colliery.

Edinburgh.—The directors of the Edinburgh and District Tramway Company have intimated to the Leith Corporation, with regard to the negotiations between them for the working of the Leith tramway system and the securing of through traffic between Edinburgh and Leith, that they cannot approve of the conduit-cable combination by which it was proposed Leith electric cars should be carried over a portion of Edinburgh cable lines, and that the only alternative solution of the difficulty was the carrying of the cable into Leith, to the foot of Leith-walk. This the Leith Town Council will not agree to, and negotiations have been broken off.

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Derby.—The contractors have commenced the work of erecting the poles in connection with the new electric tramways on certain routes. The committee have decided to substitute wood paving for granite paving in St. Peter's-street, from East-street to the spot, in connection with the construction of the electric tramways, at an extra cost of £431. The extra cost of wood over granite paving for the whole of the remaining routes in the contract will be £38,682. The committee have visited the works of the Brush Electrical Engineering Company at Loughborough with respect to the new electric cars.

Paris Metropolitan.—A Paris message dated Nov. 30 states that another fire occurred on the Metropolitan Railway there in the morning. A workman's train, while travelling on the overhead section about six o'clock, suddenly burst into flames owing to a short-circuit. The train was at once brought to a standstill. Two cars were completely burnt out. The traffic was interrupted for some time. The accident happened not far from the scene of the recent catastrophe which involved such great loss of life. Shortly after traffic had been resumed another fire occurred near the station of the Boulevard Barbes. The motorcar of the train was burnt. There were no casualties.

Newcastle.—A special meeting of the Town Council is to be held on Tuesday to consider the proposed Bill for next session of Parliament, in which extensive tramway powers are sought. At Wednesday's meeting of the Council the Tramways Committee presented a report recommending that application be made to the Board of Trade for sanction to borrow £192,516 for tramway purposes. Up to the present the tramways have cost £1,061,632 for 40 miles of track and equipment, and the amount already sanctioned is £869,116. For tramway purposes under the Act of 1899 it was estimated that a further sum of £192,516 would be expended on the completion and equipment of the tramways. The report stood over for consideration.

Bristol Accident.—A coroner's jury on Wednesday investigated the circumstances of the fatal tramway accident at Bristol. The evidence showed that the driver lost control of the car while descending a steep hill from Clifton Downs, with the result that there was a collision with another car travelling in the same direction. A cyclist named Charles Healls was caught between the cars and died three days later from his injuries. The driver, who was seriously hurt, said that the brakes failed to work, though they were afterwards found to be in good order. The jury returned a verdict of accidental death, and attributed the collision to the driver's "error of judgment" in failing to put forward the "reverser" before starting the car.

Holborn-to-Strand Shallow Tramway.—Already some 395ft. of this tramway is completed—that from the Gaiety Theatre to Drury-lane, and work on the section to run under the Kingsway has been started. To facilitate this work it is proposed to shut up the western end of Great Queen-street; but this proposal has naturally provoked much indignation, and a meeting of residents and tradesmen of the street held on Tuesday night let it be plainly understood that any attempt to interfere with their business or convenience in the manner suggested would be strongly resisted. A sum of £36,000 has been spent on the section completed, and as this is below the estimate, the Works Department of the Council is congratulating itself on such a satisfactory result.

Additional Traffic Returns.—Anglo-Argentine, £2,122 increase; Barcelona Ensanche y Gracia, £111 increase; Barcelona, £48 decrease; Brisbane, £122 increase (month of November, £10,544, increase £253), British Columbia Electric (month of March), gross earnings £10,352, net income £2,659; Buenos Ayres and Belgrano Electric, £25 decrease (month of November, £14,142, increase £444); Calcutta, £260 increase; Cape Town (month of October), receipts £16,229, expenditure £9,044; Isle of Thanet Electric, £1 increase; Lisbon Electric (month of October), receipts 93,725 milreis, expenses 50,350 milreis; Mexico Electric (month of August), receipts £48 600, expenses £27,900; Perth Electric, £227 increase; Port Elizabeth (month of October), receipts £3,972, expenditure £2,879.

Cardiff.—At a meeting of the Tramways Committee on Monday the Town Clerk reported that he had received the sanction of the Board of Trade for the following work: the substitution of double and interlacing lines for single lines in Mill-lane; laying of junctions between Newport-road and Glossop-road; a junction between Penarth-road and Mill-lane; and a passing place in the Hayes. The Borough Engineer reported that the construction of the tramway between Corporation-road, Grangetown, and the Great Western Railway bridge would be completed this week. It was stated that the amount expended in the reconstruction of the tramway lines taken over from the Provincial Tramway Company was £70,577, and it was agreed to apply to the Board of Trade for sanction for borrowing that sum.

New South Wales.—The report of the Railway Commissioners (Mr. Charles Oliver, chief commissioner, and Mr. David Kirkcaldie and Mr. W. Fehon, commissioners) for the quarter ended Sept. 30 has been laid before the State Parliament. The tramways show increased earnings of £18,940, the receipts having risen from £166,900 to £185,840, the expenses at the same time coming up by £15,711. The tramways, comprising 125 miles of line, are largely worked on the electric system, and are very popular. During the quarter the number of passenger journeys was 32,000,000. The outlook generally in the State seems promising, the present season being the most favourable experienced for very many years, and a record harvest seems assured, with corresponding inflation of the railway receipts.

Mr. Yerkes's Scheme.—The New York correspondent of the *Daily Telegraph* has been enlightening its readers with regard to Mr. Yerkes's scheme of rapid transit for London. There is much in the telegrams which is old; little that is new. The correspondent, however, gives the names of the American directors of the syndicate, which include Messrs. James Hyde, of the Equitable Life Insurance Company, Richard McCurdy, of the Mutual Life Company, James Speyer, James Blair, J. Jefferson Coolidge, jun., and President L. F. Losee, of the Baltimore and Ohio Railroad. The particulars of the large power-house now under erection at Chelsea are by now ancient history, but the *Daily Telegraph* correspondent dishes them up in the nature of a revelation. His statement that the equipment of the lines is to be of American make is, we believe, far off the mark.

Kirkcaldy.—On Saturday an extension of the tramways to Whytecauseway was inaugurated. It will meet the wants of a large population, being in direct touch with Kirkcaldy railway station. The initial part of the scheme has been conducted with financial success, while no accidents of a serious kind have occurred, and a further extension of the undertaking is now in contemplation by the laying of a double line of rails from the cottage hospital to Dysart, for which notice of a Bill has been given for next session of Parliament. A special service of workmen's cars is to be instituted at the beginning of next week, and to meet the increased traffic seven new cars have been ordered (making 22 in all), while a new 500-h.p. engine and dynamo is to be erected at the generating station. The new route is lit throughout by arc lamps. The demand for electricity, both for power and lighting, is gradually on the increase.

Birmingham and Foreign Rails.—At a meeting of the Birmingham City Council on Tuesday, the question of foreign *v.* English rails was vigorously discussed. The resolution submitted by a private member was in the following terms: "That, in the opinion of this Council, it is much to be regretted that the Tramways Committee should have considered it necessary to purchase tramrails from abroad at a time when British industry needs encouragement and support." He contended that it was not necessary for the committee to go abroad for tramrails. Two reasons had been put forward in favour of the purchase. The first was on account of cheapness, and the second that the foreign rails were superior to the English-made articles. The former he agreed was correct, but he contested the latter. But even the price ought not to be a consideration to any large extent with a Corporation like that of Birmingham. The Sheffield Corporation purchased English rails rather than foreign, although they paid 10s. more than they would have to pay for foreign rails. He contended that if the rails were made according to the specifications of the Engineering Standards Committee, the English manufacturer would be able to compete successfully with his German rival. Engineers, he found, were agreed in favour of British rails, and declared it was a fallacy to suppose that English rails were inferior to German. He was informed, however, that Birmingham omitted some of the tests usually applied to those rails, and this was an advantage to the foreigner. The saving in connection with the German rails purchased would at the utmost not be more than 6s. per ton, and he thought under the circumstances the English firm, which was that amount higher, might have been asked to reconsider before the contract was signed. Mr. Lovesey, in seconding the motion, thought the ratepayers of the city would have been better pleased if their money had been spent in the home market rather than in encouraging foreign competitors. Mr. Alderman Beale, the chairman of the Tramways Committee, pointed out that the Corporation bought no rails on their own account until the summer of this year. Before that time the rails were bought solely on behalf of the companies that owned the lines. The committee did not want to buy foreign rails. It simply did so because it thought they were the cheapest and to the advantage of the tramway companies. No one regretted more than the members of the Tramways Committee that the goods of British manufacturers were not so low in price as the foreign material. The resolution was carried with two dissentients. A resolution was then moved, "That in asking for tenders for manufactured articles of any description if the same are made, or can be made, in Great Britain they shall be specified to be of British manufacture. This is to apply to all manufactured articles purchased without tender and to manufactured articles used in buildings, machinery, plant, stores, rolling-stock, etc., in every department of the Corporation." After discussion the matter was referred to the General Purposes Committee, with instructions to obtain information from the various committees as to the probable effect of the proposed resolution.

London County Council.—Chief among the tramway matters considered at the usual weekly meeting of the London County Council on Tuesday was the question of the system of traction to be adopted for the reconstruction for the electrical working of the first sections of the Council's lines in the North of London. These lines are known as follows: (*a*) Theobalds-road terminus, *via* Clerkenwell-road, Old-street Great Eastern-street, Commercial-street, and Leman street, to near the London Docks; (*b*) Norton Folgate terminus, *via* Shoreditch, Kingsland-road, High-street, and Stoke Newington-road, to Stamford Hill; (*c*) Aldgate terminus, *via* Commercial-road, Commercial-road East, and East India Dock-road, to Poplar; (*d*) Moorgate-street terminus, *via* Finsbury-pavement and City-road, to junction with Old-street; (*e*) Holborn terminus, *via* Gray's-inn-road, to junction to Theobalds-road; and (*f*) along Old-street and Great Eastern-street and Shoreditch. The length of these tramways is about 22¼ miles of single line, and it will be practicable for the whole of them to be worked from the electric generating station which is being established at Greenwich. In a report which the Highways Committee submitted to the Council in October they stated that it would not be possible for them for some time to come to present estimates of the cost of the work, as trial holes would have to be made at certain points along the routes in order to ascertain depth available for the laying of tramway conduits over railway and canal bridges, and the positions of pipes, wires, and other obstructions under the carriageway. These investigations are being proceeded with, but are not yet sufficiently advanced to permit of estimates being framed of the cost of the work. In view, however, of the fact that the Council will have to obtain the approval of the Board of Trade to the system proposed to be adopted for these lines, the committee think that the necessary plans should be at once forwarded to the Board, and to the several borough councils concerned, in order that the Council may be in a position to arrange for the carrying out of the work so soon as the estimates of the cost are ready. The lines specified form one-half of those which on July 7 the Council

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decided should be constructed, or reconstructed, for an underground conduit system of electrical traction, and the committee propose that the system shall be exactly the same as that approved by the Council on Nov. 10 in connection with the construction of the tramways along St. John-street, St. John-street-road, and Rosebery-avenue. The following recommendations were accordingly adopted by the Council on Tuesday: (*a*) That the underground conduit system of electrical traction, approved by the Council on Nov. 10, 1903, for the construction of the new tramways along St. John-street, St. John-street-road, and Rosebery-avenue, be adopted to the reconstruction of the first sections (about 22¼ miles in length) of the Council's (northern) tramways; (*b*) that the drawings of the system of electrical traction proposed to be adopted by the Council in connection with the reconstruction of the 22¼ miles of tramways referred to in the foregoing resolution, together with a statement of the materials to be used in such reconstruction, be submitted when ready for the approval of the Board of Trade, as required by the London County Tramways (Electrical Powers) Act, 1900; (*c*) that copies of the said drawings and statement be supplied to the councils of the several metropolitan boroughs concerned in order that each of these bodies may, in accordance with the Act above referred to, have an opportunity of being heard thereon by the Board of Trade, and that a copy of the said drawings and statement be also furnished to the North Metropolitan Tramways Company. Another report was forthcoming from the Highways Committee dealing with the acquisition of property for the erection of an electricity generating station at Pimlico, which is required to supply the electric trams with energy in the western half of the county. Including the rehousing of persons displaced, the total capital expenditure on the acquisition of this property, known as the Pimlico Gasworks, will be £64,000. It is probable that the erection of the generating station will not be required to be commenced for some two years, but the committee are getting well in hand with the preparations for a suitable site. Belgian rails were again in evidence at the meeting, and Mr. J. Williams Benn had to submit to a long string of questions criticising the Council's action in purchasing their tramway rails on the Continent in preference to this country. For example, Mr. Goodrich asked the chairman of the committee whether he would say yes or no to the question whether the men engaged in the manufacture of the Belgian tramrails ordered by the Council were paid trade union rates of wages, and what method the committee had adopted to find it out. Mr. E. Collins pointed out that for some weeks he had been persistent in trying to obtain an answer to this question, but Mr. Benn had fenced with the matter and confined himself to saying that in regard to the manufacture of these rails he had had a report which was generally satisfactory. He now desired to be more definite, and would ask Mr. Benn for the name of the firm manufacturing the rails, and also whether the testing took place in Belgium or England. Colonel Rotton said that this was a subject in which the working people of this country were deeply interested, and he would now ask whether it was true that the men in Belgium worked 79 hours a week, and also in some firms on Sundays. Mr. Benn: With regard to these Belgian rails, I must refer my hon. friends to the answers I have already given. I can only say with regard to these rails, "What I have said I have said." The Highways Committee presented their report upon the regulations issued by the Board of Trade under the Motorcar Act, 1903. They recommended that the maximum fee of £3 prescribed by the Act should be charged for the assignment to a manufacturer or dealer of a general identification mark. This was adopted.

LIGHTING AND GENERAL.

Long-Distance Telephone.—We understand that telephonic communication between Liverpool and France is promised by the Post Office.

Boston.—The Council have decided to at once proceed to carry out the expiring provisional order. The cost of the scheme is estimated under £25,000.

Tredegar.—The electric light installation at Bedwellty Pits has been completed, and has proved highly satisfactory and a great boon to the inhabitants.

Whitehaven.—Twenty-one tenders for the lighting of the workhouse and infirmary by electric light have been referred to a committee of the Guardians for report, to be presented at the next meeting.

Commercial Cable Co.—The directors have declared a quarterly dividend of 2 per cent., payable on Jan. 2, 1904. The transfer books will be closed from the 19th inst. to Jan. 4, 1904, inclusive.

Chippenham.—The Rural District Council have consented to the application of the Town Council of Chippenham for a provisional order for the supply of certain rural parishes adjoining the borough with electricity.

Eastbourne.—An enquiry has been held into an application for sanction to borrow £10,000 for electric light purposes. On Tuesday the Mayor (Councillor Ashley Maude) opened an electrical exhibition at the town hall.

Swindon.—The Town Council in their new Bill ask for extension of time for authorised tramways; they also seek powers for new tramways, the extension of electricity limits, the supply of electricity in bulk, omnibuses, etc.

Tunbridge Wells.—The Town Council have received an offer from a syndicate to purchase the electric lighting works at £10,000 profit beyond the cost acready entailed by the Corporation. The cost of the works has been £80,000.

Scarborough Telephones.—At a meeting of the Telephone Sub-Committee of the Town Council on Friday specifications for a system of municipal telephones at Scarborough, received from Mr. Bennett, were referred to the borough engineer to report upon.

Western Telegraph Co.—The directors have declared an interim dividend of 3s. per share, or at the rate of 6 per cent. per annum, for the quarter ended Sept. 30 last.

Maidenhead.—The units generated for the week ending Oct. 17 amounted to 3,284; to Oct. 24, 3,641; to Oct. 31, 3,719; to Nov. 7, 4,125; and to Nov. 14, 4,336, which show a steady increase. At present 9,000 lamps are connected for private lighting.

Lecture.—Under the auspices of the Halifax Scientific Society Mr. W. M. Rogerson, the borough electrical engineer, delivered a lecture at the Literary and Philosophical Society's rooms last week on the subject of the development and uses of electric motors.

Middlesbrough.—The engineer, Mr. H. M. Taylor, in his last report states that the income of the electric light department during 1902 was £2,167, and the costs £1,637, leaving a profit of £530. In 1903 the income had been £3,127, costs £1,758, profit £1,378.

Strabane.—With regard to the Ulster electrical power scheme, it has been decided to ask the electrical power company what powers they are seeking, and also to consult Mr. Hunt, London, as to what effect the electrical scheme would have on the Urban District Council's new gasworks.

Redditch.—At the last meeting of the Urban District Council, in moving the adoption of the Electric Supply Committee's report, the chairman spoke of the highly satisfactory results which had attended the working of the temporary steam plant which had been started working at the lighting station.

European Telegraph Rates.—According to a recent letter of the Postmaster General there is at present no prospect of the rate for telegrams throughout Europe being reduced to 1d. per word. The reductions decided upon at the recent International Telegraph Conference in London will come into force on July 1 next.

Chester.—On Friday a meeting was held with regard to the movement for the extension of the free area for telephone calls in the Chester and North Wales district. A committee was appointed to approach the various county councils in North Wales and their members of Parliament with a view to urging the Government in the matter.

The "Victory."—During Admiral Sir John Fisher's inspection of the "Victory" a week ago, it was suggested that the cockpit where Lord Nelson died should be lighted by electricity supplied from stationary batteries, so that visitors could have a better view of the place where the hero of Trafalgar breathed his last. The matter is to be considered, but nothing has been settled at present.

Colchester.—The electric lighting of Mersea, Maldon, Military, and Butt roads is to be proceeded with. The electrical engineer, Mr. Sillar, has prepared the following comparative statement: output of electricity in units during September, 1903, 43,830 (1902, 28,912; 1901, 16,500); number of consumers at end of October, 387, (300 and 202); total number of 8-c.p. lamps connected, 24,015 (18 302 and 11,642).

London County Council.—On Tuesday it was agreed to lend the St. Pancras Borough Council £23,960 for electric light installation, and the Stepney Borough Council £17,930 for the purchase of property, part of which is to be used as a site for dust destructor and electric lighting works. Notices to lay mains by the Blackheath and Greenwich District and the Metropolitan Electric Supply Companies were agreed to.

Croydon.—The engineer has reported that it is not possible to supply any more lamps from the present public lighting mains, and extensions estimated to cost £340, including provision for the supply of private consumers who might be obtained in this district, have been agreed to. It has also been decided to expend £1,188 on mains, etc, in Norbury-avenue.

Stone.—A letter was read at the meeting of the Lighting Sub-Committee from the Southern District Electricity Corporation, asking for the consent of the Council to the Corporation's application to the Board of Trade for a provisional order to supply electricity in the Council's district. The committee did not think it would be to the advantage of the Council to consent to the application, and their action was confirmed.

Farnborough.—The Board of Trade have asked with reference to the Farnborough Electric Lighting Order, 1899, whether any steps had been taken by the undertakers to carry out the proposals to transfer their powers, duties, and liabilities to Power and Traction, Limited, or to establish works under the order. The Council are replying that no formal application had been made by Power and Traction, Limited, for a transfer of the powers of the order.

Inverness.—The Town Council have accepted the draft agreement with the Edmundson Electricity Company, London, for the introduction of electricity into the town. The company is to carry out the work, which will cost at the outset £18,000. At certain periods it is within the option of the Corporation to purchase it. The Corporation are to receive £2,100, which has already been expended by them in connection with the electric lighting proposal.

Woolwich.—The Electricity Committee have appointed a sub-committee, consisting of Alderman Tynemouth, Councillors Calderwood, Fennell, Ledger, Merritt, J. Turnbull, sen., and W. Turner, to consider and report on alternative schemes of electric lighting for Eltham, an assisted wiring scheme, electricity workmen's regulations, and also to act as members of the Joint Electricity and Works Sub-Committee to consider the question of street lighting by electricity.

Prestwich.—The Lancashire Asylums Board have decided that £6,000 be granted out of the asylums fund for alterations and additions to the electric light and power plant at Prestwich Asylum, near Manchester. The plant is being extended under the superintendence of Mr. R. A. Wood, the electrical engineer. The additions include high-pressure boilers, a 250-kw. steam dynamo, and new switchboard. Power will be transmitted to outlying buildings by overhead mains.

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Exeter.—At the last Council meeting a discussion took place as to the necessity for improving the lighting in various parts of the city, especially in St. Thomas. It was stated that the question could not be considered until the completion of the new electricity works, which, it was hoped, would be out of the contractor's hands by Lady Day next. The necessity for the carrying out of a scheme for the provision of a refuse destructor was also brought forward, but no action was taken.

Ramsgate.—The Corporation have accepted a bond from Edmundson's Electricity Corporation for the electric lighting of the district. The Ramsgate and District Company have agreed to insert in their order a provision for the same compulsory area as in the original Corporation order. We refer elsewhere to the support given by the Council to that company, and note that the Isle of Thanet Electric Tramways and Lighting Company, Limited, also intend to proceed with their order.

Stock Exchange.—Applications have been made to the Stock Exchange Committee to appoint a special settling day in and to grant a quotation to the Metropolitan District Railway Company's partly paid scrip of a further issue of £500,000 4 per cent. perpetual debenture stock. The committee have been asked to allow the following securities to be quoted in the official list: Blackheath and Greenwich District Electric Light Company's 50,000 7 per cent. cumulative preference shares of £1 each, fully paid.

Pollokshaws.—The Electric Lighting Committee have had an interview with representatives of the burghs of Rutherglen and Milngavie, who are interested in the proposals of the Clyde Valley Electric Power Company, and also with the directors of that company. As a result of the latter interview, the Clyde Valley Electric Power Company have made certain proposals. A deputation will also wait upon the Glasgow Corporation, and it has also been agreed to apply to the Board of Trade for a provisional order.

Ilkley.—A committee of the Ilkley Urban District Council has been authorised to recommend a site for the erection of a refuse destructor, and to prepare a scheme, including an estimate of the cost. In response to a suggestion from the National Telephone Company as to the laying of underground wires in Ilkley, it is decided to invite the manager to attend the meeting of the committee with plans of the proposals. It has been decided to circulate to the members a report of Mr. F. J. Warden-Stevens on the electric lighting.

Brighton.—Tuesday's enquiry into loans included a loan of £175 for providing 12 additional cells for the accumulation of electricity at the works in North-road in order to secure greater efficiency in the supply of current to the trams. Under the original contract 240 cells were put in, and when the Electrical Power Storage Company, who had charge of the work, were asked to estimate for the additional 12 cells they quoted £175, but only on condition that the work was put in hand while their workmen were still in the town. The work has been done already.

Ladderman's Belt.—Mr. Heathman, Parsons Green, S.W., has invented a belt which is to prevent laddermen from falling off and thus injuring themselves and their employers' pockets. This has a large snap-hook to grip the rung of any ladder, and is adjustable sideways and lengthwise, so that the worker has great freedom of movement. In fact, he can turn round with his back towards the ladder and move away if he is upon a ladder platform. These belts are manufactured at a low cost, so that expense need not retard its adoption.

Glasgow.—Upon a report of a deputation which saw the Harris Anderson water purifier in operation at the power station of the Newcastle Electric Supply Company, Limited, Wallsend, a sub-committee has recommended the adoption of the purifier for Pinkston power station. The cost of the apparatus will be between £1,400 and £1,500, and it is estimated that it will save not less than £500 a year, and remove the necessity for considering an additional water supply for the Pinkston boilers. The proposal is still under consideration.

Inventions Exhibition at Brighton.—Lady Louise Loder opened at the Brighton Aquarium last week an exhibition of inventions which has been promoted by the Corporation. Amongst electrical matters, we notice an exhibit illustrating the new telephonic system of the Corporation. The National Telephone Company also show telephones, including the new megaphone instrument for magnifying sounds, and a new fire-alarm, and there is an apparatus on the terrace destined to flash out whole sentences in electric light across the roof of the building. The exhibition will remain open until the 20th inst.

Clitheroe.—The Town Council have decided to fix their seal to the memorial for an electric lighting provisional order. Mr. Barton, electrical engineer, estimated the cost of the works at £11,260, and the borrowing powers will be fixed at £12,000. The detailed estimate is as follows: buildings £2,350 with chimney for the generating station, £1,670 for steam generating plant, £4,250 for generators, including two steam dynamos, cables, boxes, and supplies to consumers, £1,825. Approximate engineer's fee £380, travelling crane £180, and 5,000 superficial square yards of land at 1½d. per yard, at 20 years' purchase, £625 and £1,000 for contingencies, making a total of £11,260.

City of London.—At the last Court of Common Council the City Lands Committee asked the Court for authority to enter into an arrangement with the Charing Cross and Strand Electricity Supply Corporation, Limited, to supply the current (at a pressure of 200 volts) to buildings under the control of the committee, at the rate of 3d. per Board of Trade unit for lighting, and 2½d. for motive power, for a period of five years. After discussion the following amendment was carried: "That the whole matter be referred back to the City Lands Committee, with a view to enabling the City of London Electric Lighting Company, Limited, to have the opportunity of tenderngi as well as the Charing Cross and Strand Electricity Supply Corporation, Limited."

Hampstead.—At the last Council meeting it was stated that on the previous evening the electric light in one of the busiest portions of the High-road, Kilburn, had failed. The electrical engineer reported that the failure was due to a defective cable, which was part of a consignment supplied some years ago, and, in some parts of the borough, had been renewed. For a certain distance in the High-road it had not been renewed, and the consequent failure on two occasions had caused the greatest inconvenience to shopkeepers in that busy thoroughfare. The Lighting Committee were instructed to bring up a report and estimate for taking out the length of defective cable and replacing it with a new one.

Beckenham.—The Council last week considered a letter from the Board of Trade regarding the proposed purchase of the Crystal Palace District electric lighting order by the Blackheath Electric Light Company, Limited, and the proposed change in the system of supply. The Clerk stated that they had powers under this order to take over that part of the parish of Beckenham included in the Crystal Palace order. The year 1905 would be the last for taking over that district. The system used in the Crystal Palace district was similar to that in Beckenham. It was most important, therefore, that the proposal of the company should not be sanctioned until Beckenham had had an opportunity of considering whether they would take over the district. It was decided that the Board of Trade be informed that the Urban District Council were considering whether they would take over the district or not, and also that the matter be referred to the Electric Lighting Committee, and that the surveyor and consulting electrical engineer be asked to advise them in the matter.

Halifax.—The new plant now being introduced at the main electricity works is expected to be ready for use in about two weeks' time. It consists of a 1,200-i.h.p. horizontal engine, made by Messrs. Pollit and Wigzell, of Sowerby Bridge, coupled to a 750-kw. dynamo, supplied by the Electric Construction Company, of Wolverhampton. The cost is about £8,000, and was necessitated by increased applications for current for lighting and power purposes, as every machine is now running at full load. In addition to meeting these requirements, it will be possible, when the scheme is completed, to give the extra supply that is needed for the tramways. The work of erecting the new electrical sub-station at Hipperholme was commenced on Monday. This undertaking has been decided upon in order to save the expense of running a low-tension cable all the way to Brighouse for the purpose of supplying power for the tramways extension to that town. When this scheme is completed the Corporation will be in a position to give the Hipperholme district a full supply for lighting and power purposes.

Newcastle Infirmary.—The electrical equipment which is being placed in the new infirmary by the contractors, Messrs. Falconar, Cross, and Co., is being carried out in accordance with specifications prepared by Messrs. Dolby and Williamson, and includes, besides motors for driving the various power-using machinery, over 2,000 incandescent electric lights, also a complete system of telephones, electric bells and fire-alarms, electric clocks, and electro-medical appliances. There will be about 50 electric clocks spread over the whole of the building, all controlled from a master clock. The current will be supplied from the mains of the Newcastle and District Electric Lighting Company. The laundry, kitchen, and other machinery will be driven by electric motors, together with lifts for various purposes, and there will be a complete system of ventilation by means of electric fans. The whole of the wiring is being carried out in smooth-drawn welded steel tubes, fixed together with screwed unions; these tubes are in most instances sunk beneath the plaster work, and draw-in or inspection boxes are fitted at intervals with the covers made accessible and marked in a conspicuous manner, so that if necessary the whole of the sectional wires can be withdrawn.

London Gazette.—A second and final dividend of 10s. in the £ (making a total of 20s. in the £) has been declared in the estate of John Frederick Worthington, electrical engineer, Foundry Works, Foundry-street, Hanley, Stafford, payable now at the offices of Poppleton and Appleby, 26, Corporation-street, Birmingham. The creditors of the Electric Tramways Trust, Limited, are required by Jan. 1 to send their names and addresses and particulars of debts or claims, to Leslie Morse, 32, Queen Victoria-street, E.C., or Reginald Albert Goodman, Granville House, Arundel-street, Strand, W.C. The first meeting in the estate of George Neale, lately trading with John Carnaby as South-Western Electrical Contracting and Maintenance Company, electricians, 2, Fulham Palace-road, London, has been held. A dividend will be declared in the estate of John Pierrepont Child, electrical engineer, 150, Powis-street, Woolwich, and 109, Piedmont-road, Plumstead, Kent. Last day for receiving proofs, Dec. 15. Alexandra Mackintosh, official receiver, 24, Railway-approach, London Bridge. The first meeting in the estate of Cecil Wray, mechanical and electrical engineer, 16, Chevin-view, Ecclesfield, lately of 24, Simes-street, Bradford, will be held on Dec. 10, at 3 p.m., at the official receiver's office, 29, Tyrrel-street, Bradford. A receiving order has been made out in the estate of John Webster Storr, electrical engineer, 29 Grange-road, Dudley, Worcester. The first meeting in the estate of Hooley, Talbot, and Co., electrical engineers and contractors, Regent-street, Rugby, Warwick, will be held on Dec. 7, at 12 noon, at the official receiver's office, 17, Hertford-street, Coventry.

Gravesend.—The resident engineer in his report of working for three months ended Sept. 30, supplies the following figures: units supplied to tramway company, 107,777; units supplied to private consumers, 18,290; units supplied to public lighting, 14,270; units supplied to works, 5,078; units unaccounted for, 14,872; units generated, 160,287. Number of consumers connected and applied, 127; increase over last quarter, 29; equivalent number of 8-c.p. lamps, 7,467; increase over last quarter, 1,592. A letter from the Northfleet Urban District Council referring to correspondence on the Northfleet electric lighting is under consideration. The document states that owing to the limitations to the Council's powers imposed by Section 11 of the Electric Lighting Act, 1882, the

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Electric Lighting Committee of the Northfleet Council have come to the conclusion that no satisfactory arrangement can be made with any other corporate body, company, or person for the maintenance and execution of electric light works within their district, and have accordingly advised the Council to intimate to all persons who have been in communication with them upon the subject, that the Council will assist (at the expense of the promoters) in the promotion in Parliament of a supplemental or fresh electric lighting provisional order for the district, provided the undertakers contribute £250 to cover the expenses incurred by the Council in obtaining their existing order. Finally, the Corporation of Gravesend are asked whether they would be disposed to make an offer to the Council on these lines.

Islington.—The Council have agreed to carry out extensions to mains at £825, and to purchase from 70 to 100 services at an average cost for cable and labour of about £8 each, say £600; house terminal boxes, including compound and fuses, 75 at 16s., £60; service boxes for rubber cables, and junction boxes for paper cables, 40 at £5. 5s. each, £210; brick pits, etc., for junction boxes. 10 at £5 each, £50; buried service boxes for paper cable, 20 at £2 each, £40; jointing material, filling, connections, and reinstating on buried boxes for paper cable, £26; high-tension feeder boxes, two at £15, £30; special meters at Marlborough Theatre, six 150-ampere 200-volt meters at £5. 5s. each, £31. 10s.; six 150-ampere 200-volt indicators at £2. 15s each, £16. 10s.; two jointers' tents at £5 each, £10; sundry jointing material, small tools, repairs to gas services, insulating enamel, etc., £26. It is proposed, in order to facilitate supply to new customers, to submit an estimate each half-year so that the necessary expenditure for service line, terminal boxes, trenching, relay, fuse boxes, meter fixing, and other incidental works, amounting in the case of any consumer to less than £50, may be provided for. In the event of the London County Council sanctioning the borrowing of £849 for electric lighting purposes for a period of 42 years, the Borough Council propose to undertake that during the currency of the loan no further loans will be raised to replace any of the plant and machinery, the cost of which is to be defrayed out of such loan, and that any renewals required during the period thereof shall be provided out of a sinking fund to be created for the purpose or from maintenance account.

Parliamentary Notices.—Amongst the proposed new Bills for session 1904 we note Leicestershire and Warwickshire Electric Power, by company of same name. Objects: extension of periods limited by the Leicestershire and Warwickshire Electric Power Act, 1902, for commencing the works and for providing the generating stations prescribed by that Act, and also for the removal of restrictions as to erection of generating stations on lands acquired by agreement under that Act; amendment of borrowing powers of company under Act of 1902; power to acquire electric undertakings by agreement; payment of interest out of capital; application of funds; incorporation and amendment of Acts. Ulster Electric Power, by company to be formed. Objects: incorporation of company; power to establish generating stations and works, and supply electricity, etc., in the counties or parts of the counties of Down, Antrim, Londonderry, Donegal, Tyrone, Fermanagh, Armagh, Monaghan, and Cavan, and the county boroughs of Belfast and Londonderry, all within the province of Ulster; compulsory purchase and user of lands, etc.; power to take parts of property and exemption from Section 92 of the Lands Clauses Consolidation Act, 1845; special powers as to capital and borrowing, breaking up of streets, roads, etc., and power to lay down wires, pipes, etc., and exercise of other powers, rates, charges, etc.; exception from certain sections of Electric Lighting Act, 1882, and of the schedule to the Electric Lighting (Clauses) Act, 1899; provisions as to supply; agreements with and powers to local authorities, companies, and bodies; payment of interest out of capital during construction; incorporation and amendment of Acts, etc.

Natal Harbour Department.—The officials ruling the destiny of the Natal Harbour Department have just given an order for the lighting of the suction dredgers "Curlew," "Ibis," and "Water Rat" by electricity to enable them to work by night in Durban Bay. Tenders were informally called for, and Messrs. Greenwood and Batley, Limited, of Albion Works, Leeds, through their direct representative, at present in Durban, were successful in securing the order. The plant which will be supplied consists of three complete sets of 7-b.h.p. 4·4-kw. De Laval patent steam turbine-dynamos, arranged to work either condensing or non-condensing at a steam pressure of 50lb. and 110lb. per square inch, two being designed for the latter pressure. The voltage of the dynamos will be 110, and the capacity of each of the sets is equivalent to about 140 8-c.p. incandescent lamps. The De Laval turbine is extremely applicable for this class of work, where economy in space is a great desideratum, this feature being largely responsible for the installation of upwards of 5,000 h.p. in small sets of 1½ h.p. to 30 h.p. in vessels all over the world, including cruisers, torpedo boats, torpedo-boat destroyers, gunboats, liners, tugs, etc. For example, the 7-b.h.p. type weighs only 8cwt., and occupies a space of 5ft. by 2ft., being 2ft. 6in. high, and being also self-contained requires little foundation beyond a wooden bench. The installing and wiring of the dredgers will be done departmentally under the supervision of Mr. G. Stobie, A.M.I.E.E., the harbour electrical engineer. He may be considered the pioneer of steam-turbines in South Africa, having installed one of the first of the De Laval type imported. The work is to be commenced about the middle of December, and will be completed early in the New Year.

St. Marylebone.—Amongst the motions not reached at last week's meeting was a notice to the effect "That a return be presented to the Council showing (1) the total cost of obtaining the Act of Parliament authorising the Borough Council to negotiate for the purchase of the Metropolitan Electric Supply Company's Marylebone undertaking; (2) the entire cost of the arbitration, specifying (*a*) the amount paid to the arbitrator, (*b*) counsel engaged and fees paid to each, (*c*) professional witnesses engaged and fees paid to each, (*d*) payment to solicitors and general charges, (*e*) amount paid to electric company for their costs in the arbitration; (3) costs incurred (*a*) by the Borough Council, (*b*) by the Metropolitan Company as taxed in the action for specific performance before Mr. Justice Buckley stating if the Borough Council had to pay costs of both parties, (*c*) amount to be paid to the company for works executed since the appointed day for taking over the concern; (4) amount of counsel's fees for opinions and consultations and other fees and expenses paid or to be paid by the Borough Council up to the end of October, 1903; (5) total amount paid by the Borough Council or to be paid (including salaries, which are to be specified) to the end of October, 1903, in connection with and in consequence of having obtained the abortive Act of Parliament; (6) from what fund all these expenses are paid." Also, "That a committee, consisting of the Mayor, Councillor J. Watson, and Councillor Edward White, be appointed to confer with the Metropolitan Electric Supply Company with a view to an arrangement being arrived at to remove the present deadlock"; and, further, "That the engagement of Mr. Arthur Wright, the electrical expert, be determined, and that the necessary notice be given him for terminating his engagement."

Electrical Machinery.—A large number of gentlemen connected with collieries, shipyards, and engineering establishments in the Northern Counties visited the works of Messrs. E. Scott and Mountain, Limited, Close, Newcastle, on Saturday last to inspect some new electrical machinery which that firm has recently completed. The chief item of interest was an enclosed three-crank compound steam-engine of 400 i.h.p., fitted with one high-pressure cylinder, 16½in. diameter, two low-pressure cylinders, each 18½in. diameter, with a stroke of 10in., this engine giving the horse-power stated above, with a steam pressure of 100lb. per square inch when running at a speed of 350 revolutions per minute. This engine is fitted with the firm's latest system of forced lubrication, which consists of a valveless oil pump delivering oil to all bearings and working parts, and is complete with powerful crankshaft governors and steam separator. The engine is direct coupled to one of the firm's three-phase alternators, constructed to give an output of 250 kw. at a pressure of 500 volts per phase, with a frequency of 50 cycles per second, this generator being of the revolving magnet type, with stationary armature and direct-coupled exciter. The whole plant is of massive construction, and weighs in all about 40 tons. The engine and generator mentioned above have been built to the order of Messrs. Bolckow, Vaughan, and Co., Limited, and will supply current to one of Messrs. Scott and Mountain's three-phase induction motors of 100 effective horse-power, which is driven by ropes on to one of the same firm's three-throw horizontal ram pumps, fitted with gunmetal rams, each 10in. diameter, with a stroke of 15in., and delivering 500 gallons per minute against a vertical head of 400ft. There was also on view plant constructed to the order of the Harton Coal Company for their Bolden Colliery, near Sunderland, and of the Northern Counties Electricity Supply Company.

Brighton Telephones.—The agenda for last night's Town Council meeting shows that at the meeting of the Telephones Committee on Friday last the Mayor submitted to the committee the correspondence between himself and the secretary to the National Telephone Company concerning Councillor Carden's action at Burgess Hill and alleged unfair preference. In addition, the Town Clerk submitted a letter from the Postmaster-General's Department enclosing copy of a letter addressed to the Department by the National Telephone Company and asking for the Corporation's observations thereon. Mr. Gaine's letter to the Post Office recapitulates the points already published, and adds: "I am directed in particular to call the attention of the Postmaster-General to the fact that not only is money being paid by or on behalf of the Corporation to induce these subscribers to break their contracts with the company, but also that these subscribers are offered a preference over other subscribers in the area inasmuch as the Brighton Corporation is offering to supply them with a free service for a certain period of time. The company is advised that these proceedings by or on behalf of the Corporation constitute a clear breach of the undue preference provisions of its license, and I am directed to ask that the Postmaster-General will take immediate and effective action in the matter." The committee resolved: "That the Postmaster-General be informed that the Council endorse the observations contained in the Mayor's letter to the manager of the National Telephone Company of the 17th inst., and, in addition to what is stated by the Mayor on the subject of the alleged preferential treatment, they would point out that the terms offered to subscribers in the Brighton area are the same as those given in Portsmouth, Glasgow, Swansea, and other towns where corporation telephones have been established, and by the Post Office Department in the case of London."

Liverpool.—Mr. A. B. Holmes, consulting electrical engineer to the Liverpool City Council, has prepared a report on the Corporation electric supply stations and plant, in which he points out that the demand for electrical energy for power and lighting continues steadily to increase, and it is estimated that the output of the supply stations for 1903 will exceed that of the previous year by the following percentages: lighting, 20 per cent.; power, 60 per cent.; and tramways, 5 per cent. The connections to the supply mains for lighting and power (exclusive of tramways) at the commencement of the current year were equivalent to 221,000 c.p. incandescent lamps, and it would be necessary for the Electric Supply Committee to consider what extensions would be required to meet the demand for electrical energy which might be anticipated in 1904 and 1905. No more steam plant could be installed in the existing power stations in the central districts, and no suitable site was obtainable in these districts for another large steam station, by means of which the simplicity and economy of the generation of energy at the pressure of distribution to the consumer could be secured. It was consequently necessary to bring in an additional supply at high pressure from Lister-drive. His proposals are as follows: (1) at Fairclough-lane, an addition to the building and 2,000 kw. transforming plant; (2) at Oldham-place, an addition to the building and 2,000-kw. transforming plant;

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(3) at Rice-lane, the construction of a sub-station to contain transforming plant of 800 kw.: (4) at Cobbs Quarry, 800-kw. transforming plant; (5) also transforming plant at Smithdown-road. It would also be necessary to order the boilers, engines, generators, and accessories for the equipment of the second section of the Lister-drive station. It was not anticipated that any addition would be required at the Gateacre and Garston stations to meet the ordinary increase in demand for 1904, but for tramway extensions in these districts further generating plant would be necessary.

Wrexham.—At a recent meeting of the Electricity Supply Committee the borough accountant and the electrical engineer were asked to go fully into the question of revising the scale of charges for the supply of electricity in any manner, and report to the next meeting any recommendations they may consider requisite to enable the committee to come to a conclusion as to whether the present scale should be varied or otherwise. A letter was read from the St. Helens Cable Company, pointing out that under their original contract they had undertaken to maintain the cables for a period of about 12 years from the present date. Since the entire replacement of the distributing and arc cables there had been a complete absence of breakdown, only two or three trifling repairs being necessary. On every cable system containing a number of small cables there were slight repairs to be done every few months. This was usually carried out by the town electrical engineer as part of ordinary work. In repairing such defects at Wrexham the company were put to the additional expense of travelling and out allowances, besides the great inconvenience of finding an engineer to send at a few hours' notice. They therefore proposed that they compound the maintenance by a payment of £200, this amount being that which they might have to spend, whereas the Corporation engineer, being on the spot, would not spend a quarter of it. The proposal was referred to Mr. Trentham, consulting engineer, and to the borough electrical engineer for a confidential report as to whether it should be entertained. The borough electrical engineer reported that the units generated in October, 1903, were 44,394; 1902, 20,486; used for tramways, 14,764; used for lighting and motors, 29,630. Three consumers had been connected during the month, 133 lamps of 8 c.p.; corresponding month last year, 113 8 c.p. Total number of 8-c.p. lamps connected to date for private supply, 11,007. A statement is to be furnished to the committee quarterly showing the cost of generating electricity. The engineer also stated that, owing to the floods of Oct. 27, the engines were stopped from 9.50 p.m. to 10.50 p.m., the flywheels being 6in. under water. The supply was taken up satisfactorily from the accumulators. The water rose to within 1in. of the magnets, and 15in. or so up the main switchboard, rendering it dangerous. Some of the lower cables were fired. The condenser and its electric motor were immersed for two days, and rendered useless. The water burst from the brook in several places. The damage, estimated at £40, was repaired forthwith by Messrs Lewis Bros. The borough surveyor has been requested to report as to what would be necessary to prevent water backing up and flooding the depôt premises in times of storm. The Council intend to advertise for a pupil at a premium of £75, payable by three annual instalments, and half of such premium is to be paid to the electrical engineer. The Electricity Committee have prepared a scheme for the extension of the lighting cables, to cost £4,500, but it was referred back for further consideration.

PROVISIONAL PATENTS, 1903.

Nov. 23.

25473. Improvements in sensitive hot-wire voltmeters. Richard Threlfall, 30, George-road, Edgbaston, Birmingham.

25482. Improvements in or relating to apparatus for obtaining variable electrical ignition, applicable to gas-engines. Levi Mellor, 4, St. Ann's-square, Manchester.

25525. Improvements in electric starting switches. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

25526. Improvements in speed-limiting devices. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

25527. Improvements in train-control systems. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

25567. Improved process and apparatus for producing a shifting of phase of 90 degrees in alternating-current meters. Emanuel Morck, 46, Lincoln's-inn-fields, London. (Complete specification.)

25571. Improvements in or relating to electric lamps. Walter Charles Head, William Arthur Snape, and Robert Volland, 173, Fleet-street, London.

25573. Improvements connected with the adjusting mechanism of electric arc lamps used with cinematograph and other apparatus. Herbert James Dawson, 173, Fleet-street, London.

25577. Improvements in electric arc lamps. William James Davey, 40, Chancery-lane, London.

Nov. 24.

25591. Improvements in induction coils and transformers. Vernon Warburton Delves-Broughton and John Austin Cole, 80, Central-hill, Upper Norwood, London.

25677. Improvements in protecting electrical windings from static strains. John Pearson, Frederick Richard M. Cutcheon, and James Franklin Williamson, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

25633. Improvements in electric arc lamps. John William Ewart, 36, Chancery-lane, London.

25638. Improvements in surface condensers for elastic-fluid turbines. The Warwick Machinery Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

25657. Improvements in lightning arresters or devices for preventing overcharging in electric conductors. Georg Zapf, 6, Lord street, Liverpool.

25663. Improvements in telephone systems. Falk, Stadelmann, and Co., Limited, and Louis Thurnauer, 4, South-street, Finsbury, London.

25669. Improvements relating to electric conductors or cables. Sidney George Brown, 45, Southampton-buildings, Chancery-lane, London.

25698. Improvements in bodies adapted for lighting purposes and rendered incandescent by heat or electricity. John Haskins Ladd, 11, Southampton-buildings, Chancery-lane, London.

Nov. 25.

25704. A carbon-break fuse. Archibald Johnston and Stephen George Martin, St. Helen's Depôt, Swansea Tramway Company, Swansea.

25725. Improvements in electric signalling for electric railways and street tramways. Hugh Innes Rogers, Edward May Munro, and Henry Brecknell, Thrissell-street, Bristol.

25741. Improvements in glow lamp holders. Philip Braham, 18, Leigh-street, London.

25765. Improvements relating to electrical recording apparatus. Doningo Cervera, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

Nov. 26.

25792. An improved method of agitating solution in order to quicken the electrolytic deposition of metals. John Speed, 6, Kirby-street, Hatton-garden, London.

25814. Improvements in trolley heads for electric tramcars. Wilhelm Willenbücher, 51, Deansgate-arcade, Manchester. (Complete specification.)

25847. An improvement relating to dynamo-electric generators and motors. Joseph Daniel Rowbotham Blain, 13, Meadrow, Godalming, Surrey.

25848. Improvements in apparatus for measuring speeds of rotation. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

25849. Improvements in electric rheostats The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

25850. Improvements in time-limit devices for electric switches and the like. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

25851. Improvements in methods of operating repulsion motors. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

25852. Improvements in methods of exhausting vapour conductors. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

25853. Improvements in insulating material for electric conductors. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

25854. Improvements in suspenders for overhead electric conductors. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

25855. Improvements in electric switches. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

25856. Improvements in automatic air-brake systems. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

25857. Improvements in tube-coating machines. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

25858. Improvements in windings for dynamo-electric machines. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

25870. Improvements in or relating to electrolytic electricity meters. The Bastian Meter Company, Limited, Charles Orme Bastian, and Charles Henberow Churchill, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

25885. Improvements in apparatus for securing shades, reflectors, and the like to electric incandescent lamps. Henry Wollenden, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

25886. Improvements in or connected with coin operated or controlled electricity meters. John Reid Dick, Norfolk House, Norfolk-street, Strand, London.

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25887. Improvements connected with controllers for regulating the speed of electric motors. William Harding Scott, 47, Lincoln's-inn-fields, London.

Nov. 27.

25925. Improvements in electrical resistances. Percy Macaulay Ashworth Matthews, 9, Teneriffe-street, Lower Broughton, Manchester.

25937. Improvements in or relating to accumulators. Alfred Blackman, St. Brelade, Glamorgan-road, Hampton Wick, Middlesex.

25955. An improved electric safety switch-wedge. Henry John Leeves-Johnson and Maurice Moser, 55, Chancery-lane, London.

25969. An improved safety device for use in electric traction on the contact-stud system. William Griffiths and Benjamin Harry Bedell, 22, Southampton-buildings, Chancery-lane, London.

25970. Improved current collector for use in stud-contact systems of electric traction. William Griffiths and Benjamin Harry Bedell, 22, Southampton-buildings, Chancery-lane, London.

25990. Improvements in and pertaining to electrical brush-holders. Henry Alexander Mavor and Mavor and Coulson, Limited, 46, Lincoln's-inn-fields, London.

Nov. 28.

25994. Electrical shade-ring forceps. Thomas Dow Frew, 2, King James-place, Perth.

26005. Apparatus applicable to gas, electric, and other stoves. Joseph Fearnhead, 17, Mawdsley-street, Bolton.

26051. Improvements relating to voltage-regulating devices for alternating-current electric lines. Giorgio Finzi, 45, Southampton-buildings, Chancery-lane, London.

26058. Improvements in high-voltage spark arresters. James Yate Johnson, 47, Lincoln's-inn-fields. (The Elektrizitäts-Aktien-Gesellschaft vormals W. Lahmeyer und Co., Germany.) (Complete specification.)

26067. Improvements in advertising appliances, applicable for use in connection with telephones, and for other purposes. Percy Fullerton Corkhill, 6, Lord-street, Liverpool.

26069. Improvements in and relating to multiple electric motor control. Thorsten von Zweigbergk, 18, Southampton-buildings, Chancery-lane, London.

COMPLETE SPECIFICATIONS ACCEPTED.

To be published Dec. 17, 1903.

1902.

25554. Electric contacts. De Kando.

25731. Electro-mechanical regulators. Routin.

27757. Electric heaters. Carolan. (General Electric Company.)

27767. Electric arc lamps. Carolan. (General Electric Company.)

27770. Electric arc lamps for constant potential circuits. Carolan. (General Electric Company.)

28728. Fusible safety devices or cut-outs used in connection with electricity systems. Macgregor.

28820. Electrodes for primary batteries. Mann and Goebel.

1903.

47. Construction of current transformers used in conjunction with instruments measuring the energy in alternate-current electric circuits. Heap.

70. Electromagnetic apparatus in which the armature is to be turned into different positions, particularly applicable to electromagnetic switches. Siemens Bros. and Co., Limited, and Ferreira.

329. Method of and means for regulating electric motors. Lang.

455. Control of direct-current dynamos and motors. Javaux and Barbou.

1064. Electric switches. Carolan. (General Electric Company.)

1095. Electric lighting systems. McElroy.

1132. Cord grips and means for holding and securing cords and wires, intended more especially for securing flexible electrical conductors to electric lamp-holders and electric supply fittings. Dixon.

1299. Safety appliances for the prevention of injury where a trolley line or other live conductor breaks. Stewart.

1416. Miners' electric lamps. Prested.

1949. Surface-contact structures for electric railways and tramways. Carolan. (General Electric Company.)

2030. Couplings for metal tubes containing electric wires. Barber.

2060. Automatic electric lift gate lock. Chaudoir and Caston.

2198. Automatic electric switches. Bloxam. (Ellison.)

2961. Electrically-actuated semaphores. Siemens Bros. and Co., Limited, and Ferreira.

3873. Electric resistances and the like. Le Roy.

3986. Electric telegraph apparatus. Vanzetti. (Levy.)

5619. Electrical connection between terminal and trolley head of electric tramcars. Birkby.

8259. Systems of electrical distribution. Slaughter.

7026. Apparatus for detecting whether railway or like points are in their correct position, and an electrical switch for use therewith. Siemens Bros. and Co., Limited, and Ferreira.

8436. Permanent magnet electric generating machines. Somerville, Hicks, and Howard and Bullough, Limited.

15831. Apparatus for use in welding railway rail-joints by electricity. Kleinschmidt.

17367. Safety devices for strong-current overhead conductors. Van der Valk.

18680. Means for controlling electrically-operated elevators. Eriksen and Koefoed, Hauberg, Marstrand, and Helweg, Aktieselskabet Titan.

18755. Electrical indicating apparatus for communicating and recording instructions. Blender.

19540. Electrically-operated and controlled railway signals. Peters and Hellingson.

20155. Electricity meters. Rieunier. (Date applied for under International Convention, Oct. 2, 1902.)

22643. Brush-holders for dynamo-electric machines. Thompson.

22664. Contact apparatus for electric relay master clocks. Imray. (Siemens-Schuckertwerke G.m.b.H.).

22785. Storage battery plates. Smith. (Date applied for under International Convention, Sept. 10, 1903.)

23043. Magnetic compasses. Whyte.

23151. Method and apparatus for producing a suitable circulation of the electrolyte in electrolytic processes. Koller and Askenasy.

23225. Electric lamp sockets. Goehst.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.		Last price
Commercial and Industrial.—	£		£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1	..	⅛-¼
Aron Electricity Meter, 5 p.c. Cum. Pref. Shares, 1-125,000	1	..	¼-½
British Insulated and Helsby Cables, Ord., 1-100,000	5	..	5-5¼
—— 5 per cent. Cum. Pref., 1-100,000	5	..	5¼-5⅜
—— 4½ per cent. Mortgage Debentures	100	..	103-108
British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red.	100	..	103-105
British Westinghouse Elec. and Manur., 6 per cent. Pref., 275,001-375,000	5	..	5⅜-5⅝
—— 4 per cent. Mortgage Debenture Stock	100	..	100-102
Brush Electrical Engineering, Ordinary, Nos. 1-105,731	2	..	¾-1⅛
—— Non. Cum., 5 per cent. Pref.	2	..	1⅛-1⅜
—— 4½ per cent. 1st Debenture Stock	100	..	97-100
—— 4½ per cent. 2nd Debenture Stock	100	..	84-89
Callender's Cable, Debentures	100	..	106-110
—— Ordinary	5	..	11-12
—— 5 per cent. Pref.	5	..	5¼-5⅜
Crompton and Co.	5	..	1⅜-2¼
—— 5 per cent. Debentures	100	..	100-104
Edison and Swan United, "A" Shares, 1-99,261	3	..	¼
—— "A" Shares, 01-017,139	5	..	1-2
—— 5 per cent. Debentures	100	..	76-81
—— 4 per cent. Deb. Stock, Red.	100	..	72-77
Electric Construction, Limited, Nos. 1 to 112,100	2	..	1¼-1⅜
—— 7 per cent. Cumulative Pref.	2	..	2½-3
—— 4 per cent. Perp. 1st Mort. Deb.	100	..	97-100
Ferranti Limited, 5 per cent. 1st Mort. Deb. Stock, Red.	100	..	90-95
General Electric Company (1900), 5 per cent. Cum. Pref.	10	..	9⅜-10¼
—— 4 per cent. 1st Mort. Deb. Stock	100	..	96-99
W. T. Henley's Telegraph Works, Ordinary	5	..	14-15
—— 4½ per cent. Preference	5	..	5-5¼
—— 4½ per cent. Debentures	100	..	108-112
India Rubber, Gutta Percha, and Telegraph Works	10	..	18-19
—— 4 per cent. Debentures	100	..	100-103
Parker, Thos., Limited, Ordinary	10	..	14¼-15¼
Telegraph Construction and Maintenance	12	..	34-37
—— 5 per cent. Bonds	100	..	101-104
Electric Lighting and Supply.—			
Blackheath & Greenwich District Ordinary 1,201-101,200	1	..	⅜-½
—— 4½ per cent. Deb. Stk. Certs., Red. and Conv.	100	..	116-119
Bournemouth and Poole, Ordinary	10	..	12¼-13¼
—— 4½ per cent. Cum. Pref., 7,501-15,000	10	..	10-11
—— 6 per cent. Cum. Second Pref., 15,001-22,500	10	..	11-12
—— 4½ per cent. Debenture Stock, Red.	100	..	103-106
Bromley (Kent) Electric Light and Power Co., 4½ per cent. 1st Debenture Stock, Red.	100	..	100-103
Brompton and Kensington, Ordinary	5	..	10¼-10⅜
—— 7 per cent. Preference	5	..	10-10¼
Calcutta Electric Supply Corp., Ordinary, Nos. 1-40,000	5	..	6¼-7⅛
—— Nos. 20,001-30,000	5	..	7-8
Cambridge Electric Supply Company, Ltd., £10 Ord.	8	..	14½
—— ,, ,, £10 Ord.	6	..	10⅜
Central Electric Supply, Ld., 4 per cent. Guar Deb. Stock	100	..	105-108
Charing Cross and Strand, Nos. 1-70,000	5	..	3-3½
—— 4½ per cent. Cum. Pref.	5	..	5¼-5⅜
—— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000	5	..	4⅜-5
—— 4 per cent. Debenture Stock, Red. (Prov. Certs.)	100	..	105-107
Chelsea Electricity Supply	5	..	5¼-6
—— 4½ per cent. Debentures	100	..	107-110
City of London, Ordinary	10	..	10¼-10⅜
—— 6 per cent. Cumulative Pref.	10	..	13-14
—— 5 per cent. Debenture Stock	100	..	122-127
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100	..	102-105
County of London and Brush Provincial, Ordinary	10	..	7⅛-8⅛
—— 6 per cent. Cum. Pref.	10	..	11¼-12¼
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	100	..	108 111
Edmundsons' Electricity Corporation, Ordinary, 1-50,000	5	..	6¼ 6⅜
—— 6 per cent. Cum. Pref.	5	..	6-6¼
—— 4½ per cent. First Mort. Deb.	100	..	104-107
Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-30,000	5	..	3¼-4¼
—— 5 per cent. Debenture Stock, Red.	100	..	95-98
Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000	5	..	5¼-6
—— 4½ per cent. First Deb. Stock, Red.	100	..	100-103
Hove Electric Lighting, Limited, Ord., 1-13,000	5	..	7⅛-8⅛
Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000	5	..	10¼-11¼
—— per cent. Debenture Stock Red.	100	..	100-105

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Name.	Amount paid.	Last price.
	£	£
Kensington and Knightsbridge and Notting Hill	100	101-104
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	9⅜-10⅛
London Electric, Ordinary	5	1⅞-2⅛
—— 6 per cent. Pref.	5	5-5⅛
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	98-101
Metropolitan, Ordinary	10	17⅛-18⅛
—— 4½ per cent. First Mortgage Debenture Stock	100	110-114
—— 5½ per cent. Mortgage Debenture, Red.	100	96 99
Newcastle-upon-Tyne Electric Supply, Ordinary	5	98 101
—— Preference	4	100 103
Notting Hill Electric Lighting	10	12⅛-13⅜
—— 4 per cent. First Mort. Debs., Nos. 1-500 (Reg.)	100	98-101
Oxford Electric, Ordinary, 1-96 and 407-14,310	5	5⅛-5⅜
—— 4 per cent. Debenture Stock	100	98-101
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	10	98-102
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5	3-3⅛
—— 4 per cent. Debenture Stock	100	85-90
South London, Ordinary		3⅛-3⅜
St. James's and Pall Mall, Ordinary, 101-80,080	5	14-15
—— 7 per cent. Pref.	5	7⅛-8⅛
—— 3½ per cent. Deb.	100	98-101
Urban Electric Supply Co., Ordinary, 8-30,007	5	4⅞-5⅛
—— 5 per cent. Cumulative Preference, 50,001-80,000	5	4⅞-5⅛
Westminster, Ordinary	5	11⅛-12½
—— 5 per cent. Cum. Pref., 110,101-138,251	5	6-6⅛

Electric Railways.—

Central London, Ordinary	100	92-95
—— 4 per cent. Pref.	100	99-102
—— ,, ,, deferred	100	96-99
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100	115-118
City and South London, Consolidated Ordinary	100	49-51
—— 4 per cent. Debenture Stock	100	109-112
—— 5 per cent. Pref. Stock '91	100	127-130
—— ,, ,, ,, '96	100	124-127
—— ,, ,, ,, '01	100	120-125
Liverpool Overhead, 5 per cent. Pref.	—	13-13½
—— Ordinary, 1-50,000	—	7⅞-8
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	—	103-104
Waterloo and City, Ordinary	100	91-94

Electric Tramways.—

Anglo-Argentine, 1-260,007	5	4⅛-4⅜
—— Permanent 6 per cent. Debenture Stock, 1888	100	125-130
Blackpool and Fleetwood Tramroad	10	13½-14½
Brisbane Tramway Invest., Lim., Ord., 1-75,000	5	2-3
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5	3⅜-4⅛
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100	98-102
British Columbia Electric Railway Co., Ord., Nos. 1-80,000	100	79-82
—— Non-Cum. 5 per cent. Pref., Nos. 25,001-38,600	10	10-10⅛
—— 4½ per cent. 1st Mt. Debs., Nos. 1-6,250, of £40 each	40	102-104 p.c

Name.	Amount paid.	Last price
	£	£
British Electric Traction, Ord. 1-300,000 & 60,001-90,000	10	11¼-12
—— 6 per cent. Cm. Pf., 30,001-60,000	10	11¼-11⅜
—— 5 per cent. Perpetual Debenture Stock	100	120 123
Buenos Ayres and Belgrano Tram., Ord., 1-100,000	5	2⅜-2⅝
—— "A" 6 per cent. Cm. Pf., 1-40,000	5	5-5⅛
—— "B" 6 per cent. Cm. Pf., 1-27,500	5	4⅜-5⅛
—— 5 per cent. Deb. Stock, Red.	100	106-109
—— Prov. Cert., all paid	100	98-101
Cape Electric Tramways, Nos. 1-480,000	1	1⅜-2
City of Birmingham Tramways, 5 per cent. Cum. Pref.	5	5-5⅛
—— 4 per cent. 1st Mortgage Deb., 1-3,000 (1917)	100	98-101
Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red.	100	100 103
Cork Electric Tramways and Lighting Co., Ordinary	10	13-14
—— 5 per cent. Cum. Pref.	10	11-12
—— Debentures	100	96-99
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10	12-13
—— 6 per cent. Pref., Nos. within 1-60,000	10	15-16
—— 3½ per cent. Mort. Debs., 1-3,000, Red.	100	94-97
Imperial Tramways Ordinary	all	22-23½
—— 6 per cent. Cum. Pref.	all	14½-15½
—— 4½ per cent. Deb Stock	100	112-114
Isle of Thanet Electric Tramways and Lighting, 5 per cent. Cum. Pref., Nos. 30,001-60,000	5	3⅜-4⅛
—— 4 per cent. Debenture Stock	100	92-96
Kidderminster and District Lighting and Traction, Pref.	5	3¼-4
London United Trys. (1901), 5 per cent. Cum. Pref.	10	11¼-11⅜
—— 4 per cent. 1st Mt. Db. Stock, Red	100	104-106
Metropolitan Electric Trams., Deferred, 1 000 001-1,314,016	1	3/16-5/16
—— 5 per cent. Cum. Pref., 500,001-814,016	1	¼-⅜
New General Traction, Ordinary	5	⅛
—— 6 per cent. Cum. Pref.	5	1⅛-2⅛
—— 5 per cent. Mortgage Debentures, 1-1,713 (Regd.)	100	88-93
Oldham, Aston, and Hyde Tramway, Ordinary	10	10⅛-10⅜
—— 5 per cent. Cum. Pref.	10	11⅛-12⅛
Perth Elec. Tramways (W.A.) 5 per cent. 1 Mort. Deb. Stk.	100	100-103
Potteries Electric Traction, Ordinary, 20,001-40,000	10	8⅛-8½
—— 5 per cent. Cum. Pref., 1-20,000	10	8¼-8½
—— 4½ per cent. Debenture Stock	100	102-105
South Lancashire Electric Traction and Power Company—		
—— £250,000 Ordinary	1	1
—— £101,152 6 per cent. Preference	1	1
—— £528,093 4½ per cent. Debenture Stock	100 p.c.	100 p.c.

Telephones.—

National Telephone, Preferred	100	101-103
—— Deferred Stock	100	79-81
—— 6 per cent. Cum. First Pref.	10	13-14
—— 6 per cent. Cum. Second Pref.	10	13-14
—— 5 per cent. Non-Cum. Third Pref.	5	5⅛-5⅜
—— 3½ per cent. Deb. Stock, Red.	100	96 97
—— 4 per cent. Deb. Stock, Red.	100	102-104
Oriental Telephone and Electric Company	1	13/16-15/16

TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line	Traffic Returns for week			Increase or decrease.		Miles of single track open.		Accounts for past year.						Cost per car mile.
	Ending	1903.	1902.	Week.	Current year.	1903.	1902.	Ending	Total receipts	Passengers carried.	Car miles run.	Receipts per Pas-s'nger	Receipts per Car mile.	Receipts per Mile of track.	
		£	£	£	£				£			d.	d.	£	d.
Aberdeen Corporation	Nov. 28	1,076	839	+ 237	+ 5,504*h*	19¼	17¼	May 31	37,931	9,099,715	794,641	0·98	13·02	1,970	6·1
Ayr Corporation	,, 21	170	166	+ 4	+ 52	8	6	Sept. 25	12,503	2,979,276	290,099	1·00	10·34	1,560	4·7
Birmingham Tramways	,, 28	4,966	4,805	+ 161	+ 9,641	6¼	6¼	—	—	—	—	—	—	—	—
Blackburn Corporation	,, 27	700	668	+ 32	+ 912	24	24	March 25*a*	40,964	7,234,106	826,558	1·36	11·87	1,705	7·44
Blackpool Corporation	,, 25	293	279	+ 14	− 183	17½	16½	,, 31	211,168	6,169,121	784,443	1·52	10·8	—	—
Blackpool-Fleetwood Tramways	,, 28	160	188	− 28	− 133	16½	16½	Dec. 31	30,923	2,049,677	584,989	3·62	12·68	1,932	6·99
Bolton Corporation	,, 29	1,685	1,527	+ 158	+ 7,858	38	25	March 31	85,704	17,761,605	1,896,247	1·15	10·75	3,430	5·87
Bournemouth Corporation	,, 25	778	—	—	—	10½	—	—	—	—	—	—	—	—	—
Bradford Corporation	,, 29	3,394	2,811	+ 583	+15,830	41	—	—	—	—	—	—	—	—	—
Brighton Corporation	,, 29	734	698	+ 36	+ 2,554*h*	6½	—	,, 31	—	10,432,508	1,031,928	1·00	10·10	—	—
Bristol Tramways Company	,, 27	4,350	4,123	+ 227	—	51½	51½	Dec. 31	223,480	41,192,899	5,724,114	1·30	9·38	4,348	—
Burnley Corporation	,, 28	741	654	+ 87	—	—	—	—	—	—	—	—	—	—	—
Burton Corporation	,, 23	301	—	—	—	—	—	—	—	—	—	—	—	—	—
Cardiff Corporation	,, 28	1,794	1,506	+ 287	+19,150	—	—	—	—	—	—	—	—	—	—
Carlisle Tramways Company	,, 23	158	124	+ 34	+ 721	—	—	,, 31	—	2,216,583	320,129*h*	—	—	—	—
Central London Railway	,, 28	6,951	7,092	− 141	− 6,860*h*	6	—	,, 31	367,225	45,305,110	1,276,971*a*	1·87	66·6*a*	59,076	35·6*a*
City and South London Railway	,, 29	3,310	3,677	− 367	− 9,026*h*	6⅞	—	,, 31	165,003*a*	19,069,319*a*	—	—	—	—	—
Cork E. T. and L. Company	,, 26	406	405	+ 1	− 3,381	—	—	—	—	—	—	—	—	—	—
Darwen Corporation	,, 27	198	213	− 15	− 223	7·23	—	March 31*g*	12,341	2,360,735	254,279	1·25	11·65	1,707	9·36
Dover Corporation	,, 28	157	168	− 11	+ 47	3	—	—	—	—	—	—	—	—	—
Dublin & Lucan Electric Railway	,, 29	90	88	+ 2	+ 174*h*	—	—	Dec. 31	5,796	364,796	102,087	3·81	13·62	359	7·68
Dublin U. T., electric cars	,, 27	3,569	3,554	+ 5	} +7,807	46	46	March 31	125,121	24,553,133	3,429,356	1·23	8·82	2,741	5·06*h*
Dublin S. District, Electric	,, 27	717	694	+ 23											
Dundee City Tramways	,, 25	788	751	+ 37	—	22	22	May 15	35,874	9,084,522	752,814	0·93	11·276	1,630	—
East Ham Corporation	,, 28	593	416	+ 167	+ 7,052	10·75	7·52	March 31	25,341	9,971,337	650,224	0·61	9·35	2,357	—
Farnworth U.D.C.	,, 18	133	126	+ 7	—	—	—	—	—	—	—	—	—	—	—
Glasgow Corporation	,, 28	13,161	12,375	+ 785	+37,083*h*	124	101	May 31*g*	655,572	177,179,549	14,908,750	0·88	11·25	5,489*b*	7·40*d*
Halifax Corporation	,, 18	2,352	2,139	+ 213	+ 5,356	30½	27⅔	—	—	—	—	—	—	—	—
Huddersfield Corporation	,, 28	1,119	982	+ 137	—	34	35	March 31	56,631*h*	9,738,213	1,218,539	1·4	11·14	1,618	6·38
Hull Corporation, E. S.	,, 28	1,825	1,699	+ 125	+ 3,709	19	19	,, 31	87,707*h*	21,065,999	2,218,696	1·00	9·49	5,004	5·07
Ilkeston Corporation	,, 25	126	—	—	—	—	—	—	—	—	—	—	—	—	—
Kirkcaldy Corporation	,, 18	147	—	—	—	—	—	—	—	—	—	—	—	—	—
Leeds Corporation	,, 28	4,871	4,520	+ 351	+11,772	77	—	March 25	252,656	57,239,779	5,773,651	1·11	10·91	3,283	—
Liverpool Corporation	,, 21	9,465	8,893	+ 572	+15,552	101	95	Dec. 31	504,304	108,906,472	11,705,425	1·11	10·34	5,000	6·68
Liverpool Overhead Railway	,, 29	1,560	1,445	+ 115	+ 2,428*h*	15½	15½	June 30	79,252	10,466,726	986,185*a*	1·82	19·30*a*	5,110	— *a*
London County Council	,, 22	9,105	6,227	+2,878	+63,648	40	26	—	—	—	—	—	—	—	—
Lowestoft Corporation	,, 24	142	—	—	—	—	—	—	—	—	—	—	—	—	—
Nelson Corporation	,, 28	84	—	—	—	3	—	—	—	—	—	—	—	—	—
Newcastle-on-Tyne Corporation	,, 28	3,422	2,973	+ 449	—	38½	36	March 25*g*	150,334	33,474,122	3,379,119	1·08	10·93	4,175	6·17
Portsmouth Corporation	,, 28	1,292	1,202	+ 90	+ 4,230	29	29	Sept. 30	47,651	9,168,137	868,157	1·24	13·17	1,643	—
Rochdale Corporation	,, 32	117	121	− 4	—	4½	—	March 31	5,416	925,231	127,456	1·38	10·27	—	7·66
Rotherham Corporation	,, 26	419	—	—	—	—	—	—	—	—	—	—	—	—	—
Salford Corporation	,, 30	4,021	2,756	+1,265	+40,005	—	—	—	—	—	—	—	—	—	—
Sheffield Corporation	,, 29	4,259	—	—	—	53½	46½	Mar. 25*g*	216,709	56,812,049	4,926,083	0·904	10·428	7,510	7·0
Southampton Corporation	,, 26	848	839	+ 8	—	11	11	,, 31	35,874	9,084,522	752,814	0·946	11·436	3,760	—
Sunderland Corporation	,, 22	1,055	973	+ 82	+ 2,083	18·48	17·18	,, 31	69,930	13,987,121	1,270,957	1·03	11·3	3,243	6·43
Wallasey U.D.C.	,, 28	571	—	+ 66	+ 3,169	10·5	10·5	,, 31*g*	31,474	5,685,182	654,742	1·30	11·53	3,593	7·03

- Includes maintenance of permanent way and proportion of profits paid to the tramway companies for term of unexpired lease. *a* Train mile.
b per mile of single track. *c* Include rail and tram. *d* Including depreciation. *f* Including one section of horse traction. *g* 1903. *h* Half-year's figures.

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NOTES.

University College, London.—It is stated that an anonymous donor has, through Prof. Starling, presented £50,000 to University College, London, to be applied to the promotion of higher scientific education and research.

Incorporated Municipal Electrical Association. We are notified of a change of address of the secretary of the above association. In future all communications should be addressed to Mr. C. McArthur Butler, Staple-inn-buildings South, Holborn, London, W.C.

The Nobel Prizes.—It is reported that M. Henri Becquerel, the discoverer of the rays associated with his name, will, with Madame Curie and her husband, share the Nobel prize in physics, and that Prof. Finsen, inventor of the light cure for lupus, will take the award in medicine. The awards have not yet been officially announced, but were to have been made last night at a meeting of the Scientific Academy in Stockholm. Each prize is of the value of £8,000.

Standard Gauges.—A demand has arisen for the testing, for use in mechanical engineering, of standard gauges in the forms of external and internal cylindrical steel gauges, limit gauges based on the measure of the inch and the millimetre, and other forms of gauges, verniers, micrometer-callipers, etc., included in the measuring equipment of workshops. The Board of Trade announce that the Standards Department is equipped with means for testing such gauges, provided that they are of legal and recognised denominations.

Radium Supply. — Prof. Himstedt, of Freiburg, is stated to have made an interesting discovery as to the probable supply of radium, which seems to show that its existence is far more extensive than at present known. The professor's experiments are said to have proved that all products from water and petroleum wells yield a heavy specific gas, closely resembling and probably identical with the emanation of radium, whence he concludes that a very large number of bodies are imbued with the quality of emitting a kind of Becquerel rays.

The Electro-Chemical Trade.—It is reported that the trade war between English, German, and American manufacturers of bleaching powder, which has severely depressed the industry during the past 12 months, has been ended, a working agreement having been arranged. The effect of this is already evident, the price of bleaching powder having risen to from £4 to £5 per ton, as against anything from £2 upward. The companies which have suffered most severely from the war are the Electrolytic Alkali Company, Castner-Kellner Alkali Company, and the United Alkali Company.

Electro-Harmonic Society.—The committee of this society have decided to make a change which they believe will be unanimously approved by the members—*i.e.*, to hold the smoking concerts on Dec. 18 and March 25 in the King's Hall of the Holborn Restaurant, instead of in the Crown Room as previously arranged. The concert fixed for Jan. 22 will, however, take place in the Crown Room owing to other arrangements having been made for the larger hall on that night. Seventy-eight new members have already been elected during this season, and the committee anticipate that the change mentioned will result in a further accession to the membership of the society.

Birmingham Local Section.—This section of the Institution of Electrical Engineers opened its winter session last week, when Mr. J. C. Vaudrey, until lately electrical engineer to the city of Birmingham, gave his inaugural address. In it a strong point was made of the advantage of having a common home for all the technical associations and scientific societies in the Midlands. On this subject we have written a good deal and Mr. Vaudrey has taken the matter up for the Birmingham district with considerable vigour. In his address he pointed out the advantage of having a well-stocked technical library at the disposal of the members of all such associations, and also the benefit of a common organisation. We trust that the scheme proposed will be carried through, and that Mr. Vaudrey will now have time to give his personal support to the object in view.

Electricity in the U.S. Navy.—The naval authorities in the United States are showing every desire to be abreast of the times in replacing hand and mechanical operations by electrical methods on board ship. For some time the ventilation of most of the vessels in the American fleet has been carried out by electric fans, which have supplanted the old steam-driven fans, and a new departure is soon to be made with the adoption of electrically-operated water-tight doors. The particular type to be adopted has not yet been approved, but experiments are in progress, and it is expected that a satisfactory equipment will be found before long. Further, the authorities have been investigating several types of electrical steering gear, one of which is to be adopted on board the "Nevada" as an experiment. This is quite a new application of electricity so far as warships are concerned, although we believe the British Admiralty has been experimenting recently with a certain type of electrical steering gear, with what results, however, is not known.

Royal Institution.—We understand that Prof. L. C. Miall has been elected Fullerian Professor of Physiology at the above institution. The following are the lecture arrangements at the institution before Easter so far as they are of interest to the profession: three lectures on "Electrical Methods of Measuring Temperaure," by Prof. H. L. Callendar, and six lectures by the Right Hon. Lord Rayleigh on "Physics." During the season 1904 the lectures on Tuesdays and Thursdays will be delivered at five o'clock and the Saturday lectures at three o'clock. The Friday evening meetings will begin on Jan. 15, when a discourse will be delivered by the Right Hon. Lord Rayleigh on "Shadows." Succeeding discourses will probably be given by the Rev. Walter Sidgreaves, Mr. D. G. Hogarth, Mr. H. Brereton Baker, Mr. Alexander Siemens, Prof. W. Stirling, Prof. F. T. Trouton, Prof. Dewar, and other gentlemen. Dr. Andrew Carnegie, Mr. J. S. Curgenven, Dr. J. Emerson Reynolds, and Mr. R. Wissmann have been elected members of the institution.

Electric Lighting of Trains.—On the Western Australian Government railways the electric light has been employed for illuminating the carriages for some two or three years with satisfactory results all round. The system is gradually being extended to all the rolling-stock, and, as a consequence, the annual cost of upkeep is decreasing proportionately. The report of the Acting-General Manager of Railways of West Australia for last year shows that altogether some 70 carriages have been equipped with the electric light, and on the average 47½ were maintained for the full 12 months. The cost of upkeep is stated to be £892. 9s. per annum, an average of £18. 16s. per car, as compared with £20. 12s. per car in the preceding year. The reduction would appear to be consequent upon the larger number of carriages in use than in the previous year, when an average of only 26 carriages was maintained. There seems to be some little difference of opinion as to whether a comparatively inexperienced person, or ordinary mechanic, is or is not capable of satis-

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factorily attending the electric light. Enquiries, however, are to be made as to the practice where the light is in use elsewhere, which will no doubt settle the question.

Glasgow Corporation Telephones.—The committee of the Glasgow Corporation which is responsible for the municipal telephone undertaking in that city, is taking a right and proper course in regard to the undisguised hostility which is entertained in certain quarters against the municipal system, as exemplified in the articles condemnatory of the accounts which have appeared in certain electrical and engineering journals. Reprints of these, together with pamphlets, have been extensively circulated in Glasgow by anonymous agencies. The matter was before the committee at their last meeting, and, after consulting with their auditors, the committee decided to take no action, adopting the view that the accounts, having been drawn up in the form recommended by an eminent and independent firm of auditors (who certified them as correct, and after reading the articles in question had no amendments to suggest), and having been adopted, after careful consideration, successively by the Sub-Committee on Finance, the Telephone Committee, and the Town Council, call for no defence "against articles written in such obvious ignorance of the conditions which prevail in Glasgow, and with such apparent bias and purpose."

Telephones in Liverpool.—At the last meeting of the Liverpool Engineering Society Mr. C. J. Hidden read a paper on the development of the telephone in recent years. He described in detail improvements that have been made in the course of changing over old installations from the single-wire and earth system to the all-metal circuits with two insulated conductors to each subscriber. In the course of his paper he referred particularly to the work in Liverpool, where an extensive system of underground cables is being installed. The existing switchboards have also had to be altered to meet the large number of subscribers who have to be dealt with. The new exchange for the centre of the town has been laid out to accommodate 10,000 subscribers, and is complete with every modern accessory. The new multiple boards are so arranged that they can be conveniently converted in time to come to the central battery system with but slight alteration. The precautions against fire were described in detail, and the importance of this feature was emphasised. Owing to the inflammable nature of the bulk of the material used in telephone exchanges, the need for such precautions is imperative. In the course of the discussion the advantages of subways for the cables instead of conduits was taken up, but, as the author pointed out, the difficulty and cost of constructing these subways in Liverpool would be very great.

The Late Sir Frederick Bramwell.—Sympathetic tributes were paid to the memory of the late Sir Frederick Bramwell at a general monthly meeting of the Royal Institution on Monday. The Duke of Northumberland (the president) was not able to be present, but he sent a letter expressing his deep sense of the loss the institution had sustained in the death of "our respected and valued friend." His Grace continued: "His great talents and high professional reputation are known to all the world—the deep interest he always displayed in the work of the Royal Institution, and the conspicuous services he rendered it, cannot, I think, fail to be within the cognisance of every member. But it is only those who have taken part as his colleagues in the management, and who have had the privilege of enjoying his personal friendship, who can be fully aware of his genial kindliness, his wise counsels, and his indefatigable energy." The resolution, which was unanimously passed by the meeting, after placing on record the loss to the institution by the death of the deceased baronet, states that "his personality and the signal services he rendered to the institution by his unvarying devotion to and deep interest in its welfare, and in the advancement of experimental research for 27 years as manager, honorary secretary, and vice-president, will be long remembered. The managers desire to offer Lady Bramwell and her family the expression of the most sincere sympathy with them in their bereavement."

Telegraphic Communication with the North.—The Association of Chambers of Commerce, which has been chiefly instrumental in urging the Post Office to lay a complete system of underground telegraph cables to the North of England, has succeeded in eliciting some important information from Lord Stanley as to the progress which the work is making. The present state of the scheme may be concisely stated thus: The temporary wires in the pipes between Birmingham and Warrington are being replaced by a permanent cable. Seventy miles of this cable have been drawn in, and when the remaining 12 miles are drawn in there will be a permanent underground system between London and Birmingham, Manchester and Liverpool. There are already underground wires between Warrington and Manchester and Liverpool. The laying of the pipes north of Warrington to Carlisle has been finished, and temporary wires have been drawn in as far as Wigan, and will be continued to Preston. A permanent cable to Carlisle will be provided later. In Scotland it has not been possible at present to undertake more than one section of this work. That section is over the Beattock incline, where the overhead wires are much exposed and the pipework is completed. Pipes are also being laid north-eastward from Manchester to Leeds, and temporary wires will be provided, to be replaced later on by a permanent cable. It is satisfactory to learn that this work will be completed before the end of the financial year.

Proposed Electrical Post.—Interest in Count Taeggi Piscicelli's proposal to establish a system of electrical post transmission at 250 miles an hour, is revived by the announcement that a syndicate has been formed to put the invention to a practical test in Italy. Only one-third of the total capital of £150,000 is proposed to be raised in this country and the other two-thirds in Italy and France. The avowed object of the syndicate is "to demonstrate the invention on a practical scale," but however interested the public may be in such a scheme, we doubt if their interest will carry them to the length of putting their money into a concern which is admittedly formed to experiment without much prospect of profitable business in the near future. Count Piscicelli's idea is to erect aerial wires along which aluminium boxes containing the mails would be transmitted by electrical propulsion at a speed of something like 250 miles an hour. This main system would be supplemented by local systems serving the towns *en route*, and the invention involves the installation of costly automatic and other apparatus. The initial expenditure on such a system would thus be very great, and it might or might not prove to be of practical advantage. If the syndicate should progress so far as to erect an experimental line, we shall watch the results with the deepest interest. Apparently the inventor was not able to convince the Postmaster-General of the feasibility of his system, as it will be remembered the original proposal was to carry out the first experiments in this country.

German Electrical Depression.—The stagnation under which the electrical industry in Germany has been labouring for the past two years or so forms the subject of a brochure which has been issued by Dr. Bürner, of the

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Association for Guarding the Interests of German Electrotechnics. This expert estimates that in 1900 there was about £119,000,000 invested in electrical works in Germany, and he attributes the severe crisis which the industry has undergone, and from which it is still suffering, to various causes. First and foremost, he says, the electrical companies, instead of confining their activity to manufacturing, engaged in promoting ventures and obtaining concessions, and in building electric roads, lighting plants, etc., in the towns and rural districts, which should have been left to the municipalities, financial promoters, and private companies. Further, a great mistake was committed in erecting and conducting branch electrical factories in foreign countries, which caused numerous competitors to spring up in those countries, and led other German companies to enter the foreign business, thereby producing a sharp struggle to obtain profitable orders. As a third error, Dr. Bürner names the practice inaugurated by the electrical concerns of establishing installation shops in all the cities and large towns of Germany, instead of leaving that part of the business to the resident plumbers and installation firms. Dr. Bürner does not favour the plan of uniting the German electrical companies in one common concern, but urges the formation of syndicates to regulate and protect prices and limit production where such is profitable. His main recommendation to the industry, however, is to endeavour to extend and increase the export trade.

New Books.—"Fowler's Electrical Engineer's Year-Book and Directory, 1904" (The Scientific Publishing Company, Manchester; 1s. 6d.). The ever-widening field of electrical engineering has been responsible for many amendments and additions that have been made in this popular little handbook. For instance, the revised general rules for wiring issued by the Institution appear in this edition, and some valuable tables of data have been interpolated with a view to enriching the text, which in many parts has been largely rewritten, as, for example, in the case of the sections on measuring instruments, electric distribution, meters, and dynamos; while some interesting new matter on polyphase transmission and induction motors has been included. A valuable feature of the book is the data relating to station plant, equipment, and staff which are given of over 500 installations in the country.—"Transactions of the American Electro-Chemical Society" (The American Electro-Chemical Society, Philadelphia), vol. iv. A large number of valuable papers are reprinted in this issue, together in some cases with the discussions at the meetings at which they were presented. Among the papers we notice the following: "Note on Some Theoretical Considerations in the Construction of Resistance Furnaces," by Mr. FitzGerald; "Advances in Electro-Metallurgy of Iron Production," by Mr. Ruthenberg; "A New Type of Electrolytic Cell," by Mr. Salom; "The Electrolysis of Water," by Messrs. Richards and Laudis; and "The Thermo-Chemistry of the Theory of Electrolytic Dissociation," by Mr. Richards.—"Electric Traction," by Mr. J. H. Rider. (Messrs. Whittaker and Co.; 10s. 6d.). This book, to which we referred last week, has now been published. It is described as a practical handbook on the application of electricity as a locomotive power. We hope to notice the work more extensively in a subsequent issue.—"The 'Daily Mail' Year Book for 1904," edited by Mr. Percy L. Parker (The Amalgamated Press, Limited, London; 1s. 6d.).

Electricity for Rangoon.—The introduction of electricity in Indian cities has led to much local controversy and adverse criticism of the methods employed by municipal authorities in that portion of the Empire. Just now there is a stiff fight proceeding over the tendering for the electric lighting and tramway concession in the city of Rangoon, and our contemporary, the *Indian and Eastern Engineer*, throws an interesting light on the way the city authorities are going about the scheme. From our contemporary's remarks, it would seem as if the one object the municipality has in view is to put as many restrictions as possible on the concessionaires in carrying out the work. Thus, the tenderers have been forced to agree to pay a minimum tramway track rent of Rs 3,000 per mile of double and Rs.2,000 per mile of single track per annum, which is held to be an excessive amount when compared with other Indian cities. For instance, in Calcutta, where there is a greater track mileage, much greater scope for expansion, and a traffic far superior to any that can be hoped for in Rangoon, the total track rent is only Rs.30,000 per annum, whereas in the present case, the total rent, based on the above figures would amount to Rs.36,000. The electric tramway in Colombo pays only Rs.800 per annum per mile of track up to eight miles, and above that Rs.500 per mile. The greatest trouble, however, appears to be in the matter of tenders. Our contemporary states that a Calcutta firm should have been awarded the concession on the original tenders, but fresh tenders were called for on the plea that no proper comparison could be made of the four tenders which were received. If anyone is to blame for this, it is held to be the municipality itself, since the tenders were based on its own tender form. The one satisfactory feature about the whole scheme would seem to be in regard to the plans for lighting the city. These are admitted to be generous and well conceived, although some exception might perhaps be taken to the method of installation, which leaves little provision for future extensions.

Mechanical Stokers.—At the meeting of the Society of Engineers held on Nov. 30, Mr. Albert Gay, the electrical engineer of Islington, read a paper on the use of mechanical stokers in electricity generating stations. The paper is commenced with a table which gives approximately the detailed losses in British thermal units from the coal fed into the boiler down to the electricity delivered to the lamps in consumers' premises. These approximate figures show that only 7·27 per cent. of the British thermal units in good coal are actually developed in the lamps. The largest losses are in the gases passed up the chimney and in the engine exhaust. Mr. Gay, like a number of other writers on the subject, takes the absolute efficiency of the engine into his calculations instead of the practical efficiency. In other words, he compares his steam-engine with a heat engine able to work down to absolute zero. A description is given of a large number of mechanical stokers, and then follow figures of tests. The first table of these deals with the underfeed stoker which has been experimented with at the Islington station. The comparisons between this and hand firing are not so valuable as they would otherwise be, because during the trial of the mechanical stoker the boiler was not forced in any way. In fact, the output in steam from the hand-fired boiler in nine hours was approximately the same as that from the mechanically-stoked boiler in 16 hours. The author concludes that the average evaporation with mechanical stokers is somewhere between 9lb. and 10lb. of water per pound of coal. He, however, gives records where these figures were considerably exceeded. Perhaps the most interesting part of the paper is the end, in which replies received from a large number of central stations in London on the question of mechanical stoking are given. The conclusion from these is that in London it pays to use the best coal, and in several cases hand firing has been found more economical and less liable because of smoke trouble than mechanical stoking. As the author puts it, a large

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proportion of the cost of fuel in London is made up of carriage, and hence it pays to carry a high-class fuel rather than a low-grade coal.

Electric Transmitting Mechanism for Automobiles.—In many forms of automobiles a considerable disadvantage is the use of the intermediate gearing which is necessary to transmit the movement from the motor in front of the car to the differential, which is generally placed on the rear axle. To give the different changes of speed a number of sets of gears is necessary, thus involving much loss of energy in the transmission, as well as increasing the mechanical shocks of the car. A device which is designed to overcome this disadvantage, and give an easy running, has been recently brought out in Paris, and is stated to have worked very successfully. The transmission is carried out by an electric device, which will be understood from the following abstract of an article illustrating the invention, published in the *Western Electrician*. The shaft of the petrol motor has its flywheel formed by the field magnets of a dynamo. The armature of this dynamo is fixed on a shaft carried in bearings which passes to the rear. A second dynamo has its field fixed and independent, while its armature is carried on the main shaft. To the end of the shaft is fixed the bevel gear, which engages with one or the other of the bevel gears of the differential which is mounted on the rear axle of the car. The two machines are coupled together and excited in series, the field of the second machine being shunted by a rheostat of 12 points. When the rheostat is short-circuited the first machine acts as a simple coupler, and a very small slip between its field armature suffices to obtain the current which corresponds to the normal couple of the petrol motor. This position represents the maximum speed of the car. If the resistance of the rheostat is increased, the field current is increased in the second machine. The counter E.M.F. which is thus given makes it necessary, for an equal current, to obtain a greater slip in the first machine. The speed of the car therefore diminishes and the effort increases, since to the normal couple of the petrol motor is added the couple of the second machine, the latter being proportional to the field strength, and can, therefore, be varied as desired by the action of the rheostat, which acts thus as a speed controller. Another set of connections gives an electric braking action by reversing the rate of the two machines. The speed reversal, however, cannot be obtained electrically, but is brought about mechanically by shifting the bevel gear to one side or the other of the differential. In general, the principle of the above arrangement is similar to that used on the single motor carriages on the North-Western Railway.

Fog and Electricity.—Following up his lecture before the Physical Society in London, Sir Oliver Lodge has explained to the members of the Scientific Society of the Birmingham and Midland Institute his suggestions for the dispersal of fog by means of electricity. He showed that an alternating current would not give the effect required in order that the particles of fog might cohere, but that an unidirectional discharge was wanted. On the other hand, alternating current had the advantage that exceedingly high potentials could be obtained. He, therefore, suggested that while alternating currents might be generated for the purpose, a mercury interrupter could afterwards be used in order to damp down the oscillations in one direction. The Cooper-Hewitt lamp evidently prompted the idea, and it will be interesting to see how far experiments on the lines laid down by Sir Oliver Lodge will be successful on a large scale. He has this week added to his previous information on the subject in a letter addressed to Mr. J. W. Bradley, M.I.Mech.E., who had written suggesting that it might be possible to devise an arrangement to be fitted to street arc lamps so that electricity could be discharged at a large number of points and in situations likely to be productive of most benefit. Sir Oliver commends the suggestion as practical, and proceeds: "The difficulty is the insulation. If that could be guaranteed, the matter would be comparatively easy; but the potential is extremely high, say 100,000 volts. The quantity is next to nothing and very little power is sufficient if only one could avoid leakage." Describing the Liverpool experiment, he says: "I was using a potential higher than 100,000 volts; one could take sparks 4in. long. But a good deal smaller voltage would do if there are walls or other earthed surfaces in the neighbourhood. For a lofty isolated mast the potential must be higher in order to secure adequate discharge. My view, of course, is that a town fog ought not to be produced; that it is very extravagant of a community to go to the double expense, first of producing a fog by incomplete combustion, and next of coping with it. But inasmuch as combustion reform will take some time, and meanwhile fogs are a nuisance, it is quite possible that something temporary ought to be done even in a town. Fogs at sea and at harbours come in a different category, and it is quite appropriate to attempt to deal with them. There is, however, no more difficulty in dealing with one than with another, and, in fact, the thicker the fog the more easily it is to deal with, if only adequate arrangements are made for the genuine supply of electricity into the air."

The Carbon Vaporised in Incandescent Lamps. Incandescent lamp filaments, as is known, are mostly of amorphous carbon as obtained by calcination of a vegetable thread. This, on being brought to a white heat in the vacuum by the electric current, will yield a trace of carbon vapour, the condensation of which on the walls of the bulb in most cases results in the latter becoming lined with a brown coating, producing a gradual darkening of the lamp. In a paper read before the French Academy of Sciences Prof. Berthelot examines the state of this vaporised carbon at the lowest possible temperatures, comparing it with the well-known allotropic modifications of carbon—namely, diamond, graphite, amorphous carbon. The main results of this investigation are as follows: Carbon exhibits an appreciable vapour tension at a temperature not exceeding 1,500deg. C., this tension being so low as to require several hundreds of hours to produce some milligrammes of condensed carbon even in the nearly absolute vacuum of electric lamps. On the other hand, the carbon thus vaporised at the lowest possible temperatures is, under Prof. Berthelot's experimental conditions, amorphous carbon without any addition of graphite or diamond. The temperature at which a vapour tension of carbon may be noted proves thus about 2,000deg. below the boiling temperature, which, according to Prof. Violle, is 3,600deg. This interval is very much larger than the interval of temperatures, during which most of the remaining bodies exhibit an appreciable vapour tension. This tension, however, in the case of carbon, does not, in Berthelot's opinion, correspond with a simple vaporisation occurring without any intimate change in the chemical constitution of the body in question. Although representing the same chemical element, carbon assumes in the solid state a multitude of different conditions exhibiting rather different physical and chemical properties. There seems to be a series of progressive condensation, the limits of which would correspond to the different modifications of carbon. According to ordinary analogies, the physical properties of compound bodies susceptible of being formed directly are related to those of their components,

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but they are more or less modified on account of the energy loss undergone in virtue of this direct combination. The combination of hydrogen, boiling at −252deg., and that of oxygen, boiling at −182deg. C., will thus give water, which boils at +100deg. The internal force maintaining at the gaseous state the free molecules of hydrogen and oxygen has thus decreased to an enormous extent, as corresponding with the 59,000 calories lost at the instant of their combination with the formation of a molecule of gaseous water. The same seems to be true of carbon in its combinations with hydrogen. The real existence of this element in a true gaseous state, no matter what the origin, is shown by spectral analysis, both in the electric arc and in the sparks, through its oxides, hydrides, etc., as well as in the flames produced by the combustion of these different compounds.

Recent Developments in Gas-Engines.—The members of the Junior Institution of Engineers held a meeting at the Westminster Palace Hotel, on Friday, to hear a paper read by Prof. D. S. Capper on "Recent Developments in the Construction and Working of Gas-Engines." After a short reference to the Otto gas-engine, the author showed that the efforts of experimenters have been chiefly directed either to the improvement of the Otto cycle, or to endeavouring to replace the Otto cycle by one which shall give greater efficiency and easier regulation. A third direction in which developments have been made is the cheapening of fuel by the introduction of producer gas and use of blast-furnace gas. The author then described the modifications in the Otto cycle engine introduced by various makers, resulting in the consumption of coal gas being reduced, the inequality of the crank effort being partly overcome and the speed being kept constant to about 1 per cent. by automatic governing. Probably the largest engines on the Otto cycle hitherto constructed have been made by the Société Cockerill, of Seraing. Engines with two tandem cylinders, 51in. in diameter, have been made by this firm and develop 2,500 i.h.p. Among earlier attempts to replace the Otto engine was that made by Mr. Dugald Clerk, who removed the suction and compression strokes to a separate pump cylinder. Although this engine did not supersede the Otto, it has been reintroduced, with modifications, as a double-acting engine by Messrs. Korting, and is now being manufactured in sizes up to 1,000 h.p. and over. Another departure from the Otto principle is the engine made by the Diesel Company, which closely follows the Carnot cycle, and if this can be successfully applied to gas-engines of large size, constant pressure ignition in a gas-engine will be an accomplished fact. The engine recently invented by Messrs. Vogt and Hecklinghausen was designed to overcome the difficulty of cooling with the thicker castings rendered necessary by the increased explosion pressures, and promises to give striking results. By recent improvements in construction the gas-engine has been brought to a position in which in economy it surpasses the steam-engine, and in regularity of running, steadiness, size, and handiness for given power it approaches very closely and promises to surpass the steam-engine also. Compound gas-engines have been tried by Messrs. Crossley and by other makers, but although these have been successfully worked, the gain has not been commensurate with the added cost, and they have therefore not been adopted as a commercially possible type. If the reciprocating engine were to give place to a rotary turbine there is little doubt that its future would bid fair to equal, and probably to surpass, the steam-engine for universal application. Many experimenters are working on the problem of a gas-turbine, and it is rumoured that a solution has been found. The place the reciprocating gas-engine has already won is proved by the significant fact that even firms which have created the demand and met the supply for high-speed steam electric generators are almost without exception experimenting with gas-engines, as the coming thing which will supply the second, if not the first, string to their bow. The meeting closed with the announcement of a visit on Dec. 19 to the electricity works of the Walthamstow Urban District Council, which are operated by gas-engines.

Electrical Development in Cornwall.—We briefly referred last week to an electric tramway line which has been laid down in one of the mining districts of Cornwall for the carriage of iron ore, and we are now able to give some interesting particulars of the system, which is probably the first of its kind in this country. It has been carried out in connection with the recently constructed Camborne and Redruth electric tramway, and the Urban Electric Supply Company have contracted to carry all the ore from East Pool and Wheal Agar to the stamps at Tolvaddon, the distance being about 1½ miles. An average traffic of about 200 tons of ore a day has been provided for. The ore is first carried from the mines over about half a mile of the Camborne and Redruth tramway permanent way, branching off at the power station at Carn Brea. A light railway has been laid down on private property, crossing two main roads to the stamps. In the construction of this line it was necessary to build a bridge over the gasworks road, and a large amount of levelling had to be done; a trestle bridge was also found necessary from the second to the third stamps, owing to the difficulty of getting curves of a reasonable radius in such a cramped area. This special work in conjunction with the permanent way produced many difficulties for shunting of trucks and locomotives owing to the limited space at disposal. Locomotives are used for drawing the freight cars. They were supplied by Messrs. Milnes and Co., and the electrical equipment, including the motors and controllers, by the British Thomson-Houston Company. Each locomotive is equipped with two 25-h.p. motors of the firm's K-60 type. The rolling stock consists of 14 side-tipping steel trucks—eight carrying 2¼ tons per truck, and six three tons per truck. These trucks are provided with powerful brakes on all four wheels, and a train will consist of three trucks and locomotive. The construction of the line, etc., was carried out for Messrs. Edmundson's Electricity Corporation, Limited, by the resident engineer and manager, Mr. F. S. Hanning. Incidentally we are able to give particulars of the works, which have been completed under the Camborne, Redruth, and Illogan lighting orders and the Camborne and Redruth tramway order. The entire installation of both the lighting and tramway system was carried out direct without contractors, with the exception of Messrs. Callender's Cable and Construction Company, who laid the cables to the instructions of the resident engineer, and of which over 100 miles have been put down in mains and network. The present position of the undertaking may be stated thus: the equivalent number of 8-c.p. lamps connected is 6,000; number of motors, 17, representing about 200 b.h.p.; number of tramway motors, 10, equal to 500 b.h.p., making the grand total equivalent to 25,000 8-c.p. lamps. Such a result for 12 months' working may well be considered as excellent when compared with some of the large industrial towns in the kingdom. For instance, Rochdale, with a similar combined system, with a population of 83,000, has only an equivalent of 18,000 8-c.p. lamps after three years' working. We understand that the company have arranged with the Post Office to have letter-boxes affixed to the cars, the mails to be collected hourly at both Camborne and Redruth, thus imitating the example set by some of the northern towns.

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WORKS' VISITS.

II.—Messrs. Royce, Limited, Trafford Park, Manchester, Works.

As was the case in the first article of this series, we have here to deal with extension works erected at a distance from the original site. Messrs. Royce, Limited, established their head works at Hulme, Manchester, in 1884, and soon gained a local reputation for their dynamos and motors. But from local circles the good repute of the firm's manufactures has now spread even to the Colonies. Perhaps it is with electric cranes and hoists that the name of "Royce" is more generally associated. Indeed, the firm claim to be pioneers in the particular branch of electrical and mechanical engineering dealing with the application of electrical energy to cranes, hoists, etc., and have specialised in this department with a degree of success which may be justly described as phenomenal. From a small beginning the establishment at Hulme increased until it occupied the full extent of the land available, and then recourse was had to a site which offers greater facilities. This site is situated in Trafford Park, Manchester, directly opposite Messrs. Glover's cable works. It is three acres in area, and by virtue of position enjoys all the advantages due to the elaborate system of railways designed to serve the several works on the Trafford Park Estate, besides those advantages incidental to the supply of power at the cheap rate of 1¼d. per unit provided by the Estate Company, and to its close proximity both to the Manchester Ship Canal docks and the Bridgewater Canal.

Main Bay of Machine Shop, looking towards Side Bays, Messrs. Royce Limited, Trafford Park Works.

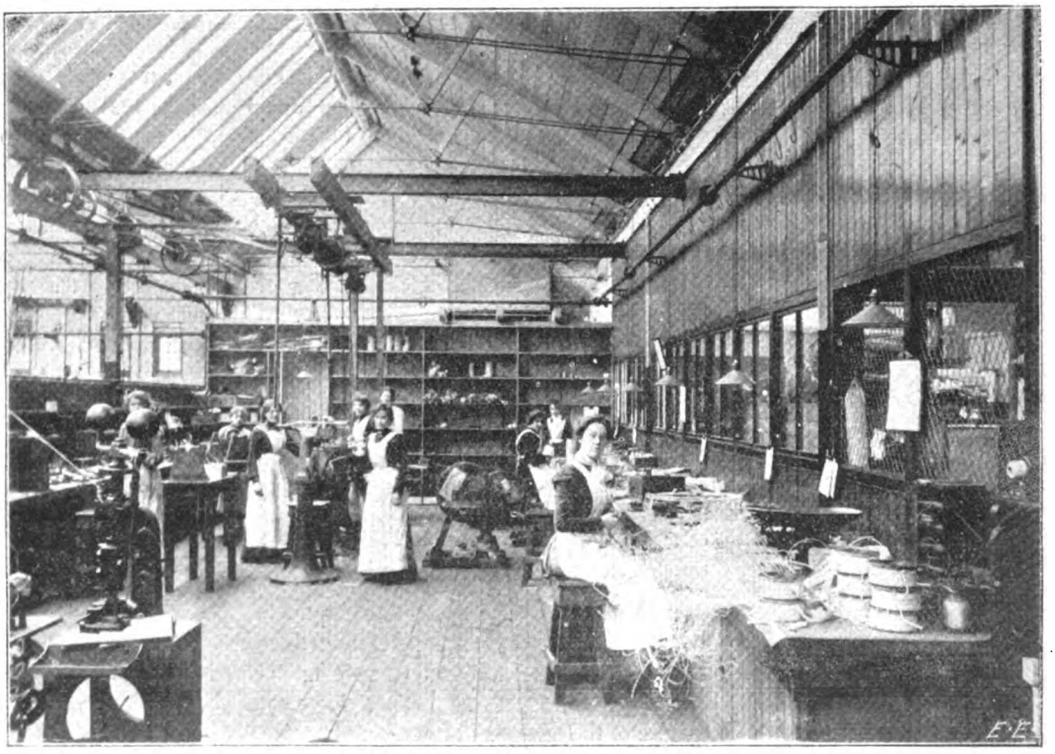

FIG. 2.—Girls' Bay, Trafford Park Works.

It is the principal object of this article to describe the

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branch works which Messrs. Royce, Limited, have erected upon this site. In regard to what may be looked upon as the first instalment of these works the firm would not seem to have erred on the side of excess, but rather to have adopted a policy of moderation, while at the same time making ample provision for future developments. In the normal course of things this branch will at some date not far distant exceed the present head establishment in size and importance. Indeed, from the electrical point of view, it may be said to already surpass the older establishment in the latter respect, since the bulk of the electrical work formerly carried on at Hulme has been transferred to the branch, the Hulme establishment now confining its attention more to structural parts for cranes, and to the manufacture of controllers, arc lamps, and the various small electrical accessories specialised by Messrs. Royce.

Roughly speaking, the new works consist of two buildings—one containing the machine shop, with auxiliary bays, stores, offices, etc., and the other being a foundry. The main bay of the machine shop—a view of which is shown in Fig. 1—measures 160ft. long by 40ft. span. It is here where the various operations, including heavy machining, fitting, erecting, and testing incidental to the manufacture of the firm's standard type dynamos and motors, are done. To the right of this bay and at right angles to the same are ranged six other bays, each having a floor area of 60ft. by 18ft. 3in. The first of these smaller bays (Fig. 2) may be termed the girls' bay, for here woman labour is employed in winding light magnet coils on metal bobbins, and in making cotton-covered wire adapt itself to the shape of formers in its process of evolution towards the finished armature coil state. In the

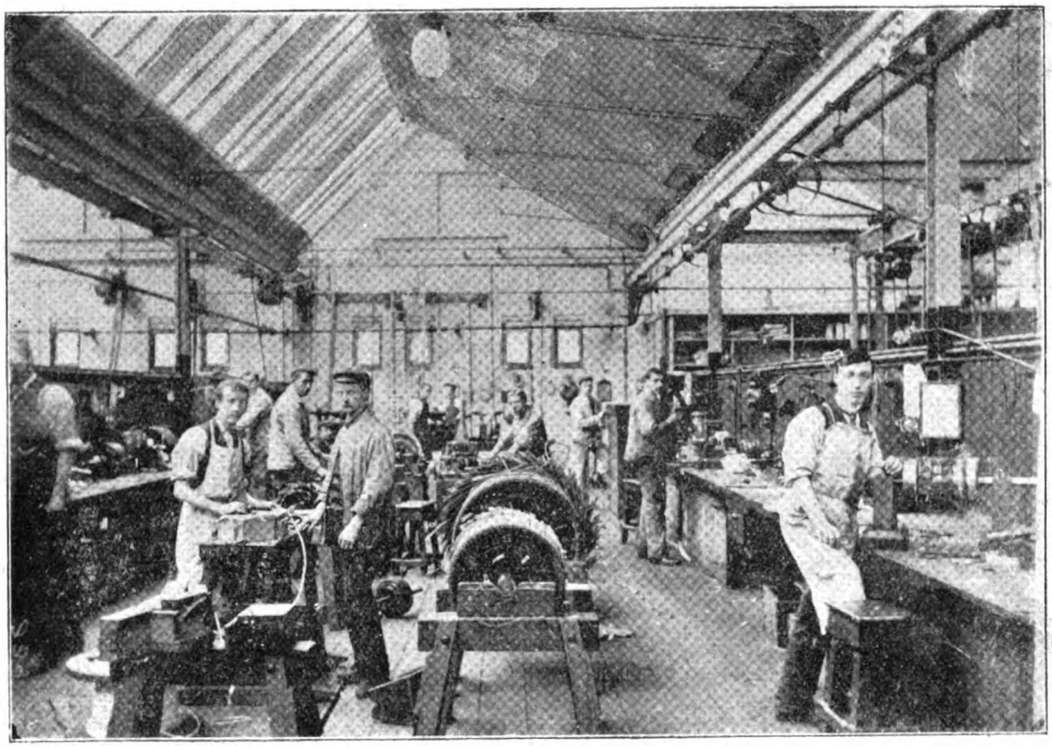

FIG. 3.—Armature-Winding Bay, Trafford Park Works.

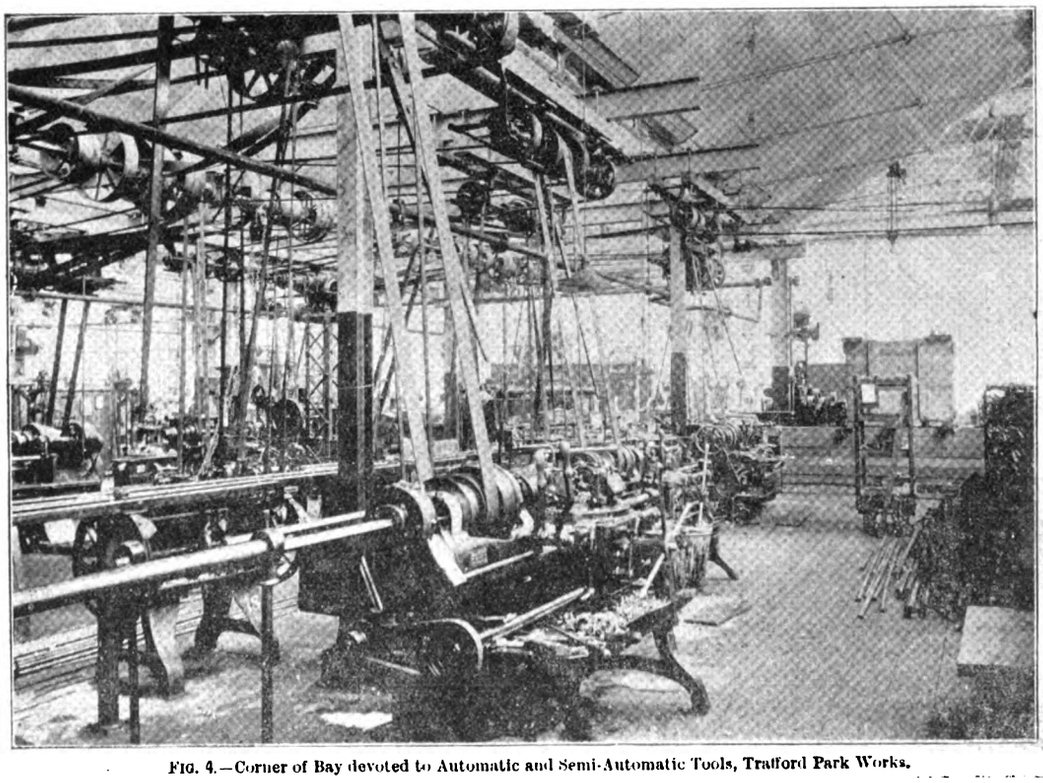

FIG. 4.—Corner of Bay devoted to Automatic and Semi-Automatic Tools, Trafford Park Works.

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same department the smaller sizes of armatures are wound, the girl operatives being particularly adept at this class of work. The next bay (Fig. 3) is devoted to the winding

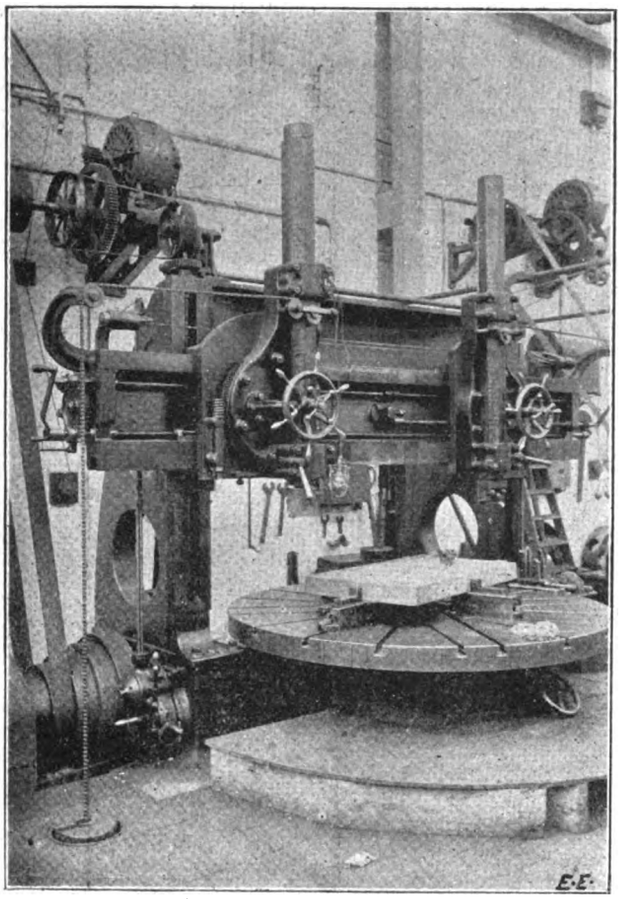

FIG. 5.—View of 72 Boring Mill, showing Electrical Drive, Trafford Park Works.

of the heavier armatures and field coils, requiring man labour, and abutting on this is a bay in which small machines are erected, commutators built up, and light fittings constructed. The fourth bay in the order of succession here observed is equipped with medium weight turning lathes, drills, and heavy semi-automatic tools, while the fifth bay has been set apart for the milling of armature cores, general milling work, and hack saws, etc. The sixth and last bay of this range—a corner of which is shown in Fig. 4—contains automatic and semi-automatic machines of divers descriptions and sizes for the manufacture in bulk of small duplicate parts, such as screws and bolts, and the turning of armature shafts, etc. The offices are located in the front of the building, the stores adjoining the girls' bay, while the foundry is a detached building situated in the rear of the machine shop. Of the buildings themselves there is little to be said, except that iron enters largely into their construction instead of heavy masonry. A notable example of this is seen in the main machine bay, a feature of which is the independent support given to the powerful overhead travelling crane which serves it. The excellent lighting of the shops by day also impressed us. But it is principally in the direction of equipment that our interest gravitates when new works come under review. In the present case we were prepossessed of the knowledge that Messrs. Royce had long specialised in the application of electrical drives to machine tools—hence journeyed to Trafford Park with expectations high. Nor were we, in fact, disappointed, but, on the contrary, found works set out to illustrate the advantages peculiar to the electric motor for driving machinery of all classes used in the engineering trades. Several of the drives employed call for something more than passing notice. To this category belongs that applied to the planing machine, shown on the left in Fig. 1. This machine is capable of taking work 4ft. by 4ft. by 16ft., and is electrically driven by means of a motor fixed on the wall face and coupled up to a short length of shaft, which in turn carries the necessary driving pulley and flywheel. The length of drive allowed varies, of course, with the nature of the work and with the power to be transmitted. In this particular case the length is necessarily considerable. Another interesting drive is applied to the 72in. boring mill shown in Fig. 5. The motor, it will be observed, is carried from the wall on a bracket support, and has mounted on its shaft a rawhide pinion, which gears into a spur wheel mounted on the same shaft as the cone driving pulleys. In conjunction with this motor is used an automatic reversing switch, which allows the mill to be run in either direction. This switch is controlled by means of two ropes,

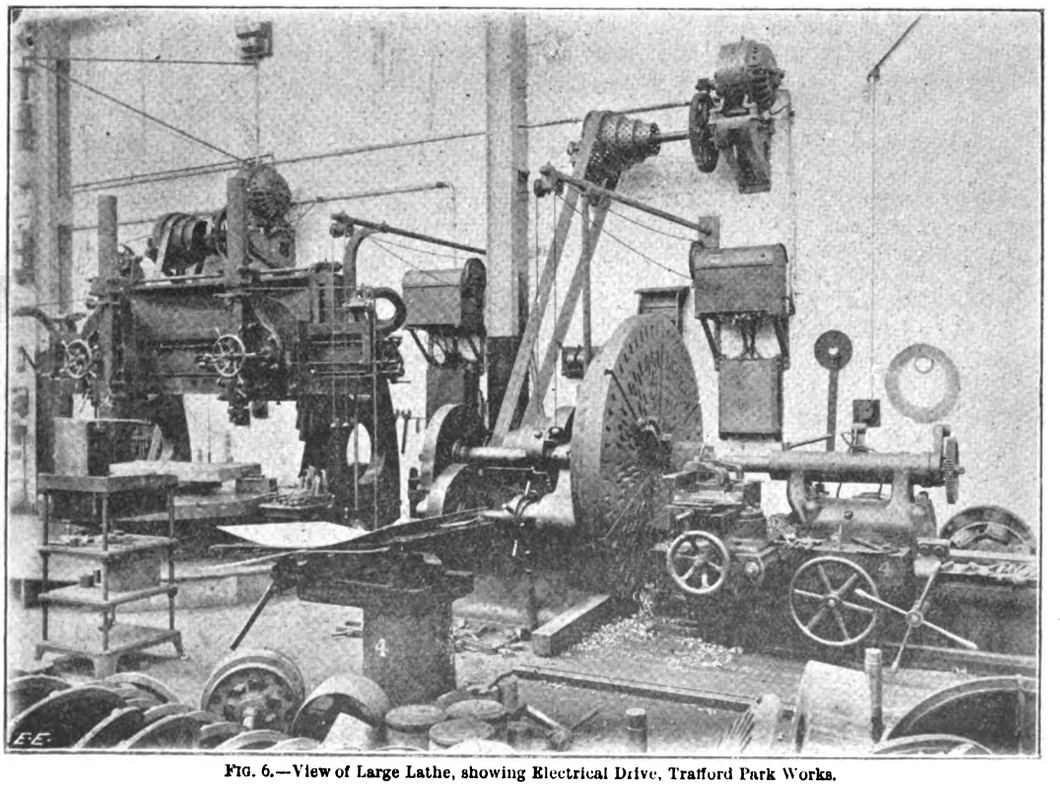

FIG. 6.—View of Large Lathe, showing Electrical Drive, Trafford Park Works.

which are brought from the switch over grooved pulleys to the side of the man operating the machine. If needed, these controlling ropes can be carried along the machine so that the operator can start, stop, or reverse the motor

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driving his machine tool from any point on the machine. Similarly driven and controlled is the large lathe shown in Fig. 6. The special arrangement of the controlling gear is seen to better advantage in this illustration. Another and perhaps a greater novelty in the way of drives is that illustrated in Fig. 7. This drive is transmitted from a motor carried at the top of a latticed girder mast to a hack saw below, the driving shaft being geared to the motor, and fixed underneath the same as shown. Numerous other special drives are included. Indeed, the works might almost be regarded as an exhibition in this respect—a circumstance which does but emphasise the fact that the application of electrical drives has been constituted a special study by Messrs. Royce. The main bay of the machine shop is served by a "Royce" three-motor overhead travelling crane, having a lifting capacity of 10 tons, while side bays 2, 3, and 4 are each provided with an overhead hand-driven travelling crane capable of lifting one ton, communicating with a narrow-gauge railway which extends from end to end of the works.

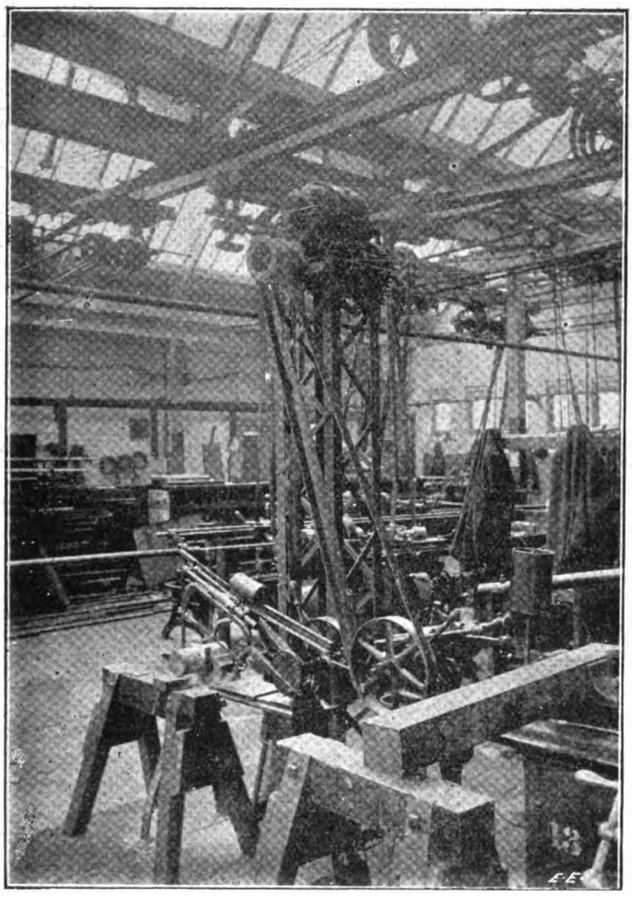

FIG. 7.—View f Motor mounted on Iron Mast, Trafford Park Works.

Most of the automatic tools comprised in the equipment of the works are by Messrs. Alfred Herbert, Limited, Coventry, a noteworthy exception being in the case of the smaller automatic tools, which were designed and made by Messrs. Royce themselves. The method observed in the arrangement of the machine tools generally is such as to facilitate the evolution of the different parts used in the construction of the firm's manufactures from their embryo to their finished state. In other words, the amount of handling required during the progression of the different parts towards the stores or erecting branch, and so on to the testing and packing departments, is reduced to a minimum.

But before proceeding with the question of the works organisation a little further reference may be made to the foundry. This is conveniently placed in the rear of the machine shop, from which it is, however, quite detached. It is contained within a building measuring 80ft. by 40ft., and has been designed for an output of about four tons of castings per day. The equipment includes a Royce three-motor overhead travelling crane having a lifting capacity of 10 tons. The cupola which serves the foundry with its requirements of molten metal is provided with a blower driven by an electric motor. This motor is connected to a switch combining a variable-speed arrangement, whereby any desired blast can be obtained. An electric hoist, which incidentally serves to illustrate another of Messrs. Royce's specialities, is used to raise the iron and other materials required to feed the cupola. Contrary to the practice of many dynamo builders, Messrs. Royce make all the iron castings used in the machines which they turn out.

These works have been designed and equipped for the manufacture to stock of all the parts used in the construction of the firm's standard sizes of open, ventilated, and enclosed types of dynamos and motors on the most economical lines. It may be explained here that their standard four and six pole enclosed and ventilated type machines range in output up to 75 b.h.p. as motors and to 50 kw. as generators. For larger outputs, open-type machines with six or more poles are supplied. As a general rule, machines of the sizes mostly in demand, ranging from

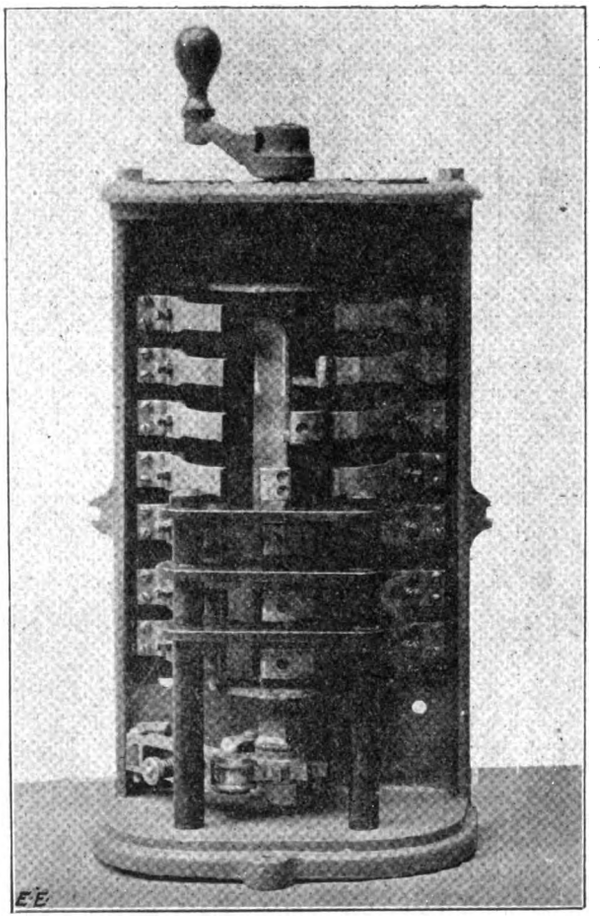

FIG. 8.—Tramway Type Controller for Crane Work, Trafford Park Works.

3 b.h.p. to 40 b.h.p., can be supplied in a finished state from stock, but in regard to the larger sizes the constituent parts only are made to stock, these being drawn upon as required to execute orders. The great feature, then, of the works organisation consists in that the machine shop is steadily employed in making finished parts to stock. This applies not only to small parts, but also to large ones, such as armature and field-magnet cores, frames, shafts, bed-plates, etc. When it becomes necessary to replenish the stocks for any standard size of machine, the necessary parts of this are each repeated in series of 20's. The jig and template system being employed throughout, it is ensured that like parts of any series are absolutely identical, and therefore interchangeable. If a modification in design or a new pattern of machine is to be introduced, it is commenced with a new series—never in the middle of one. The works had not been started many months when we visited them and took the accompanying photographs, but even then parts were in stock, we understood, for about 200 machines of the different standard sizes supplied. To illustrate the promptitude which the above organisation ensures in the execution of orders, it may be

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mentioned that one order for 18 motors of different sizes for one month's delivery was going through the shops with every prospect of being completed within the time specified. A few words may be added here with regard to the testing equipment provided. This is located at the erecting end of the machine shop (main bay) adjoining the stores, and includes motor-driven generators designed to furnish almost any pressure between 65 volts and 500 volts. For the higher pressures required for breakdown tests an additional set is being installed. This set will be capable of supplying pressures from three to five times greater than the working potentials of the machines to be tested.

It will not be out of place to deal now briefly with the features which distinguish the finished machines turned out from the above described works. In this connection it is noteworthy that Messrs. Royce's standard type machines for continuous running are designed to admit of them giving their respective outputs for periods of six hours with a temperature rise not exceeding about 70deg. F., and to render them capable of carrying a 10 per cent. overload for two hours, or an overload of 25 per cent. for periods not exceeding 15 minutes. The machines are of simple but substantial construction, all parts being easily accessible. In all the smaller sizes the yoke rings are made of high permeability steel, with magnet limbs of mild steel bolted in. The construction admits of a field coil being removed, if necessary, without disturbing the armature, this being of great advantage in cases where the machines are not provided with split yokes. All machines, however, above 30 h.p. are provided with split yokes. The armatures are of the solid drum type, having cores built up of plates possessing high magnetic permeability and low hysteresis, insulated from one another in such a manner as to reduce the eddy currents in a complete core to an exceedingly low value. Each core is mounted on a substantial hub, which is designed to carry the commutator, and is so arranged that the shaft can be removed at any time without disturbing the winding or the commutator. In the case of generators this method of construction allows of the armature being keyed directly on to the engine crank-shaft. The coils composing the armature winding are arranged symmetrically, thereby ensuring equal self-induction and equal position of commutation, while all the coils being former-wound, a few spares can be kept for eventual repairs.

As regards the commutators, these are built up of hard-drawn copper segments, each section being insulated from the next and from the sleeve by means of mica. The commutator bars are held in position at each end by special rings having a V section, and the whole is put together under hydraulic pressure and held by means of stout bolts. The brush gear is so designed as to allow of easy accessibility, and the brushes are of high-grade carbon. In machines of the smaller sizes the brush-holder supports are carried from a rocker bar mounted on the bearings, but in the standard 50-kw. machine and larger sizes they are carried from the yoke, which enables the whole of the brush gear to be held with much less vibration. Moreover, the insulation can be carried out in a more substantial manner. Field coils are usually wound on heavy metal bobbins, which can be removed from the magnet cores. The bobbins are very thoroughly insulated, and the inside ends of shunt coils are each connected to an insulated flexible conductor, which is so arranged that, should the end connection be broken, it can be repaired without rewinding the coil. Each coil is impregnated *in vacuo*, whereby the insulation is rendered practically perfect and watertight. In compound-wound machines the series coils are usually wound with substantial copper tapes, quite separate from the shunt coils. The field magnets are of circular cross-section, which form gives the greatest efficiency for a given length of conductor.

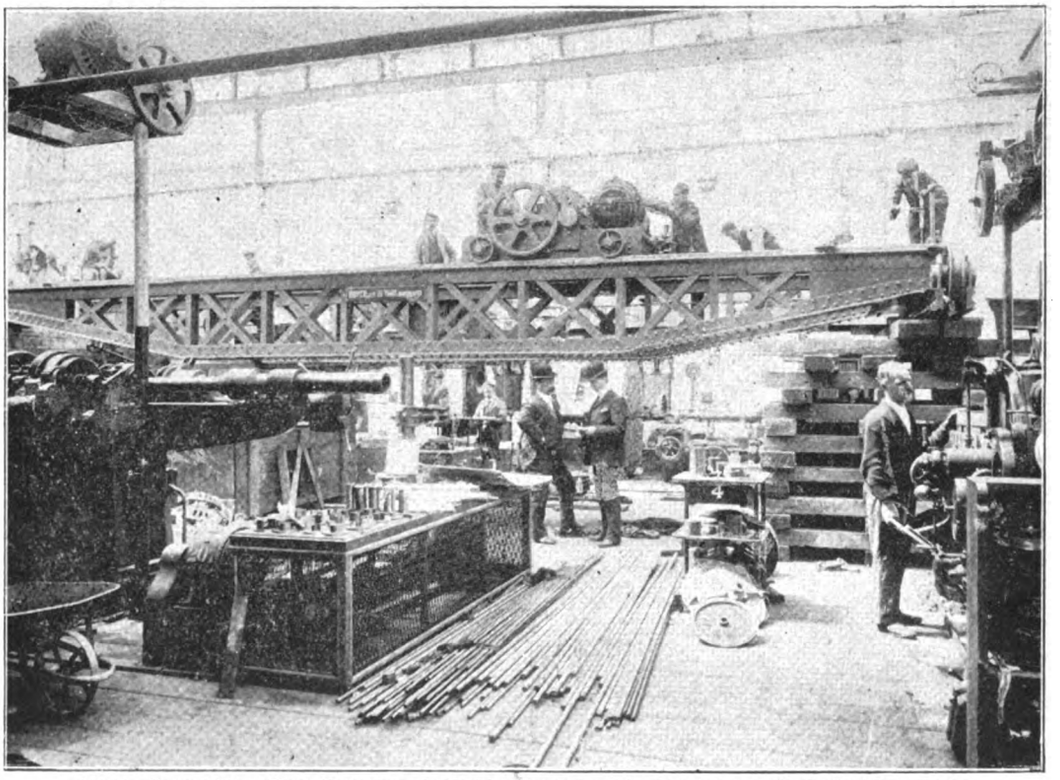

FIG. 9.—View of 10-ton Three-Motor Crane in Machine Shop prior to its shipment to India, Trafford Park Works.

It now remains to describe some of the features embodied in the design of "Royce" electric cranes, which have contributed to the firm's success in this department. In their three-motor overhead travelling cranes the motors employed are almost invariably of the series-wound type, and will consequently run at a constant speed with a constant load, but with a light load will accelerate in a certain ratio. Needless almost to say, these motors are of a design which has been evolved to meet the conditions peculiar to crane work, the result being a type of machine which combines high electrical efficiency with mechanical strength, and is capable of withstanding an overload of 50 per cent. for short periods without distress. They are so constructed as to be totally enclosed and dust-proof. The bearings are of the firm's patent self-oiling type, the bushes of which are arranged to swivel at the centre of their length. Of the three motors comprising the equipment of one of these cranes, that used for actuating the hoisting and lowering gear is of the "Royce" standard slow-speed multipolar type, and is securely fixed in a readily accessible position on the framework of

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the crab. A noteworthy feature relating to the gearing through which the power developed by this motor is transmitted is the introduction of a patent automatic governor lowering gear, which can be so adjusted as to take charge of all loads when being lowered and control the speeds to within reasonable limits. The cross traversing arrangement which forms part of the crab consists of a motor of similar construction to the hoisting motor, together with the necessary gearing for actuating one of the axles.

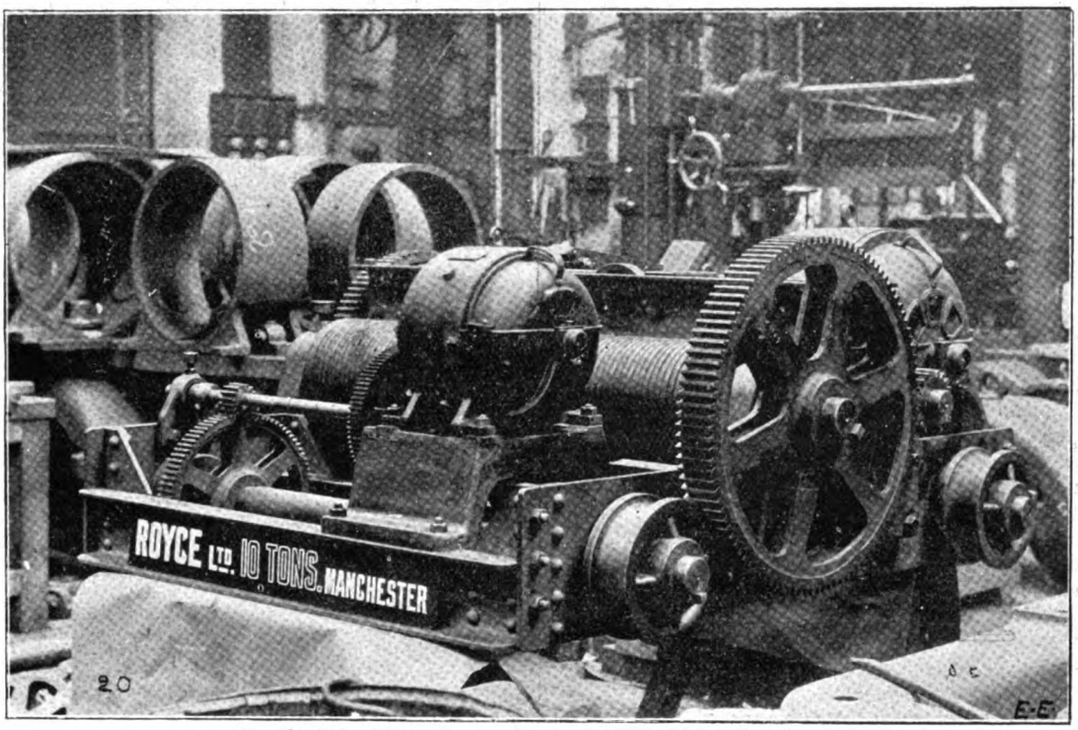

FIG. 10.—Crab of 10 ton Three-Motor Crane for India, Trafford Park Works.

Messrs. Royce obviate the difficulty incidental to the longitudinal travelling of cranes by driving the cross-shaft from the centre of the crane span, thereby ensuring an equal turning movement at each end. Extra expense is incurred by this arrangement on account of the additional wiring necessary, and the special brackets required to carry the motor; but the user gains from the fact that wear and tear of the track wheels and the liability to mount the rails, are reduced to a minimum.

In a crane having a span of, say, 30ft. or more, considerable inertia has to be overcome before the crane can commence travelling, and when it has attained full speed a corresponding amount of energy must be absorbed before it can be stopped. It follows that to start, attain full speed, and stop in the shortest space, must be an advantage worth having from a time-saving point of view. To effect this combination, Messrs. Royce have introduced their patent slipper drive between the longitudinal motor and cross-shaft, which enables the crane driver on starting to give full-speed current without risking damage to his motor. For stopping he can actually reverse the running of his motor. In other words, this drive prevents the longitudinal motor being overloaded in attempting to start a heavy crane too quickly, and permits of it being reversed and used as a brake. The electrical equipment of a three-motor crane also includes three controllers. These are of the tramway type illustrated in Fig. 8. Should the supply

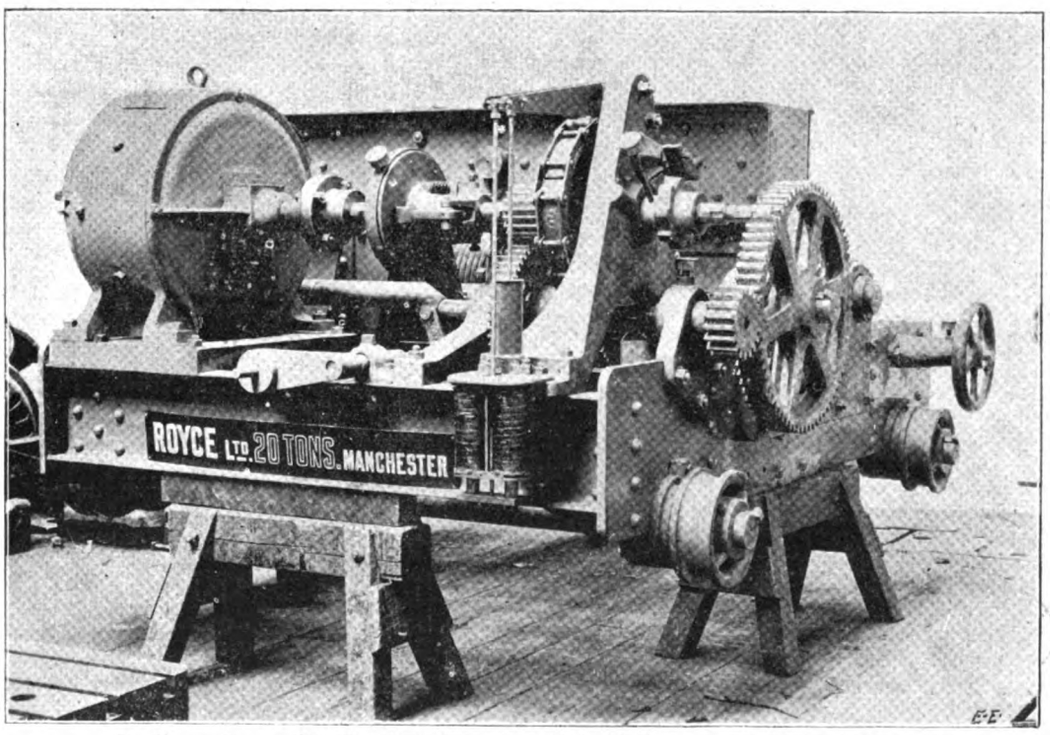

FIG. 11.—A "Royce" 20-ton Electrically-Driven Crane Crab with Change Gear, Trafford Park Works.

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of current fail, or be interrupted from any cause whatever, an automatic magnetic brake comes into immediate action, whereby the load is securely held in whatever position it may happen to be. Or should either of the controllers become inoperative, an emergency switch placed within instant reach of the driver can be used.

The three-motor 10-ton crane shown in Fig. 9 combines all the features mentioned above. This particular crane has now been shipped to India. It was in course of dismantlement at the time of our visit to the works. A nearer view of the crab of this crane is shown in Fig. 10. The 10-ton travelling cranes comprised in the equipment of the works are of similar design. A "Royce" 20-ton electrically-driven crane crab, fitted with change gear, is shown in the last of the accompanying illustrations (Fig. 11).

But in this department Messrs. Royce by no means confine their attention to the overhead travelling type of crane—Goliath and jib cranes, elevators, hoists and winches, capstans, etc., of their own design and make being also very largely used throughout the country. Probably the success of these cranes, etc., is quite as much due to the perfecting of the mechanical details as to the excellence of their electrical equipments. For example, the bearings of the axles carrying the runner wheels of the crab in a travelling crane of the firm's manufacture are not only swivel but also of the roller type. It is attention to such details that tells in favour of a particular make of article, and full credit is due to Messrs. Royce for having recognised this in regard to their various specialities.

INDEPENDENT TELEPHONY IN GREAT BRITAIN.

BY GARDNER AND HOLME

(Continued from page 846.)

(7) JUNCTION AND TRUNK LINES (*concluded*).

Arms.—These should be of well-seasoned oak, 78in. by 3in. by 2¾in., dressed and bored to take eight $\frac{11}{16}$in. insulator bolts, also pole and $\frac{7}{16}$in. combiner bolts, and given two coats of good paint before leaving the stores. They should be fitted fully 1½in. into the pole, the slots being cut and formed 12in. apart from centre to centre and 9in. from the head of the poles, care being taken to fit the arms tightly and parallel to each other and at right angles to the pole. Galvanised iron bolts and washers are used for fixing the same to the pole, generally ⅝in., and spanners used to tighten all bolts. Workmen generally are careless and neglectful as regards the use of spanners, and in most cases attempt to do pole fitting and mounting with a pair of heavy pliers.

Roofs.—Galvanised iron roofs are generally used for the protection of the head of the pole. In many instances, however, ornamented iron or wood finials are fitted when entering villages, these giving a much better appearance and finish to the poles. In past years it was customary to cut the iron roof for the purpose of fitting a saddle which carried a single insulator, thus giving a better appearance than the plain uncut roof, but the present day of metallic circuits has done away with the use of saddles, as it is imperative in telephone junction or trunk work to erect the wires so as to form exact squares.

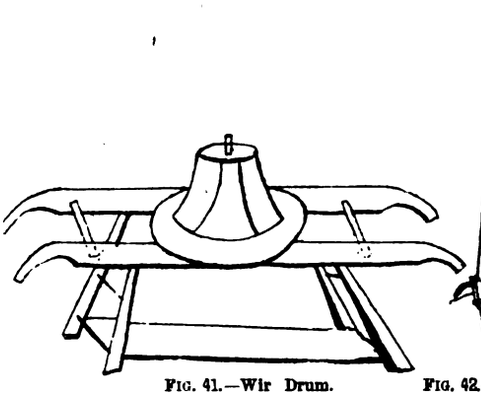

FIG. 41.—Wir Drum.

FIG. 42.—Climbi Iron.

Pole Steps.—Galvanised iron pole steps ought to be fitted on all large poles, especially on poles through villages, the general or minimum height of fitting being 15ft. from the ground, galvanised iron coach screws being used to fit the pole steps to the poles.

Insulators.—The "Bennett" pattern is most suitable for telephone work, as the wires can be made off on different grooves, either top or bottom, and yet be well insulated. They are also not so liable to breakage from stone throwing and are very neat in appearance. The screw insulator should be used and care bestowed on fitting, so that the spindle which screws into the cup is provided with a suitable indiarubber washer, and the cup is firmly secured down upon it. The nuts of the spindle should be screwed up with suitable spanners and not by hand pressure on the cups.

Wiring.—The poles being planted, mounted, and insulators fitted, next follows the actual wiring of the lines. On junction lines No. 14 S.W.G. hard-drawn copper wire, 100lb. per mile, is used. The coil of wire

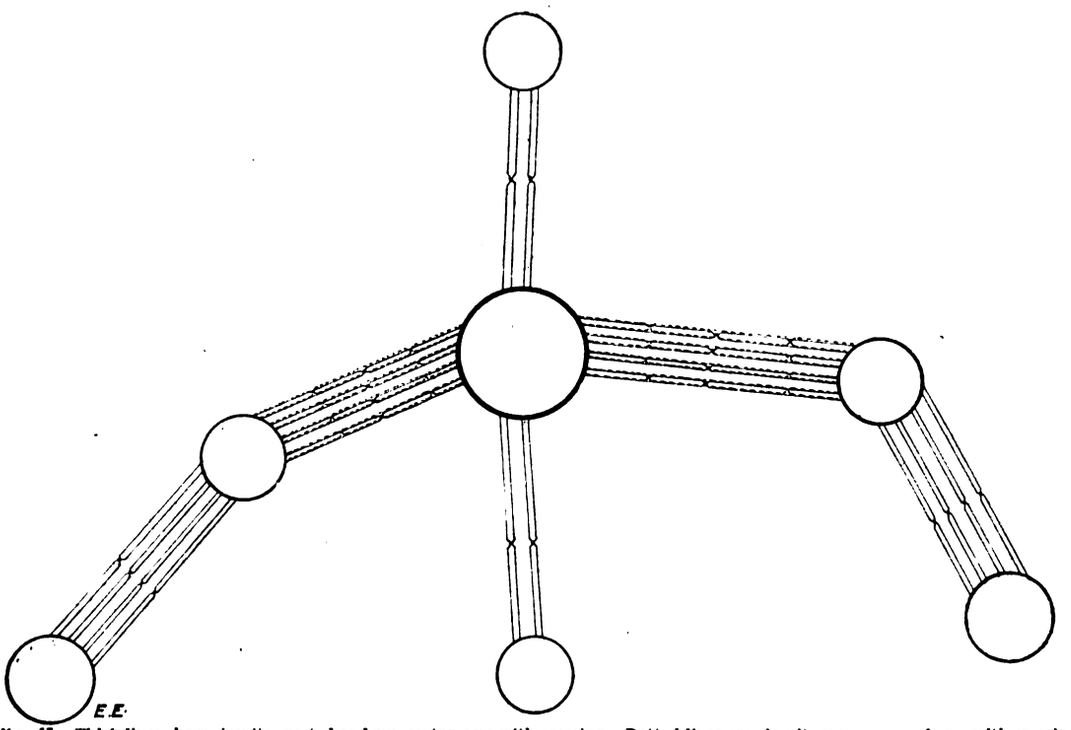

FIG. 43.—Thick lines show circuits erected and run on top arm with crossing. Dotted lines are circuits run on second arm with crossing, midway between that of the top crossing.

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being placed on a hand drum, as shown in Fig. 41, one man is left to see that the drum does not rotate after the strain on the wire ceases, as this would cause kinking. If the wire is allowed to run off loose, it forms into bights, which will pull up and break when attempting to straighten. The loose end of the coil is taken from the drum and carried away in the direction it is proposed to take. The wiremen should take the side of the road which is clear of traffic, preferably the green sward which usually exists between the pole position and the edge of roadway. He should stop at intervals to allow another wireman following up to carry the wire to the pole-head and place same in position. The quickest method of lifting the wire into position is by means of climbing irons, as shown in Fig. 42, although many engineers are against this method, and insist on ladders being used. Another method, and where the heights of the poles will allow, is to use what are known as contact rods, these rods being made of light bamboo, fitted together by brass tube joints and reaching to a maximum height of 30ft., when used from the ground. They are also used for the purpose of clearing the wires from trees and small branches. The process of paying out and lifting to the pole-head is continued until the coil of wire is all run out, or until the number of spans in the section are wired. The wire is then fixed at one end of the line of poles to the insulator by a make-off joint, then pulled up by hand, and made off temporarily until the desired number of wires or circuits are run. Temporary line stays being fixed to the poles, the wires are next strained up to a uniform tension by means of a hand vice provided with a registering tension ratchet, in order that the system of regulation may be uniform throughout. In straining up any wires for overhead purposes, care must be exercised to avoid injury through nicking off or over-tight squeezing, as once the skin of the wire is injured the strength is impaired. Various stresses and sags for spans to be observed in erecting copper or bronze wires are given in many text-books, so that it is not necessary to enter into the details, but the facts that the temperature and length of span play important parts should not be overlooked. On a line of poles one wire should be pulled up and strained with the tension ratchet to the recognised tension, so that all other wires added will be similarly strained if regulated to the same curve or sag as the first one. It is always best to adjust and bind in all the lines on an arm simultaneously, as the strain on the wires will pull over the arm unequally and destroy the appearance of the head of the pole, if not done so.

Binding In.—The wires are next bound in to the groove of the insulator, the line wire being laid in on the inside next to the pole, with the exception of, firstly, insulators on sharp curves, and secondly, the two insulators next to the pole, the wire in these cases being laid in on the outside of the insulator. Semi hard-drawn copper wire, or, preferably, copper tape, should be used for binding in. In running wires, great care must be given to the temporary staying of the poles longitudinally, so that should there be more strain in one direction than in the other, the temporary line stays will keep the pole in position until rectified by the continuation of the running of the wires.

Jointing.—For large gauge of copper wire the "Britannia" joint should be adopted, as no other method has yet surpassed it, although many forms of patent sleeve joints ave been tried.

Crossing of Roads.—The number and length of the poles will vary according to the number of wires which they eventually will carry. For short lines carrying only one line or metallic circuit, 18ft. to 20ft. may be adopted in the straight, but on junction or trunk lines the number should never be less than 25. Their length will depend not only on the ultimate number of circuits to be carried, but on the buildings, obstacles, and trees to be cleared. Generally on clear roads 26ft. is the minimum length, the lowest arm never being less than 20ft. from the ground, and at all road crossings of any description the minimum is raised to 30ft. This variation should take place gradually, the appearance of the line thus being maintained, and the stress which would otherwise be thrown upon the insulators and wire avoided. For instance, if on a line of 26ft. poles the necessity arose for employing a 30ft. pole, the pole on each side of it should be 28ft. The wires at all road crossings should be made off and all joints soldered. All wire ends and cuttings of copper wire during wiring should be collected and brought into the stores, the foreman being instructed to give this point his special attention, and check from time to time the outside stores under his charge to prevent waste and careless handling. The method of erecting telephone wires for junction and trunk lines in this country consists in causing the wires to twist or revolve clockwise round one another like the strands of a rope, the wires making a complete revolution in every four spans. This method, although answering the purpose of destroying induction, has many drawbacks, such as the liability of the wires to come in contact, and also tracing faults is made more difficult. For short junction lines wires run on the straight with transpositions or crossings at regular intervals answer perfectly. This method was adopted by Mr. A. R. Bennett many years ago, and if understood and carried out correctly works excellently. There are many points in its favour as against that of the twist system, the principal being the rapidity with which faults are located and cleared, and the repair of complete breakdowns, owing to the wires being more easily traced, repaired and regulated. Four metallic circuits may be run on the same arm, the circuits having their crossing made at the same poles by double J insulators. The same number may be erected on the second arm, but in order to destroy the inductive influence more crossings should be introduced than on the upper arm, as will be seen from the Fig. 43. The full lines represent the top arm, and the dotted lines the second or underneath one.

Aerial Cables.—These have become a necessary part of pole line construction, and are more convenient to handle than an equal number of open wires, and with central battery systems reduce the trouble which arises through contacts and earth faults. If well erected and tested in the first instance, they give no trouble till they wear out. On junction lines with a small number of circuits, and where difficulties are met through trees, the cheapest and best method is to use aerial dry-core cable, generally from 6 to 18 pairs being found ample. Aerial cables cannot be handled too carefully, and in erecting every precaution should be taken to prevent injury. The steel suspender should be erected, and a man stationed on each pole of the route. As the cable is run off the drum, the man at the drum fixes the clips, and as these clips come up to the man on the first pole he hooks some of them on the suspender wire, about every fourth or fifth being sufficient. Great care should be taken to see that the cable is not run off quicker than required. As the cable is drawn to the next pole the man unhooks the clips, assists the cable past the pole on to the next suspender, the same operations being repeated at every pole until the cable is suspended in place. Then all clips are suspended on the wire. Overhead cable presents many advantages over the use of open wires, but in many instances it becomes a question of cost as to whether it is not better in the first instance to place same entirely underground.

(To be continued.)

QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any questions should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

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QUESTIONS.

643. A country town of about 5,000 inhabitants has a power company's high-tension mains passing through it from which it could obtain power—high-tension three-phase—in bulk at a fixed rate. State the advantages and disadvantages and compare the costs of distributing energy on (*a*) direct-current, three-wire system and (*b*) low-tension, three-phase, four-wire system, the lamp voltage being same in both cases.—V.

644. What are the methods of regulating the voltage on each leg of a three-phase, four-wire distribution, and also of balancing the same?—V.

ANSWERS.

[The following answer to No. 633 was accidentally omitted from last week's issue.—ED. *E. E.*]

Question No. 633.—Several car axles of an electric tramway have broken lately, all *exactly* in the same place—viz., ½in. inside keyway of gear wheel. Upon examination of these and other axles they show signs of being eaten away by electrolysis. Describe a remedy for this, also the action of the electric current upon the axles. The motor box is used for the earth return.

Answer to No. 633 (*awarded* 7*s.* 6*d.*).—Broken car axles have become quite common of late in some towns since the adoption of electric traction. They occur more on narrow-gauge lines than the standard 4ft. 8½in. We in England do not seem to have quite got away from the old horse car practice, in that not enough allowance is made in the size of the axles for a modern 10-ton, four-wheel, double-deck car (strength being by far the most important point to consider) as compared with the now old-fashioned, easy-going horse car of only about 2½ tons, where lightness is really the chief consideration.

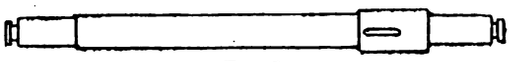
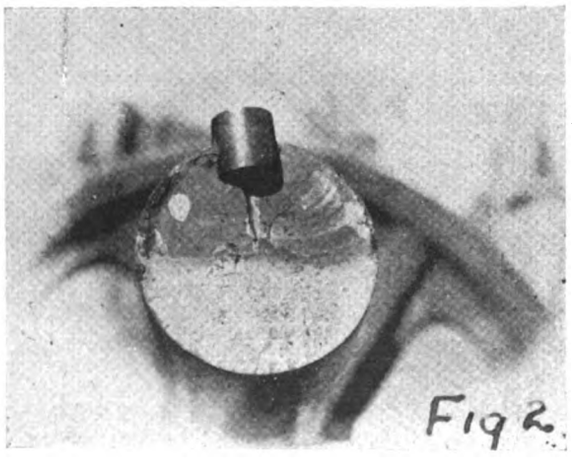


FIG. 1.

The breakages, no doubt, are caused by having too small an axle, which will not stand the severe shocks caused by rounding 35ft. and other radius curves at a fairly high rate of speed; also the fact that part of the weight of the motors is carried direct on the axles without a spring support, which makes the hammering effect of passing over bad rail joints and other irregularities of the track much more severe. These undue strains no doubt cause small fractures to start until the axle finally breaks asunder. I have examined about 30 axles that have broken just inside keyway, and have seen no signs of electrolysis. Neither should I think that the "juice" would have any perceptible effect on them. As is well known, electrolysis only sets up when the current leaves a metal, which would certainly not be under the gear wheel, where they usually break.

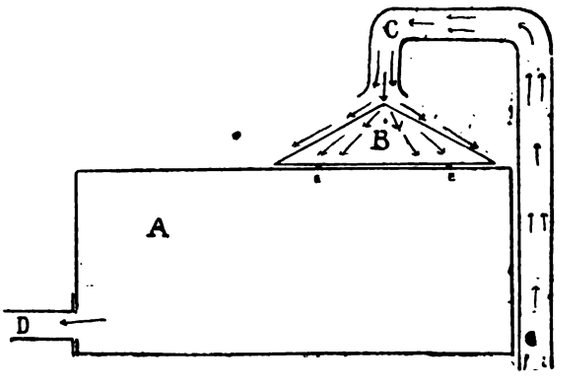


Axles should not be less than 4¼in. in diameter for the type of car referred to above, more especially if the system is very hilly and has many sharp curves. If the axles now in use, say 3¾in. diameter, cannot be increased in size throughout their length owing to the motor suspension bearings, they should be replaced when broken by axles enlarged at keyway end (Fig. 1) to, say, 4⅜in. or 4½in. diameter, the truck and gear wheels being bored out to suit. This has been done on a certain tramway system I am connected with, and so far with success. When new cars are being ordered, however, it would be advisable to specify a larger axle as before mentioned. I may add that we have tried cold-rolled steel axles, but with little success, as they bend too easily and so cause the cars to roll.

The reproduction (Fig. 2) of a photo taken of one of our first broken axles shows very clearly the flow about halfway through set up by the enormous strains and shocks it had been subjected to. The end of the gear wheel key is seen projecting.—MAGNUS H. VOLK.

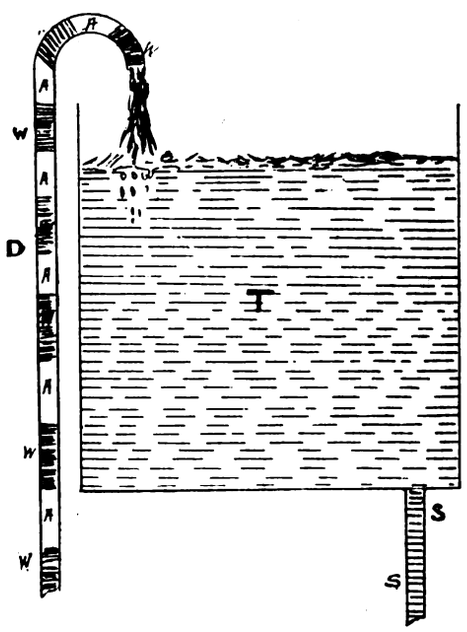
Question No. 635.—Describe some method of extracting air from water to be used for condensing purposes, the water having been raised from a borehole by compressed air.

Answer to No. 635 (*awarded* 7*s.* 6*d.*).—Connect supply pipe, C, from borehole to deliver water into tank, A, fix a cone-shaped distributor, B (preferably made of galvanised iron), on two supporting bars, E E, so that it is directly under the centre of the bellmouth of supply pipe, C. This cone should not be less than 6ft. diameter and about 2ft. high.



The water will then flow uniformly over the whole surface of the cone in a thin stream, and all air contained in the water will be set free. D is the supply pipe to condenser.—B. S. H

Answer to No. 635 (*awarded* 7*s.* 6*d.*).—In raising water from a borehole by means of compressed air, the air is not, as is very often supposed, thoroughly mixed with the water which it raises, but is disposed somewhat in the manner shown in the sketch. D is the delivery pipe, or "rising main," as it is termed; the shaded portions, W, represent



water, and the blank spaces, A, represent air. It will be noticed that there are alternate columns of water and air. It will be obvious from this sketch and the short description of the action which takes place in raising water by compressed air that, if the air is given a chance, it will escape. The diagram shows a method whereby the air is given every facility to escape. D is the delivery pipe, delivering downwards into the tank, T. This tank should be made of as large a capacity and as deep as circumstances will permit. The supply to the condenser is taken from

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pipe S, which is fixed, as shown in the diagram, on the opposite side to the delivery. By making the tank of large capacity and as deep as possible, a large reserve of water is kept, and as the agitation caused by the force of the water delivered to the tank is confined to the surface of the water in the tank, it will be apparent that the water has every chance to settle, and the air every chance to escape, before the supply pipe, S, is reached.—W. T. W.

Answer to No. 635 (*awarded* 5*s.*).—If only a comparatively small quantity of water is required, it could be subjected to a reduced pressure in a closed vessel. Under an approximate vacuum any gases dissolved in the water would quickly escape. On the other hand, if large quantities of water are used, it would be better to treat the water with some substance in order to absorb the gases present, with precipitation of salts and other deleterious matter; this matter to be afterwards removed by filtration. It has been found satisfactory to pass water through horizontally revolving cylinders in which was placed a quantity of cast-iron borings. A series of baffle plates are fitted to the inner surface of the cylinders, in order that the borings may be thoroughly mixed with the water. The process is: iron borings converted into ferrous oxide by the oxygen in the water, ferrous oxide partly dissolved by carbonic acid gas as bicarbonate, the latter being easily converted into ferric oxide. The ferric oxide precipitates, carrying with it any suspended matter in the water. This precipitate can be filtered out or allowed to deposit in settling tanks, the top water in the latter case being employed for condensing.—M. M.

Question No. 636.—Give sketches of how you would arrange to control a pump and motor of 2 h.p., 550 volts, two miles away to indicate when the water was at maximum and minimum height.

Best Answer to No. 636 (*awarded* 10*s.*).—"G. H." does not say whether the current is supplied from the controlling station, but it is to be presumed it is. First as to the control of motor. A 2-h.p., 550-volt motor can be controlled by a switch and resistance box without special field wire, but a series motor is preferable. As to showing maximum and minimum height of water, many devices are in use for this. Most of them rely on floats, with rods, chains, or wires actuating a variable resistance. A galvanometer at the far end is graduated in feet, and thus reads the height in the reservoir. Unfortunately, the resistance, owing to the damp surroundings, often takes to varying on its own account, irrespective of float, etc., and has been known to put the engineer in a cold perspiration and send him to the window expecting to see a roaring flood rushing down the road. Others, again, need a dozen wires, which are blown down every winter, so that it is less work to walk the two miles and look at the tank. Fig. 1 illustrates a method in which two wires only are used. Above the dotted line is one station, below the controlling station. A B A_1 is a pressure gauge reading in pounds per square inch to half the height of the reservoir in feet. On the dial are screwed two pieces of vulcanite with nickel contacts. The pointer has platinum contacts soldered on either side. The mains to the motor are shunted to this gauge, which should be on the level of the bottom of the tank, and placed in the motor and pump room. It should be hermetically sealed. At the controlling station is an ordinary starting switch, F. Across the mains are connected four 16-c.p. 250-volt lamps earthed at the middle, while in series with these is a maximum cut-out operating with ¼ ampere, and short circuiting the holding magnet, F. The operation is as follows: On gradually starting F the motor will start. As the pressure rises the pointer, B, will gradually turn till, when the reservoir is full, B will touch A. Now B is earthed, as shown, hence the lamps, G, will light up, the maximum cut-out, D, will operate and switch off the current. To tell whether the reservoir is full or not, the engineer, on returning, has but to glance at the lamps. When the reservoir empties B turns back to A_1, and the lamps, H, light up to warn it is time to start up. This method will not do on a three-wire system, or a botched job with odd earths here and there. If the height at any moment is desired, a gauge, as in Fig. 2, may be used. The pointer has a small nickel wheel rolling on contacts on each side. These contacts have resistances, as shown, wound inside the gauge. As one resistance goes out the other goes in. All is hermetically sealed. To the pointer (frame) is

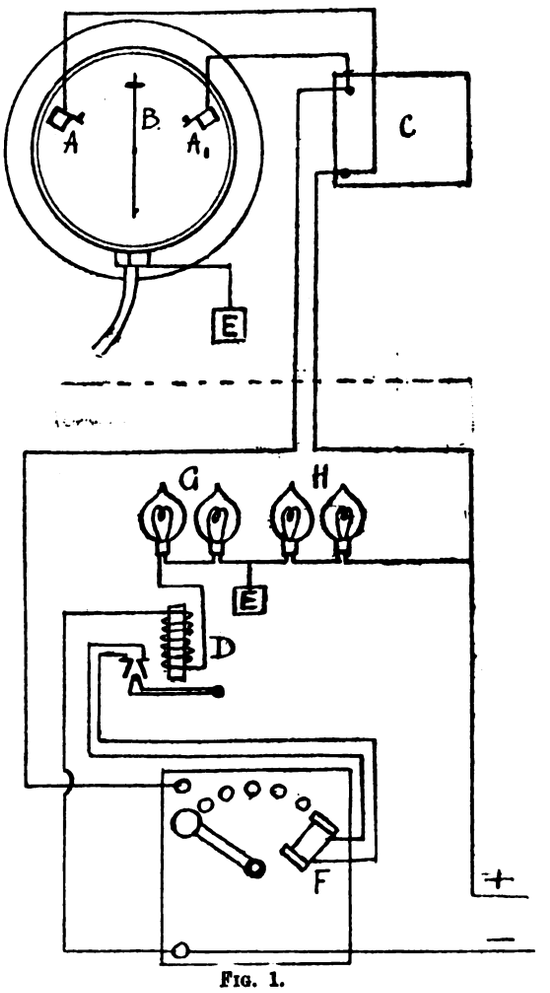

FIG. 1.

connected a four-cell battery with the zinc earthed. At the receiving end is a differential galvanometer calibrated in feet, the common terminal of the coils being earthed. This will show the height at any moment, a switch

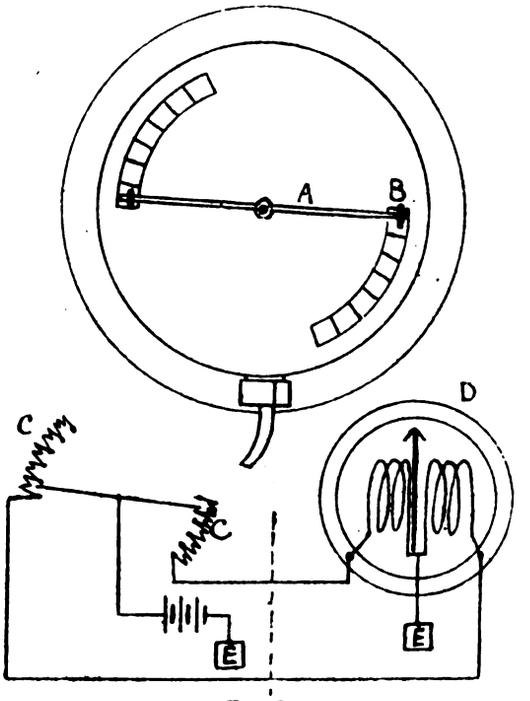

FIG. 2.

being used to make the test when required. Thirdly, if "G. H." wishes to merely control the current, he may control the motor by means of the water itself. In Fig. 3, A A_1 are two copper cans fixed on an arm and connected to

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a shaft. This shaft is carried back from the tank to the motor starting switch, which has a no-load release. At the top of the reservoir is an overflow pipe, B, carried down to A, and near the bottom is a valve, C, with pipe over A_1 (ordinary cistern ball-valve). When the water falls to within an inch of C, C opens and gradually fills A_1. It slowly falls against the starting switch, E (Fig. 4), the contacts being rounded to make sure of no middle stops.

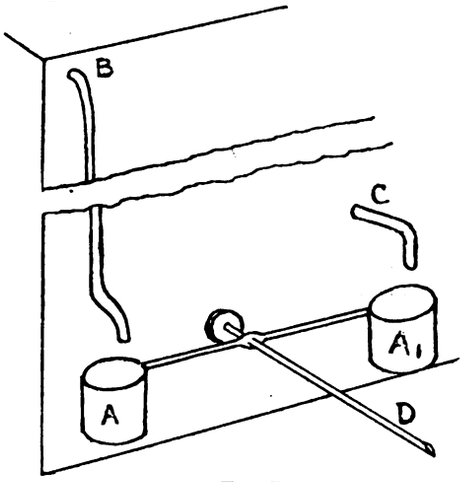

FIG. 3.

Finally, the no-load release magnet grips the switch handle. When the reservoir gets full it overflows and water flows into A. Now in both A and A_1 two small holes are drilled in the bottom, so that A_1 is now empty. A gradually fills, and at last forces the no-load release magnet to let go. The motor is immediately switched off. The same routine is gone through each time the water falls and rises, but the following precautions are necessary: the valve, C, should not open too slowly; make it just tight enough to act jerkily; the overflow from A and A_1 should be led back to the pump well; a starting resistance should be placed at the controlling end if the current is to be cut off at intervals; an ammeter at the controlling end will indicate whether the tank is being

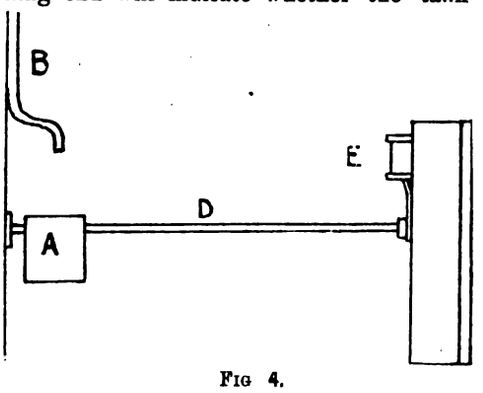

FIG 4.

filled or is full, as when the motor is going it is filling and when stopped is falling.—POLYPHASE.

Answer to No. 636 (*awarded 7s. 6d.*).—"G. H." can accomplish his task in innumerable ways, each, perhaps, suited to some particular case. The following three diagrams, however, treat the question from as many different standpoints, and he may therefore be able to modify or augment one of them to fit in with the special circumstances, if any, of his particular case.

In Fig. 1 we have the full control of the motor at the supply end of our two miles run of mains. Presume that the motor, M, is running, in due course the ballcock, B C, on the end of the pump discharge pipe will begin to close, putting gradually increasing resistance against the pump, and, of course, causing the motor to absorb more and more current. By suitably adjusting the overload on the hand-operated motor starter, M S, the motor circuit will be broken by the opening of the overload when the tank, T, is full. When the water falls sufficiently the lever arm of the float switch, F, will throw over the weighted arm and close its circuit through the four incandescent lamps, L L. (These are connected as drawn to obviate risk of failure through any one lamp burning out.) In this arrangement we have, therefore, a visible signal at each end and the ringing of the bell—wound for the case in question—at the supply end. The contacts on the rope which operates the float switch should be so adjusted that the switch will return to normal when the water-level has risen even very slightly.

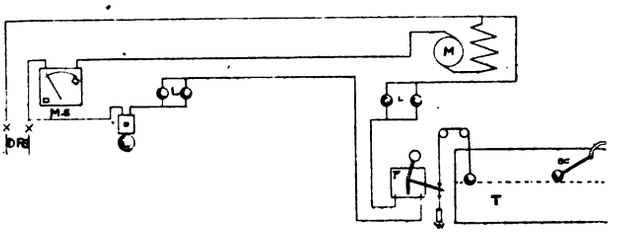

FIG. 1.

Fig. 2 shows an entirely automatic arrangement, and although the rheostat is drawn as being at the supply end, it may be put close to the motor if desired. When the water in the tank, T, becomes low, the float switch, F, is operated as before. The closing of the circuit excites the solenoid main switch, S M S, which in turn closes the motor circuit. If the maximum cut-out, M C, is already closed, the automatic rheostat, A S, will gradually cut out resistance, bringing the motor, M, up to speed. Provided the contacts on the rope attached to the weight, W, are so adjusted, the

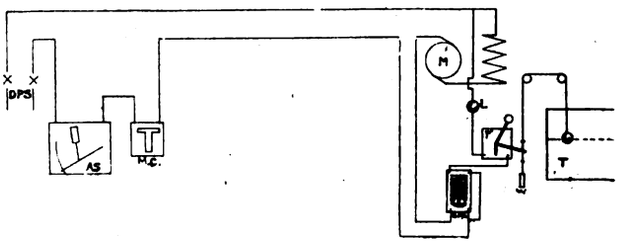

FIG. 2.

float switch will be opened when the tank is full, the main circuit consequently being broken at S M S, and the motor will come to rest.

In Fig. 3 is shown a signalling system, where C_1 C_2 are fixed contacts, each composed of two pieces of metal which are short-circuited by the conical contact piece, C C, fixed to the rope and weight, W. Accordingly as to whether

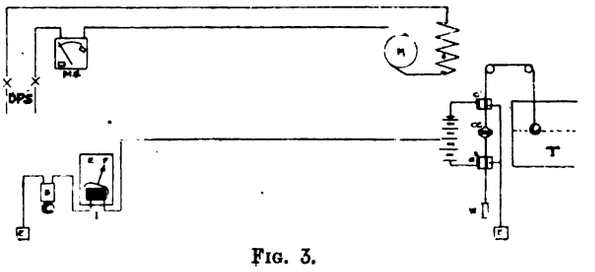

FIG. 3.

the upper or lower pair of contacts are short-circuited, the indicator, I, points to E or F, signifying empty or full, and the bell, B, is put in action. This bell will continue to ring until the water is at a more normal level, unless switched off. This arrangement, as will readily be seen, is capable of almost unlimited modification, and may very easily be used in conjunction with almost any mode of control. It may be as well to state that float and other automatic switches referred to above may be obtained from the Sturtevant Company.—F.

Answer to No. 636 (*awarded* 5*s.*).—The most suitable way would be as shown in Fig. 1. When the float is at top of tank, tank consequently being full, current is cut off from the motor by means of the switch, S. This switch is arranged to start and stop the motor at any specified depths of water in the tank by adjusting the tappets, T and T^1, on the chain that carries weight and float. It will be noticed that the switch is fitted with a balance weight. When brought just past the vertical this weight flies over, giving a quick make and break. In both figures motor is shown cut out of circuit. Suppose water were drawn from the tank float would fall

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and weight rise. Tappet T¹ would then engage with lever and carry balance weight on switch to the vertical position; balance weight would then fly over, giving a quick make. Solenoid being energised, starting switch lever is drawn over contacts gradually cutting out resistance and motor

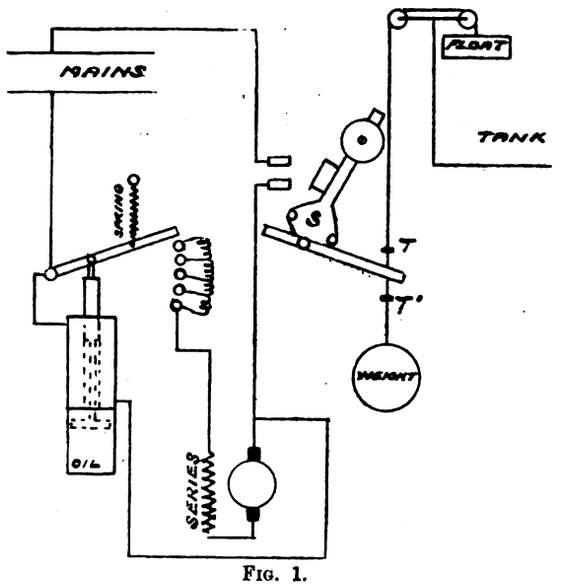


FIG. 1.

brought up to full speed. The solenoid must be so wound that it may bear the full potential of the mains across its terminals continuously without injury; it is fitted with a dash-pot to prevent starting resistance being cut out too quickly. Dash-pot, piston, and connecting piece between piston and core of solenoid must be made of brass or gunmetal. An instrument fitted as shown in Fig. 2 would give a record of the time motor was running. The drum, D, driven by internal clockwork, carries a paper on which a record of the current passing is traced by a pen at the end of the index, I. The iron armature is attracted over, in proportion to the current flowing, to the motor passing round the electromagnet of the instrument. When motor started the current could be

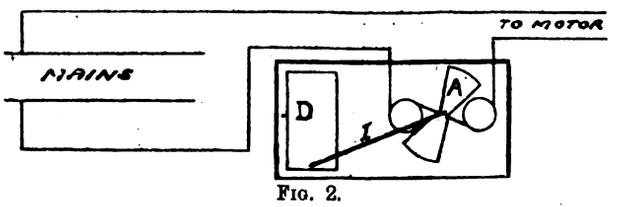
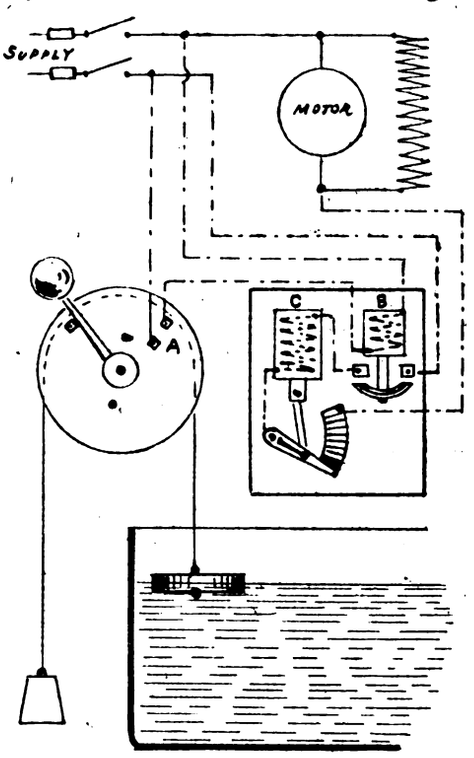


FIG. 2.

made to ring a bell to call attention to the fact that the motor was running.—M. M.

Answer to No. 636 (*awarded* 5*s.*).—Assuming that "G. H." wishes to raise water into a tank by means of the 2-h.p. motor, and does not wish to keep an attendant on the spot to stop and start it as required, the best way is to instal an automatic arrangement as shown. If it is a country district and on private ground, the leads from source of supply could be bare copper wire on porcelain insulators carried on pine poles. The leads should be protected by double-pole fuse and controlled by double-pole switch, and then run direct to starter, and coupled up as shown in diagram. The action is as follows: When level of water in tank falls, the float actuates a switch, A, which closes the circuit of a solenoid, B, and this switches on current to motor with all resistance in series with the armature. The current passing through armature also passes round solenoid, C, which gradually draws up the switch arm, and cuts out resistance as motor comes up to speed. When the tank is full the float rises and opens switch, A, cutting off current from solenoid B, and this immediately opens main switch, and cuts off current from motor and solenoid C; therefore, switch arm will be released, and all resistance cut in armature circuit ready for starting again, when water is drawn off from the tank. I believe the Sturtevant Engineering Company, of London, supplied the apparatus I have described. By observing an ammeter placed in circuit with motor leads it could be seen when motor stopped, which would indicate maximum height of water;



also when motor started, which would indicate minimum height.—A. T.

BALLADS OF BUSINESS.

No. 4.—Some Specifications, and a Suggestion.

No. I.

The manager reviles it,
It's sworn at by the Works,
The estimater's verdict
This pen description shirks.
And whosoever reads it
Says, as a general rule:
"It's written by an idiot,
And it's printed by a fool."

No. II.

It's fat and very wordy,
It's full of legal jaw,
It threatens one with penalties
And processes of law.
It wants a ton of samples,
Till one feels, a trifle riled,
That it's written by a father
For a very naughty child.

No. III.

Like visits from the angels
It comes, if not so rare;
It tells you what you wish to know
Without the aid of prayer.
Its plans are clear and ample,
Its schedules clear and few;
It's written by a man who knows
Just what he wants to do.

The Suggestion.

O! prithee, good consultants,
Upon whose words we hang,
To cultivate the Jingle style.
If not the Andrew Lang.
But, should you deem it *infra dig.*
To alter what you've done,
Add here and there a Limerick
And here and there a pun.
'Twould help to cheer those pages drear
If sprinkled o'er with fun. B. C. H. J.

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BELGIAN RAILS.

The excuse put forward by Mr. Benn during the discussion on Lieut.-Colonel Rotton's motion at the meeting of the London County Council last Tuesday was childish in the extreme. It consisted of, so far as the published reports go, "We were not the first nor are we the only ones to buy in the cheapest market." Colonel Rotton proposed: "That it be referred to the Highways Committee to ascertain and report to the Council (*a*) the number of hours of labour per week worked by the men employed by the Belgian firm in making rails for London tramways, and (*b*) the rate of wages per hour paid to such men, and if they do any work on Sundays in connection with the manufacture of such rails."

An amendment was moved by Mr. McKinnon Wood as follows: "That it be referred to the Highways Committee to ascertain and report to the Council (*a*) the number of hours of labour per week worked by the men employed in foreign firms in making rails for the Government, provincial corporations, London tramways, and railways; (*b*) the rate of wages per hour paid to such men, and if they do any work on Sundays in connection with the manufacture of such rails; and (*c*) the amount of mining royalties paid by foreign firms as compared with those paid in Great Britain."

The amendment was carried by a large majority without a division. We entirely agree with one of the speakers, that the amendment is calculated to smother the whole enquiry. The London County Council might just as well have added another clause, to the effect of seeking to know the age when elephants cut the eye teeth, or whether they have any eye teeth. What has the London County Council to do with other corporations' orders? It has its own sins of omission and commission to answer for, and that is enough. We have said before, and we say it again, as emphatically as possible, the London County Council on this question shows the grossest ignorance. It is within the last few years that a deputation of British ironworkers went to Belgium, with Mr. J. S. Jeans, if we remember aright, as secretary. This deputation issued a report containing most, if not quite, all the information required relating to wages, methods, organisation, etc., to be found in Belgium. If Mr. Benn and his coadjutors did not know of this report when they were determining the clauses of their specifications in contracts, they ought to have known it. The following are the terms of the contract embodied in Clause 34:

34. The contractors, notwithstanding Clause 33, may sub-contract for all or any of these portions of the work to be executed by them under this contract, which comprises the manufacture of the track rails, slot rails, and conductor rails, etc., subject to the following conditions and provisions which the contractors hereby agree to observe, perform, and fulfil—*vide licet:*

1. That sub-contracts shall be made with such person or firm or firms only as shall have been first approved by the engineer.

2. That no sub-contract shall operate to relieve the contractors from any of their liabilities or obligations, and that the contractors shall be responsible for all the acts, defaults, and neglects of the sub-contractors as fully as if they were the acts, defaults, and neglects of the contractors.

3. That there shall be inserted in each sub-contract a covenant by the sub-contractor (1) that he will pay all workmen employed by him in or about the execution of such sub-contract wages at the rates arranged between the employers and workmen in the rail trade in that part of the kingdom of Belgium or other country where the order is placed, with such approval as aforesaid; and (2) that such sub-contractor will at all times during the continuance of the sub-contract, whenever called upon to do so by the clerk of the Council, produce to such officers of the Council

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as the clerk may direct the time and wages books and sheets of the sub-contractor to show whether or not this stipulation has been and is being complied with.

4. That in case of any breach by the sub-contractor of the covenant as regards rates of wages to be inserted in any sub-contract (and notwithstanding the connivance of the contractors of such breach or any prior breach), the Council shall have power to cancel this contract so far as it relates to any part of the work not totally or partially manufactured whether by the contractors at any time on one week's notice to the contractors.

Is it Mr. Benn's view of equivalence of wages and time incidence in Britain and Belgium, that if local conditions are complied with all is well? The labour members are against him, for Mr. Steadman, a labour member, speaking on the first order in the Council on March 4, 1902, is reported to have said: "If you force organised labour in this country to demonstrate by its strength that it is enabled to get an increase from the employers, then, on the other hand, you have no right to turn round and blame organised workers for your sending contracts to a foreign country in consequence of the conditions which you yourselves have laid down. Now, sir, I shall be told that I am advocating protection. Yes; but protection of what sort, sir? I am advocating a protection which, if I had not taken the stand I am taking on this particular thing, I should be unworthy to occupy the position that I am now occupying in the great trade union movement in England to-day. Yes, sir, I am going to stand up—and you can call it protection as much as you like, but I intend to stand up and fight for the protection of British labour as against the sweated labour on the Continent."

Mr. Benn and such as him combine to force higher wages and shorter time in this country; hence impose conditions upon masters which have to be met by higher prices, and when these prices are quoted they practically say, "Pay your wages and keep your factories going if you can. How you can do it we neither know nor care, but one thing is certain, you won't get higher prices from us. Oh, we buy in the cheapest market." In his reply, Colonel Rotton said that Mr. Benn had not faced the music, but danced round it. The whole of this question is closely connected with the hitherto generally accepted doctrine of supply and demand. For some years past the natural course of supply has been interfered with, hence these troubles. It is easy to gain a temporary popularity by playing down to the passions and prejudices of the *oi pollio*, but Nemesis is sure if tardy. You cannot artificially inflate wages unrestrictedly without the effect being shown sooner or later. Men do not like to acknowledge the error of their ways, hence try to find a thousand excuses for their actions except the right one. How does Mr. Benn know that the conditions he imposes in this country are natural? If they are not, he is wrong in this matter. We think he is wrong, because the costs of rail production have again and again been analysed, and are known to the remotest decimal of a penny, and the excuses he puts forward have been also proved to be wrong. Our large steel manufacturers are owners of iron and coal mines, and hence do not pay royalties, so that the fiction of royalty addition is merely to draw attention from the real point. Given equivalent machinery, equivalent raw materials, on the one hand, with added higher wages and shorter hours, and the product cannot compete with longer hours and lower wages.

Newcastle Local Section.—At the ordinary meeting of the Newcastle Local Section of the Institution of Electrical Engineers on Monday, Dec. 14, a paper entitled "Experiments with Eddy Currents" will be read by Mr. W. M. Thornton.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

STEAM TURBO GENERATING PLANTS.

SIR,—As managing director of the Cambridge Electric Supply Company, Limited, and also of the Scarborough Electric Supply Company, Limited, and as, therefore, in some measure responsible for the exclusive and continued use of steam-turbines by these two concerns, I feel called on to draw attention to what appears to me to be the entirely misleading nature of the comparisons between the results obtained in steam-turbine stations on the one hand and reciprocating engine stations on the other, recently published in your columns by Messrs. Belliss and Morcom.

For their purpose Messrs. Belliss and Morcom state that they have selected reciprocating engine stations which are "under approximately similar circumstances as to costs of labour, fuel, output, etc.," as the turbine stations. No doubt they have made this selection as fairly as is possible, but to show how unsuccessful they have been in this respect, it is only necessary to point out that among their reciprocating engine stations they have included Salisbury, where a portion of the electrical generation is carried on by means of water power, and where both fuel and works costs are therefore abnormally low. Again, though Messrs. Belliss and Morcom specially mention the matter of output, their own figures show an average annual output of 1,464,907 units for their reciprocating stations and only 738,924 units for the turbine stations—a ratio of practically 2 to 1.

How greatly the mere quantity of output affects results may be seen from the following figures, which show how the costs of fuel, etc., have decreased at Cambridge and at Scarborough as the output has increased in the last seven years:

	Total units sold.	Fuel.	Oil, waste, and stores.	Works costs	Total costs.
Cambridge.					
1895	150,510	1·98	·19	3·91	4·53
1902	419,005	·66	·14	1·57	2·40
Scarborough.					
1895	135,177	1·66	·12	3·47	4·36
1902	431,777	·85	·08	1·61	2·65

Incidentally the above figures also go to show that the efficiency of steam-turbines does not fall off with use, as has been suggested in some quarters.

Another most important omission from Messrs. Belliss and Morcom's figures is any consideration of the question of load factor, which, as all station engineers are aware, has a greater effect upon costs than almost anything else. The following are the load factors of the turbine and reciprocating engine stations selected by Messrs. Belliss and Morcom for the same years that they have given the other costs:

Steam-Turbines.		*Reciprocating Steam-Engines.*	
Blackpool	14·32	Leeds	12·31
Newcastle District	13·67	Halifax	16·98
Cambridge	9·13	Bootle	28·44
Scarborough	9·34	Taunton	12·77
West Bromwich	9·27	Darwen	12·12
Morecambe	7·06	King's Lynn	15·58
Melton Mowbray	11·11	Salisbury	11·49
Average	10·55	Average	15·67

As will be seen, the average load factor of the reciprocating stations is practically 50 per cent. better than that of the group of turbine stations.

To recapitulate, the following are the points to which I desire to draw attention: (1) among the reciprocating stations Messrs. Belliss and Morcom have selected there is one where, owing to the use of water power, the results are abnormal; (2) the average output of the reciprocating stations Messrs. Belliss and Morcom have selected is about double that of the turbine stations; (3) the former have, on the average, a 50 per cent. better load factor than the latter. I think that most engineers will agree with me that, under these circumstances, Messrs. Belliss and Morcom's comparisons are of no value at all.

Lastly, I note that in Messrs. Belliss and Morcom's list of turbine stations they have left entirely out of account

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that belonging to the Newcastle-on-Tyne Company, which, if I mistake not, is now almost entirely run by means of steam-turbines. Would it surprise Messrs. Belliss and Morcom to learn what I am informed on good authority is the fact—namely, that the works cost of this station are now less than half the most favourable similar figure of ·62d. per unit which Messrs Belliss and Morcom give for Leeds? Now, the cost of coal and labour at Newcastle and Leeds cannot differ very greatly, so this enormous difference must be due to matters of load factor and output, and probably also to some amount of superior economy in steam-turbines over reciprocating engines.—Yours, etc.,

A. A. CAMPBELL SWINTON.

66, Victoria-street, S.W., Dec. 3, 1903.

SIR,—In reply to the bulk of Mr. Wilkinson's reply in your issue of Nov. 27, 1903, we need only refer to the previous correspondence. For the rest, we can assure Mr. Wilkinson that we have had a very large and satisfactory experience with high superheat in our reciprocating engines during recent years, and, as our customers know, have done a great deal of hard work in assisting to make the advantages of superheat practically possible. We omitted Shipley, as we found that they were receiving steam gratis from the destructor works.

Mr. Wilkinson's suggestion that a trial should be made with the best examples of reciprocating engines and steam-turbines, under ordinary central-station conditions as to superheat and vacuum, is, in our opinion, a good one. The difficulty is to get such a prolonged trial made under impartial and useful conditions, but if any of the leading engineering associations are prepared to take the matter up in the interests of their members, we should be very pleased to lend an engine for the purpose.—Yours, etc.,

(for Belliss and Morcom, Limited),
ALFRED MORCOM, Managing Director.

Dec. 8, 1903.

SIR,—Mr. Wilkinson states in his letter published in your last issue that "it is an undoubted fact that turbines give no trouble when working with superheated steam." Now, I have information that about a fortnight since about one-fourth of the total number of blades were stripped off one of the turbines in a station in the Midlands, and the trouble was attributed to superheated steam, and that the blades are to be replaced by others of a metal specially adapted to withstand the effects of superheat. I also know of a similar thing having happened not long since at another station, the failure being also attributed to the use of superheated steam. At this station reciprocating engines were in use as well as steam-turbines, and when subequently extension sets were required, reciprocating engines were installed. I have also heard of the blades being stripped off a large turbine in the States where superheated steam was in use. These sort of experiences are not, as a rule, published in the papers; indeed, it seems almost indecent to drag them into light, but if without any special sources of information I have heard of three different instances of trouble with superheat, no doubt others have occurred which have not come to my knowledge. Perhaps Mr. Wilkinson might say as to experiences he has had with blades being stripped off the turbines at his station —Yours, etc,

RECIPROCATING ENGINE.

THE DIESEL ENGINE.

SIR,—In the first answer to Question No. 634 in the *Electrical Engineer* of the 4th inst., "A. C. G. I." would appear to have got a little mixed. In the diagrammatic drawing shown accompanying the answer your correspondent simply reduces the Diesel engine to a compound expansion engine with two cylinders. He also shows the low-pressure cylinder double acting. It is true that in his earlier experiments the inventor used as many as three cylinders, but the engine which is now upon the market, and which has become a commercial success, is in every respect similar to an ordinary gas or oil engine, having what is commonly known as the Otto cycle, the whole of the work being done in one cylinder, assisted in compression by an air-pump. In the two-cylinder type there are simply a pair (sometimes called twin) of complete engines connected together in the usual manner adopted by the makers of gas and oil engines, and by this means an impulse is obtained each revolution.—Yours, etc., E. F.

FLATS IN COMMUTATOR.

SIR,—I am in charge of a dynamo, 110 volts 40 amperes, and am troubled with a flat constantly coming in one of the segments of the commutator. As soon as it appears I have it turned out in the lathe, but it soon reappears. The coils of the armature appear to be all right. The springs of the brushes are all right. The brushes we use are copper gauze filled in with graphite. I should be pleased for any valuable correspondence on it.—Yours, etc.,

F. J. HOPLEY.

FORTHCOMING EVENTS.

FRIDAY, DEC. 11.

Tramways and Light Railways Association.—At 8 p.m., inaugural meeting. Address by Mr. Atherley-Jones, K.C., M.P. on "Protection in Special Relation to Tramway and Light Railway Enterprise."

Physical Society.—At 8 p.m., at the Royal College of Science. Papers: "A Method of Mechanically Reinforcing Sounds," by Rev. T. C. Porter; "The Simmance-Abady 'Flicker' Photometry," by Messrs. Simmance and Abady; "Exhibition of a Conductometer," by Mr. M. R. Appleyard; and "A Model to Illustrate Various Properties of Wave Motion," by Prof. L. R. Wilberforce.

SATURDAY, DEC. 12.

West Hartlepool Scientific Society.—At 7.30 p.m., ordinary meeting. Paper: "Mr. D. B. Morrison's Scheme for the Advancement of Apprentices," by Mr. Wm. Kennedy.

Glasgow Scientific Society.—At 7.30 p.m., ordinary meeting. Paper: "Steam-Turbine Machinery," by Mr. Arthur A. Wynne, M.A.

MONDAY, DEC. 14.

Institution of Mechanical Engineers.—At 7.30 p.m., graduates' meeting. Paper: "Main and Auxiliary Steam-Pipes for Power Plants," by Mr. Henry Baker.

Society of Arts.—At 8 p.m. Cantor lecture: "The Mining of Non-Metallic Minerals," by Mr. Bennett H. Brough (Lecture IV.).

TUESDAY, DEC. 15.

Institution of Electrical Engineers (Manchester Section).—At 7.30 p.m., ordinary meeting. Paper: "Electric Traction with Alternating Currents," by Mr. A. C. Eborall.

Institution of Civil Engineers.—At 8 p.m., ordinary meeting. Papers: "Deposition in Pipes and other Channels conveying Potable Water," by Mr. J. C. Brown, D.Sc.; "The Purification of Water Highly Charged with Vegetable Matter," by Mr. O. Chadwick, C.M.G.

WEDNESDAY, DEC. 16.

Liverpool Engineering Society.—At 8 p.m., ordinary meeting. Paper: "Polyphase Working," by Mr. H. W. Wilson.

Society of Arts.—At 8 p.m., ordinary meeting. Paper: "Science and Industry," by Sir Wm. H. Preece.

Institution of Electrical Engineers (Birmingham Section).—At 7.30 p.m., ordinary meeting. Paper: "Testing of Electric Generators by Air Calorimetry," by Prof. R. Threlfall, F.R.S.

Royal Meteorological Society.—At 7.30 p.m., ordinary meeting.

Society of Engineers.—At 6.30 for 7 p.m., annual dinner, Hotel Cecil.

Chemical Society.—At 5.30 p.m., ordinary meeting.

THURSDAY, DEC. 17.

Institution of Electrical Engineers.—At 8 p.m., ordinary meeting. Paper: "The City and South London Railway—Working Results of the Three-Wire System applied to Traction," by Mr. P. V. McMahon. Leeds Section.—At 7.30 p.m., ordinary meeting. Paper: "Methods of Charging for Electrical Energy," by Mr. E. H. Crapper.

Engineering Society, King's College.—At 5 p.m., meeting.

FRIDAY, DEC. 18.

Institution of Mechanical Engineers.—At 8 p.m., ordinary meeting. Papers: "An Enquiry into the Working of Various Water Softeners," by Messrs. C. E. Stormeyer and W. B. Baron.

Electro-Harmonic Society.—At 8 p.m., in the King's Hall, Holborn Restaurant, smoking concert.

Institution of Civil Engineers (Students' Section).—At 8 p.m., ordinary meeting. Papers: "The Action of the Sea upon the Foreshore," by Mr. C. B. Case; "The Causes of the Loss of Beaches," by Mr. F. W. Cable.

SATURDAY, DEC. 19.

Junior Institution of Engineers.—At 3 p.m., visit to the electricity works of the Walthamstow Urban District Council. Train leaves Liverpool-street at 2.23 p.m.

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THE INSTITUTION DINNER.

The fifteenth annual dinner of the Institution of Electrical Engineers was held in the Grand Hall of the Hotel Cecil on Wednesday last. The President, Mr. Robert Kaye Gray, was in the chair, and was supported by a number of illustrious guests, amongst whom we may mention Lord Reay, Lord Monkswell, Lord Biddulph, Lord Claud Hamilton, M. Hospitalier (president of the Société Internationale des Electriciens), and Mrs. Ayrton (the only lady member of the Institution). A number of the general managers of our leading railways were present. The President and the Council are to be congratulated on the large number of members present, and it is evident that the reorganisation of the toast list is increasing the popularity of this annual function. This year, apart from the loyal toasts, there were only three other toasts to be honoured, and in each case the five minutes' limit to the speeches was strictly adhered to. The result was that at a comparatively early hour members were able to adjourn to the reception room, where the Imperial Orchestra acted as accompanists to the general conversation.

After the loyal toast had been honoured, Lord MONKSWELL, the chairman of the London County Council, proposed in an able speech "The Institution of Electrical Engineers." He referred to the members of the Institution as the spoilt children of science, and of their "earning fame and wealth." We trust that his speech is prophetic.

The PRESIDENT, in reply, mentioned the great work which the London County Council had in hand in converting their tramways for electric traction. This undertaking had the warm approval of the Institution. While admiring the larger works that the Council are engaged in, he was afraid they could not be so hearty in their commendation of some of the smaller works which the Council, in common with other such bodies, sometimes undertook. The tendency to be universal providers extended to all Government establishments, and even the great railway companies showed a desire to possess departments which would furnish all their requirements. While this tendency had certain advantages, there existed many drawbacks, the principal of which would appear to be the narrowing of the sources of production, and as an outcome of this effect the checking of the spirit of invention and development. In conclusion, Mr. Kaye Gray alluded to the steam-turbine and the high-speed steam-engines as being essentially the outcome of electrical engineering. He advocated the general improvement in our educational methods, but at the same time individualism was required in education as in other matters. It was this individualism which had raised the country to its present position, and he did not think we were yet so decrepit as to require artificial barriers for our protection.

Mr. JAMES SWINBURNE proposed the toast of "Railways and Telegraphs." He said there was no doubt in the minds of the members that it was the right thing to electrify every railway forthwith. Unfortunately, the aid of Parliament had to be sought, and this resulted in great and interested opposition. He thought that these large companies should have the power to develop and improve without restrictions which tend to render profitable working impossible. With respect to the telegraphs, our interests were enormous, and he looked to telephones to solve the traffic problem which Sir John Wolfe Barry was engaged upon. He gathered that the enquiry had shown ordinary methods to be quite useless, as if the facilities of transport were doubled four times as many people tried to travel. A telephone system that would work would save the situation.

Sir C. J. OWEN replied for the railways, and acknowledged the service which electricity now rendered. He hoped that with legislative restrictions removed, an even closer alliance between railways and electrical engineering would be for the commcn good.

Sir JOHN WOLFE BARRY, replying for telegraphs, said the country should be proud of having led the way in submarine telegraphy, because it still held the predominating interest in such undertakings. He gave statistics of these cable enterprises and of the great reduction in rates—*i.e.*, from 60 to 70 per cent.—which have been made during comparatively recent years. The average charge for telegraphing 100 nautical miles was only ½d. per word, or only double the charge on land lines, which cost so very much less to construct. With respect to wireless telegraphy, he took a great interest in the same, and thought the facts were not always appreciated. His company had five cables from Cornwall, which at busy times dealt with 15,000 words an hour. Forty cables touched English soil, and at the same rate it meant 120,000 words an hour, or 2,000 a minute, equal to 12,000 letters a minute. Fancy that discharge of letters bombarded into the ether and encountering an equal bombardment from foreign countries! It was an appalling prospect, and any attempts at tuning would encounter tremendous difficulties and complications.

Prof. S. P. THOMPSON then proposed "Our Guests," to which toast Lord CLAUD HAMILTON, Sir WILLIAM WHITE, and M. E. HOSPITALIER replied. The last-named received a great ovation.

FIREPROOF CABLES.

A speciality in the way of cables which will, no doubt, find wide favour has recently been introduced by Messrs. W. T. Glover and Co., Limited, Manchester. We refer, as the headline indicates, to the firm's fireproof type of cable. The need for such a cable has been increasingly felt of late, especially in some of the newer fields of electrical enterprise—mining and railway work, for instance. Nor will it lack employment in connection with older-established branches of electrical work. Behind switchboards, and for arc lamp leads, theatrical displays, temporary installations, etc., fireproof cables should find a large field of employment awaiting them.

Glover's Fireproof Leather-Braided Cable.

The following is a description of the general method of manufacture: The cable is insulated with pure and vulcanised rubber and served with proof tape in the ordinary way. It is then passed through a bath of the patent fireproof solution, and a braiding of tanned jute, which has been treated with this solution, is then put over this. After braiding the cable passes through another bath of the solution, which completes the operation. If further protection is required, another braiding of leather thongs is put over all, the whole making a thoroughly well-insulated and strong mechanical job (see illustration herewith). For cases where cables already installed require protection from fire, Messrs. Glover make a fireproof tape which can be lapped over these cables and will answer the purpose. This doubtless will be of considerable use in those risky situations where an arc would play havoc with the well-dried braids and tapings that are still to be found behind switchboards all over the country.

The following are some particulars of tests made upon these cables by a very prominent firm largely interested in electrical railway work, to satisfy the Board of Trade as to the use of the same in connection with a large railway scheme. A length of ordinary $^{0}1/_{13}$ rubber cable which was being made in the works was taken, the fireproof coverings of which consisted of three braids of asbestos and three braids of fireproofed tanned jute. A piece of bare copper strand was fastened to the outside of this cable, and the cable and bare strand were connected to the terminals of the generator, capable of giving 1,200 amperes at 500 volts. Half a dozen punctures were made in the coverings of the insulated fireproof cable, and a short-circuit was made by a piece of copper wire from the conductor thus exposed to the bare strand outside with the object of starting the arc. It was found that an arc of 700 or 800 amperes could not be maintained owing to the rapid carbonising effect of such a heavy current. The

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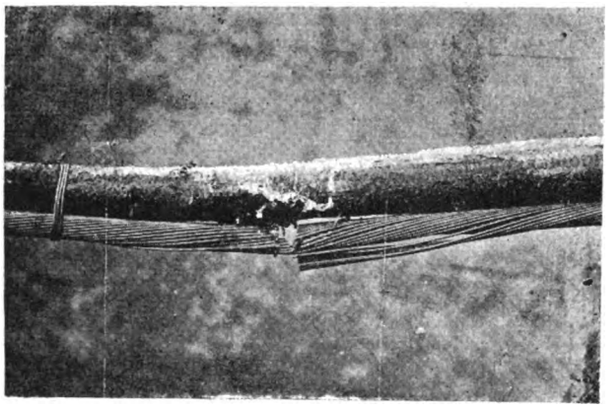
largest current which could be permanently kept on for 10 or 15 minutes was, roughly, from 150 to 200 amperes. This current did not give a steady blazing arc, but sparked about the faulty places generally. This condition was kept up for 12½ minutes. Ultimately the current increased very suddenly to 1,500 amperes or more, when the circuit breaker operated. The application of the current to the faulty spot was repeated five times, but the time during which it was possible to maintain an arc varied from a few seconds to a few minutes before the maximum current passed, operating the circuit breaker. The same terrific arc and blazing flash took place each time, and the final state of the cable is shown on the photo reproduced herewith, which was taken within 20 seconds of the last application of the current. The absence of smoke or smouldering of the fireproof coverings is clearly shown in the photograph, and this is in spite of the fact that the experiments were made in the open air with a fairly strong wind blowing.



Glover's Fireproof Cable, showing effects of short-circuiting test.

Fuller details and samples, we understand, may be obtained by applying to Messrs. Glover direct.

TRADE NOTICES AND NOVELTIES.

"Ediswan" Specialties.

CELL-TESTING INSTRUMENTS (Leaflet No. I, 2,018).—This comprises a new line of small portable ammeters and voltmeters for stationary and portable accumulators; they are also specially suitable for motorcar batteries. The larger ones are made in both round and square cases, the former being of polished brass, the latter of cast aluminium. The terminals have a special device which makes it impossible for the milled nuts to come off. Both instruments can be supplied either as ammeters or voltmeters. A watch type of voltmeter, with flexible cord and two contacts, is also listed; this is also suitable for ignition cells, etc. It is put up in gunmetal case with silvered dial. All these instruments are made at the works at Ponder's End, and whilst the price is on competitive lines, the workmanship and finish are of the highest.

CONTINUOUS-CURRENT "LILIPUT" ARC LAMP (Leaflet No. H, 2,019).—Describes the "Liliput" arc lamp with accessories. This lamp is too well known to necessitate a special description.

IMPROVED RADIATOR LAMPS (Leaflet No. L, 2,021).—During past years it has been a frequent complaint of the people using electric glow radiators that they could not obtain spare lamps. The "Ediswan" Company have taken steps to see that this need not occur again, and this leaflet illustrates the new and improved "Royal Ediswan" radiator lamp. An oval window has been introduced into the obscured glass, through which the filaments can be inspected. In addition, an improved and ventilated flanged cap is provided and secured by hard cement. This ensures better fixing of the cap. The filaments are prepared by a very special process, giving increased strength.

THREE-PLATE PATTERN H.V. CEILING ROSE (Leaflet No. A, 2,022).—In order to avoid the necessity of having so many "points" in such places as offices, factories, etc., where appearance is not a *sine quâ non*, the Ediswan Company introduced their three-plate pattern H.V. ceiling rose, by means of which two or more flexible pendants may be controlled by more than one switch. The special porcelain bridge separates the terminals from each other, and secures absolute immunity from short-circuit, whilst relieving the terminals from all strain.

THE CHOICE OF THE ROTOR DIAMETER OF INDUCTION MOTORS.*

In the design of induction motors the mistake is often made of choosing a very large diameter for the rotor with a view to obtaining a good power factor. Since, however, the length of the end connections, and, therefore, their inductance, is increased by this means, it may often happen that the desired result is not obtained, and that, in spite of the increased cost of manufacture, the power factor may be actually lowered.

In the following article the writer wishes, in the first place, to emphasise the importance of that part of the total inductance which is due to the end connections,† and, in the second place, to develop a simple and practical method by which the best dimensions may be decided.

On p. 36 of Behrend's excellent treatise‡ on induction motors, the following formula for calculating σ is given:

$$\sigma = C\frac{\Delta}{t},$$

where C is a figure which is dependent on the slot dimensions and other conditions, Δ is the length of air-gap, and t the pole pitch. Behrend estimates that C varies between 10 and 15 for half-closed slots. This formula is extremely useful on account of its simplicity, especially if experimental results are available by which to decide the value of C.

The present writer has attempted to estimate the leakage flux of induction motors by a method analogous to that which has been found satisfactory in determining the reactance voltages of continuous-current machines. Table I. has been obtained in this way, and is in fair agreement with test results.

TABLE I.

Pole pitch in centimetres.	Flux per 1 cm. length of winding embedded in iron, per ampere-turn, in C.G.S. lines.		
	Open slots.	Half-closed slots.	Completely closed slots.
20	·86	1·04	1·24
25	·69	·83	1·0
30	·57	·69	·83
35	·49	·59	·71
40	·43	·52	·62
45	·38	·46	·55

It will be seen that the number of magnetic lines per 1cm. length of winding in iron and per ampere-turn has been taken as inversely proportional to the pole pitch. The flux per 1cm. of end length may be taken as ·4 for all values of pole pitch. Naturally, considerable variations from this may occur with different mechanical arrangements of the end connections. For motors having squirrel-cage rotors ·3 C.G.S. lines per ampere-turn per 1cm. of end length should be used, and the total should be estimated on the basis of the length of the stator end connections. The predetermination of the inductance of induction motors is carried out in the same way as the determination of the magnetising current, but whilst for the latter the magnetic circuit looped with the secondary winding alone is considered, all the remaining magnetic circuits are taken into account when calculating the inductance.

Compared with the short-circuited coils of a continuous-current machine the leakage paths are much more restricted, and this explains why the figures in Table I. are so much lower than those employed for the calculation of the reactance of continuous-current machines. For the latter an average value of 4 C.G.S. lines per ampere-turn per 1cm. of embedded length and ·8 C.G.S. lines per ampere turn per 1cm. of free (or end) length have been found satisfactory. The conductors per pole and phase are also much more spread out in the case of induction motors than in con-

* Translation of an article by H. M. Hobart in *Elektrotechnische Zeitschrift* for Nov. 12, 1903.

† This has long been known, and has been pointed out by several designers. (See M. Breslauer's criticism of Behrend's treatment in *Elektrotechnische Zeitschrift*, 1903, No. 24). It is doubtful, however, whether the effect has been estimated at so high a figure as in the motor given as an example in this article.

‡ "The Induction Motor," New York *Electrical World and Engineer*, 1901.

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tinuous-current machines. Since the pole-pitch in the former varies between 18cm. and 45cm., the conductors of each coil side take up from 6cm to 15cm., and this in great measure accounts for the low values in Table I.

An example of the estimation of σ is worked out below in order to show the application of the method. Diameter of rotor, 102cm.; periphery of rotor, 320cm.; number of poles, eight; pole pitch, 40cm. The slots are approximately three quarters open, and therefore the values chosen are ·44 C.G.S. lines per ampere-turn per 1cm. of embedded length, and ·4 C.G.S. per ampere-turn per 1cm. of free length.

Effective length of core parallel to spindle = 25·4cm.
Average length of one stator turn = 181cm.
Length of one turn embedded in iron = 51cm.
Free length of one turn = 130cm.
C.G.S. lines per ampere-turn of embedded length = 51 × ·44 = 22.
C.G.S. lines per ampere-turn of free length = 130 × 4 – 52.*
C.G S. lines per ampere-turn = 74.
Number of stator slots = 120.
Number of stator slots per pole and phase = 5.
Conductors per slot = 4.
Turns per pole and phase = 10.
(In reality there is one coil of 20 turns per pair of poles, and not one coil of 10 turns per pole.)
Leakage flux per coil per ampere = 74 × 20 = 1,480.
Inductance per coil = 20 × 1,480 × 10^{-8} = ·000296 henry.
Inductance per phase = ·000296 × 4 = ·00118 henry.
Periods per second = 40.
Reactance per phase = 6·28 × 40 × ·00118 = ·296 ohm.

The motor is built for a terminal voltage of 550, and as the stator winding is star coupled the voltage per phase is $\frac{550}{\sqrt{3}}$ = 318 volts. The short-circuit current at normal terminal voltage will then be

$$\frac{\text{terminal volts per phase}}{2 \times \text{reactance per phase}} = \frac{318}{2 \times \cdot 296} = 536 \text{ amperes } (= A).$$

Calculation of the magnetising current:

Primary terminal voltage (= E) = 318.
Turns in series per phase (= T) = 80.
Periodicity per second = 40.
Total flux per pole (E = 4·2 T N M × 10^{-8}) M = 2·37 × 10^{6}.
Length of iron core (= λ) = 25 4cm.
Diameter of rotor = 102cm.
Pole pitch (= t) = 40·2cm.
Breadth of (slot + tooth) for stator = 2·68cm.
Breadth of (slot + tooth) for rotor = 2·23cm.
Stator slot opening = ·9cm.
Rotor slot opening = 8cm.
Part of stator surface composed of iron = 66 per cent.
Part of rotor surface composed of iron = 64 per cent.
Average surface composed of iron (= p) = 65 per cent.
Average section of air-gap per pole (= $\lambda \times t \times p$) = 660 square centimetres.
Factor to allow for fringing, 1·2.
True section of air-gap per pole, 790 square centimetres.
Average air-gap density, 3,000.
Maximum air-gap density (= 1·7 times the average density) = 5,100.
Air-gap length, ·32cm.
Air-gap length (including allowance for tooth saturation) = ·35cm.
Ampere-turns per pole, 1,430.
Ampere-turns per pole and phase, 715.
Turns per pole and phase, 10.
Maximum current per phase, 71 5 amperes.
Effective magnetising current per phase = 50 amperes (= B).
Diameter of the Heyland circle = A – B = 486 amperes.

$$\sigma = \frac{B}{A - B} = \frac{50}{486} = 103.$$

$$\cos \phi = \cdot 83.$$

It is clear that Behrend's formula was based on the assumption that the inductance was directly proportional to the iron length.* The above method, which takes the effect of the end length into account, shows, however, that the inductance of only that portion of the winding which is embedded is proportional to the iron length. The inductance of the free length is directly proportional to the pole-pitch, so that the total inductance falls off much less rapidly with increasing pole-pitch than would be expected from Behrend's formula, and it may even increase with increasing pole-pitch. Nevertheless, Behrend's simple formula forms a quicker and more satisfactory method for predetermining σ than the method based on the calculation of the flux per ampere-turn per 1cm. of embedded length and free length respectively.† It is only necessary to determine suitable values for the constant C, and those given in Table II. are in close agreement with the figures in Table I.

TABLE II.

Ratio of effective core length to pole pitch in percentages.	Value for C in Behrend's formula: $\sigma = C \frac{\Delta}{t}$	
	Open slots.	Completely closed slots.
150	6	12·5
140	6·2	12·6
130	6·4	12·7
120	6·7	12·9
110	7·1	13·1
100	7 5	13·4
90	8·2	13·8
80	8·8	14·3
70	9·5	14 8
60	10·3	15·4
50	11·3	16·1
40	12·2	16·8
30	13 5	17·7

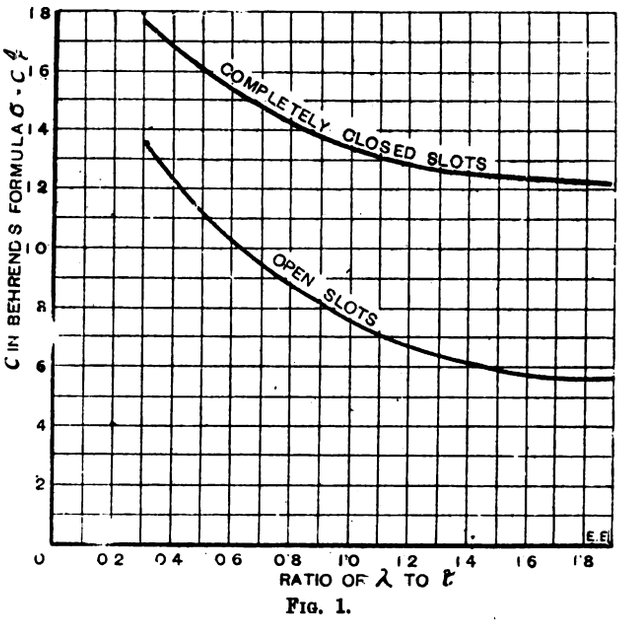

FIG. 1.

These results have been put into curve form in Fig. 1, and form a good basis for the calculation of σ.

A CENTRAL TECHNICAL COLLEGE PUBLICATION.

Many old students of the Central Technical College will be interested to learn of the publication of a new magazine

* This example shows the great importance of the end connections. A much better motor as regards power factor would have been obtained if the diameter had been made smaller and the coil length greater.

* It would seem as if the simplest formula in which the facts can be embodied is

$$\sigma = K \frac{\Delta (\Delta + K_1)}{t^2},$$

where K and K_1 are constants which are proportional to the ratio of $\frac{\lambda}{t}$ and to the slot depth respectively. It is, however, preferable to keep the formula as simple as possible, so that the writer thinks it better to retain Behrend's original formula, together with the values of C got from Table I. and Fig. 1.

† Though this method gives a better insight into the relative effects of embedded and free length.

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which has been brought out under the auspices of the Central Technical College Old Students' Association. Its comprehensive title is "The Central," and it has as editors Prof. E. Frankland Armstrong and Mr. Maurice Solomon. The laudable object of the magazine is to keep old students, whether on the banks of the Nile or on the plains of India, in touch with what is doing at the college and in the laboratories in which they spent their early days—in a word, it is to be a journal devoted to the maintenance and spreading of the interests of the college. The first number which has reached us is well calculated to give a good impression. Its get-up is in the best style, and the reading matter is of the highest standard. An excellent portrait of Prof. W. C. Unwin is presented as a frontispiece, and among the principal contents is an article on some research work of the past session, and another on the special work of an Old Centralian by Mr. W. Duddell, to be followed by others of a similar kind on the work which other old students are doing. The new electrical laboratories at the college are described, and some excellent illustrations lend a special interest to the subjects discussed. At first the magazine will be published two or three times a year, and more often later on should this be justified by the demand.

WALLASEY MUNICIPAL TRAMWAYS.

Mr. R. R. Greene, general manager of the above undertaking, has presented his report to the chairman and members of the Tramways Committee for the year ending March 31 last. The report states that on March 17, 1902, the first service of electric cars was commenced on the Rake-lane route, and on the 19th of the same month the cars started to run on the Sea Bank-road route. To meet the requirements of workmen and others desirous of reaching Liverpool in the early morning, a service of cars was also established from Molyneux-drive and Wallasey-road. These cars are much appreciated, and show satisfactory financial results. The Warren-drive route was opened on May 17, 1902. The suite of offices which the committee decided to erect in Sea View-road for the accommodation of the staff has been completed, and has proved well adapted for the purposes intended. A successful benefit society was established in July, 1902, by and for the employés, who elect their own committee, and the management is solely in their own hands. For a small weekly contribution a payment is made to members during sickness, and a funeral allowance is also provided by the society for the burial of deceased members. The efficiency of the lifeguard adopted by the committee and fitted on the cars has been proved on at least two occasions, when children who ran in front of the cars and were knocked down would have been seriously injured, if not killed, but for having been picked up by the guard. The comparative immunity from serious accidents during the year is matter for congratulation, and may fairly be taken as evidence of the care and vigilance exercised by the members of the traffic staff in the performance of their respective duties. The rolling-stock at present in use consists of 30 double-deck cars mounted on Brill single trucks driven by two motors of 25 h.p. each, seating accommodation being provided for 22 passengers inside and 34 outside. One of these cars has been fitted with a top covering, and four others are being similarly fitted; also one combined track cleaner, watering-car, and snow-plough on Brill single truck driven by two motors of 25 h.p. each.

Attached we give an abstract of the accounts for the year. The total expenditure on capital account on March 31 was £120,503.

Cr. Revenue Account No. 1.	£	s.	d.
Traffic receipts	30,907	3	8
Advertising rents	455	7	9
Other receipts	47	9	10
National Telephone Company—compensations	64	14	8
	£31,474	15	11

Dr.	£	s.	d.
Maintenance of cars	1,550	13	4
Maintenance of buildings	7	16	6
Maintenance of lines	96	11	7
Depôt expenses	1,276	1	1
Traffic expenses	13,951	4	4
Rates and taxes	210	15	5
Printing and stationery	82	7	6
Advertising	82	9	0
Salaries	620	17	0
Law expenses	157	10	5
General charges	1,158	6	9
Depreciation and renewal fund	4,500	0	0
	23,694	12	11
Balance carried to credit of account No. 2	7,780	3	0
	31,474	15	11

Cr. Revenue Account No. 2.	£	s.	d.
Balance, March 31, 1902	308	4	3
Revenue account No. 1—excess of receipts over expenses	7,780	3	0
	£8,088	7	3

Dr.	£	s.	d.
Interest on loans	3,772	16	5
Sinking fund	1,408	12	4
Proportion of loan charges on promotion expenses (Act, 1899)	100	0	0
	5,281	8	9
Balance, March 31, 1903	2,806	18	6
	£8,088	7	3

Following we give a statement showing the electrical energy consumed, miles run, passengers carried, and receipts during the year: energy in Board of Trade units, 979,133; miles run, 654,742·390; passengers carried, 5,685,182; receipts, £30,907. 3s. 8d. Average per car mile: Board of Trade units, 1·49; passengers, 8·68; receipts, 11·33d.

PERSONAL.

Mr. Standen Leonard Pearce was on Wednesday appointed to succeed Mr. G. F. Metzger in the position of chief engineer to the electricity department of the Manchester Corporation. Mr. Pearce is at present deputy chief electrical engineer. The appointment will begin on Feb. 1 next, on which date Mr. Metzger will take up the position of consultant engineer, which position he will keep until his extension scheme has been completed. Mr. Metzger's salary is £900. Mr. Pearce is to have £800 a year, the same that his predecessor had to begin with. His present salary is £500 a year. The committee have decided to appoint an assistant electrical engineer at a commencing salary of £250 per annum. The *Manchester Guardian* says: "Mr. Pearce is a son of the late Rev. Standen Pearce, Baptist minister, and was born at Crewkerne, Somerset, in 1872. Although young, he has had a very varied experience of electrical work for 15 years. After education at Bishop's Stortford College, he was apprenticed in 1888 to Messrs. J. G. Statter and Co., West Drayton, electrical and mechanical engineers. His identures were for four years, but at the end of two years the firm gave up business. Mr. Pearce then joined himself to Messrs. Thomas Richardson and Sons, Hartlepool, marine and electrical engineers. He remained with this firm for over four years, spending 3½ years in the various workshops and a year in the drawing and scientific office as a draughtsman. In this way Mr. Pearce gained a practical knowledge of mechanical engineering work, especially as it affects electricity. Desiring to gain further practical acquaintance with machinery, he entered the service of the British India Steam Navigation Company, London, and for two years, on various vessels, had complete charge of a 'watch,' having control of all the main and auxiliary electrical and hydraulic machinery with which all modern ships are equipped. In 1896 Mr. Pearce became assistant engineer with the Metropolitan Electric Supply Company, London. With that firm he remained till 1899, and when he left he was chief assistant engineer. From the Metropolitan he went for a year or so to the British Thomson-Houston Company, London. Thence he passed to the Central London Railway Company, and became superintendent engineer at the power station. He was in the company's service during the construction of the 'Twopenny Tube,' as the London electrical railway has been called. In March, 1901, Mr. Pearce came to Manchester, having been appointed deputy chief electrical engineer to the Corporation."

Mr. L. B. Hogarth, assistant engineer Sculcoates lane electric light and power station, Hull, has been appointed assistant engineer to the Ebbw Vale Steel, Iron, and Coal Company, Limited.

Mr. Thomas Mason, I.S.O., telegraph traffic manager at St. Martin's-le-Grand, retires at the end of the year. He will be best remembered as superintendent of the special staff, a position which he held for 30 years, during which the telegraphing of the most important events and speeches in the United Kingdom was effected under his control. In acknowledgment of his long and meritorious service the King in March last personally conferred on him the insignia of a Companion of the Imperial Service Order.

Mr. J. B. Hudson, the senior assistant at the Bootle electricity works, has been appointed to act as deputy electrical engineer during the absence of the electrical engineer, and Mr. E. W. King has been appointed assistant electrical engineer at the salary of £110 per annum, rising by annual increments of £10 to £150 per annum.

Mr. Grimsdale, the electrical engineer at Warrington, has resigned.

Mr. J. R. Williams, A.M.I.M.E., A.M.I.E.E., A.I.N.A., of Sheffield, has been elected a Fellow of the Society of Arts.

APPOINTMENTS VACANT.

Assistant Electrical Engineer, Sanitary Commissioners Gibraltar. Salary, £200 per annum. Applications by Dec. 16. See advertisement in former issue.

Traveller with connection amongst buyers of arc lamps and switchboards, Box 808, *Electrical Engineer* Office.

Surveyor and Electrical Engineer, Boston. Salary, £300. Dec. 18.

Switchboard Attendant, Motherwell. Salary, 25s. per week.

Shift Engineer, Fulham. Salary, £104 per annum. Dec. 12. See advertisement in last issue.

Clerk and Accountant, Portsmouth Telephone Department Salary, £90 per annum. Dec. 14. See advertisement in last issue.

Wireman, at the Goldsmiths' Institute, New Cross, to conduct classes in electric wiring. See advertisement.

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PHYSICAL SOCIETY.

At the meeting of the society on Nov. 27, Dr. R. T. Glazebrook (president), in the chair,

Mr. Horace Darwin exhibited an electric thermostat. The thermostat shown at the meeting was made for Lord Berkeley, and is similar to one made for the spectograph of the 24in. refractor of the Royal Observatory, Cape of Good Hope. The vessel, the temperature of which is to be maintained constant, is surrounded by oil contained in a bath. In the oil are placed two heating coils, through which electric currents pass. By automatically controlling these currents the temperature of the oil, and consequently of the inner vessel, is kept very nearly constant. The control is effected by means of a Wheatstone bridge in the outer oil bath. This bridge has two opposite arms of copper and two of manganin, so that it is only balanced at some definite temperature. Its deviations from balance affect the position of a long horizontal boom attached to the suspended coil of a galvanometer. The position of the boom determines the greater or less descent of a "hit-or-miss" arm which is periodically raised by a rotating cam, and can only fall to its lowest position when the galvanometer boom is to one side and allows it to pass; this position of the boom corresponds to a fall of temperature of the controlling bridge. Thus the position of the "hit-or-miss" arm at its lowest position depends on the temperature, and it is the variation of this position which regulates the amount of current passing through the heating coils. When the "hit-or-miss" arm is at its highest position the galvanometer boom is absolutely free to move to its position of equilibrium. We may call the two coils the intermittent and the permanent heating coils. At every rotation of the cam the "hit-or-miss" arm is lowered, and if it passes the galvanometer boom a key is closed and a current passes through the intermittent heating coil. Thus the frequency of the intermittent current depends on the temperature of the oil-bath. The duration of the time that the key is closed also varies, it may be long or very short. Every time the key is closed a movement takes place which increases the duration of the next closure of the key. The arrangement of the mechanism is such that when the temperature is steady the "hit-or-miss" arm will pass the galvanometer boom as many times as it is stopped by it in a given time. The current passing through the permanent heating coil is also automatically regulated: if there is not enough heat passing into the oil, this current is gradually increased. This is done by cutting out resistance coils which are in series with the permanent heating coils. The cam which moves the "hit-or-miss" arm is driven by a worm-gear and any suitable motor, and the oil is kept thoroughly stirred by a fan.

Mr. W. C. D. Whetham asked what accuracy was aimed at in the instrument?

Mr. A. P. Trotter said that the use of thermostats would become more and more important with the perfection of thermometers. It was possible to keep a temperature constant within $\frac{1}{100}$deg. C., but it was very difficult to determine the temperature to that degree of accuracy. In high-class resistance measurements with a Carey Foster bridge one of the greatest difficulties was with regard to the temperature, which must not only be constant but also capable of exact determination. In the constant temperature room at the Board of Trade standardising laboratory the temperature varied by less than $\frac{1}{4}$deg. C. from day to day, and he would like to know the greatest accuracy obtainable with ordinary devices in such a room before considering the introduction of the complicated instrument shown to the meeting.

The **Chairman** expressed his interest in the author's communication, and said he had recently been trying to solve a somewhat similar problem by making use of a horizontal boom, attached to the suspended coil of a galvanometer, for making and breaking a current. His object was to regulate a current of the order of 50 amperes. Dr. Glazebrook asked if it was desirable or important to utilise all the adjustments in the instrument.

The **Author**, replying to Mr. Whetham, said the instrument had been made as sensitive as possible, but he was not aware within what limits it would maintain the temperature of the bath. The thermostat supplied to the Cape Observatory was capable of keeping the temperature within $\frac{1}{100}$deg. C. for a period of eight hours. In reply to the Chairman, he said that when working with small variations of the external temperature it might be possible to dispense with one or other of the adjustments; but when the external variations were large it was necessary at times to supply a large quantity of heat to the oil-bath, and in order to do this effectually he thought all the adjustments of the instrument were desirable.

A paper **"On the Occurrence of Cavitation in Lubrication"** was read by **Mr. S. Skinner.** The experiments described in the paper arose from an observation made when determining the refractive index of a liquid by means of Newton's rings. As Newton showed, the rings can be obtained when a liquid is run into the space between the lenses. If, when the liquid has been introduced, the upper lens be rolled on the lower, the observer sees following the central dark spot a crescent-shaped space, very bright provided the illumination be sufficiently oblique. This is a vacuous or vapour-filled space, for when the motion of rolling ceases the liquid flows into the space and completely fills it. The inflow of the liquid depends in some way on the viscosity, and the effects are more pronounced when a more viscous liquid is used. The most convenient mode of observation is to use a deeply-coloured liquid, and to look at the space by transmitted light. The author has found that a convenient liquid is a strong solution of fuchsin in glycerine. This red solution is so deeply coloured that, even up to the point where the lenses are nearest, some colour shows, and light is only brightly transmitted at the place where there is a break in the liquid. The cavities which are formed must be produced either by splitting the liquid itself, or by tearing the liquid from the glass surface. The effect may be described as a case of "cavitation." Some experiments were made to imitate the actual case of a fully lubricated axle rotating under a bearing. For this purpose, a thick disc with its edge worked to a spherical surface of curvature equal to the radius of the disc, mounted on an axle, was arranged so that the lower part of the disc dipped into an oil-bath, whilst a flat plate of glass rested on the upper edge of the disc. As the disc rotated oil was carried round, so that the point of contact of the disc and plate was maintained copiously lubricated. The disc represented the axle and the plate the bearing on it. What happened on rotation could be observed by looking through the glass plate with a magnifying glass. It was seen that during motion a cavity was formed on the side where the edge of the disc was moving away from the plate. The size of the cavity depended on the rate of rotation. In ball-bearings completely immersed in oil, the experiments show that there must be a small cavity near the point of nearest approach of each ball to its neighbours, and also to the surface on which it is running. As the friction of the bearing is the viscous friction of the oil, it follows that the friction must be considerably reduced by the formation of these cavities, which are filled with relatively non-viscous vapour. The high lubricating property of oils owes its origin not only to their superior viscosity, but also, possibly, to the facility with which cavities may be formed in them.

The author illustrated his paper by a series of experiments showing cavitation produced by rolling lenses on plates.

Prof. J. D. Everett said it was interesting to note that cavitation had been observed and correctly explained by Newton. He (Prof. Everett) mentioned that a similar phenomenon was exhibited by a steam-roller working on mud, and gave an explanation of the production of pressure and tension respectively in the liquid near the contact of the roller and the mud. If the mud were sufficiently viscid, cavitation might occur behind the roller.

Mr. W. A. Price said that the observations of the author could not fail to be of interest to engineers. He asked to what extent cavitation was going on in an ordinary round bearing or in the slide valve of a locomotive, and suggested that the views of engineers upon the subject of lubrication might require considerable modification in the light of the present paper.

Mr. C. V. Boys expressed his interest in the paper and the experiments shown by the author. He said that, like Mr. Price, he had been thinking of the influence of cavitation upon machine bearings, but, unlike him, he had not come to the conclusion that our ideas on the subject should be changed. In the author's experiments cavitation was produced by the approach of two surfaces on one side of their line of contact and their recession on the other side. In the case of a cylindrical bearing the space between the shaft and journal was believed to be completely filled with oil, and if the shaft were truly concentric there would be neither approach nor recession. He thought that in the case of any cylindrical bearing, the rate of approach and recession would never be great enough to produce cavitation. The case of ball-bearings, when using a thick lubricant, was different, and cavitation might occur. If it did, it would occur behind the point of contact, and although the production of cavitation involved a loss of energy he questioned whether it did any appreciable harm. Mr. Boys referred to the dendritic patterns formed, when mixing paints, by lifting the muller from the plate, and suggested that their formation was a phenomenon of the same kind as cavitation.

Mr. R. Appleyard said there were two distinct cases to be considered: (1) a wheel on a plane, and (2) a shaft in its bearing. He agreed with Mr. Boys that the cavitation occurred behind the point o contact and did not matter in the case of a ball-bearing. But if cavitation occurred in a cylindrical bearing, the cavity would form between the two surfaces which were next coming into contact. If the surfaces were smooth little harm would ensue, but if they were rough the occurrence of cavitation would be detrimental, for it would result in direct contact.

Dr. A. Griffiths asked the author if cavitation in lubrication was supposed to be an advantage or a disadvantage.

Mr. Skinner, replying to Mr. Boys, suggested the construction of glass bearings to determine whether cavitation occurred in cylindrical shafts. He thought that cavitation in lubrication was an advantage as a rule, because spaces formerly filled with viscous material were then filled with something with small viscosity.

Prof. R. Threlfall then exhibited and described the following instruments which he has used in the testing of electric generators by air calorimetry: (1) A "hot-wire voltmeter" accurate to $\frac{1}{10}$ volt. The wire in this instrument is very fine, and special precautions are taken to keep the tension on it constant, so that the elongation measured is due only to the expansion of the wire caused by the heating effect of the current. (2) A "Pitot tube" for the measurement of air velocity, the velocity being proportional to the square root of the pressure produced in the tube. (3) A "manometer" for determining pressure differences in Pitot tubes with accuracy. This consists essentially of two bottles containing coloured water, which are connected by a siphon, and the air-space of each bottle is put in communication with its appropriate tube. The readings are taken by setting a pair of needle points just to touch the liquid surface, and then measuring how they differ in level by micrometer screws, or by callipering suitable jaws. The instrument is reliable to 0·01mm. of water pressure. (4) A multiplying pressure gauge, in which the motion of a float or ball is used to operate a finger moving round a dial. The dial is divided in such a manner that the square roots of the pressure differences are read off. Air velocities are therefore given directly.

Mr. Duddell, referring to the voltmeter exhibited, asked if there was any trouble with regard to the temperature variation of the resistance of the wire. In using the instrument with large alternating currents it was necessary to use a standard shunt, and difficulties then arose because of the fact that the self-induction of a shunt, formed of straight bars and capable of carrying the necessary current, was comparable with its resistance. It might be possible to get a satisfactory

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shunt by doubling the bars upon themselves to reduce the self-induction.

Prof. Threlfall said that there was no difficulty with regard to changes in temperature of the room, because they only altered the zero of the instrument. Referring to the possibility of constructing a low-resistance standard shunt, he said he had calculated the self-induction of the bars forming his shunts, and had come to the conclusion that it was negligible in his experiments. Experimentally he had found that it could not produce an error of 1 per cent. It might be possible to so design a shunt that the mutual induction of its parts would balance the self-induction to a certain extent.

LONDON TRAFFIC ENQUIRY.

The Royal Commission on London Locomotion sat again on Thursday and Friday last week at the Westminster Palace Hotel, Sir David Barbour in the chair.

Mr. Arthur Harrison, borough engineer and surveyor of Southwark, said that the danger arising from costermongers' stalls in the streets was enhanced in the roads along which the electric tramways of the London County Council ran. He urged that the control of the streets by borough councils should not be reduced, but increased, and extra powers should also be given with regard to the opening of trenches, etc. He though the appointment of a board of locomotion was desirable On the question of the veto on tramways, the witness was of opinion that that should be retained by the borough councils. It would be utilised by them with great care.

Lord Ribblesdale: Do you object to having the veto removed because it would deprive you of the power of bargaining which you at present possess?—No, I do not think a bargain has been made with a company, but the veto gives us the power to say that a tramway must be made in such a way as to provide for other traffic.

Mr. R. M. Prescott, town clerk of the borough of Fulham, having given evidence,

Mr. Norman Scorgie, borough engineer and surveyor of the borough of Hackney, gave some interesting figures with regard to the breaking up of roads. In the two years ended Sept. 30, 1903, the Gaslight and Coke Company made 5,981 openings in the street, disturbing 81,773 square feet; the East London Water Company, 2,347 openings, covering 35,880 square feet; the New River Company, 1,833 openings, covering 34,236 square feet; and the Borough Council, including a few by the Post Office Telegraphs Department and the London County Council, 1,113 openings, covering 29,710 square feet. The companies should be required, except in cases of emergency, to obtain the consent of the borough councils before making street openings. The controlling power of the borough council should extend over all bodies having authority to open streets, including the London County Council. No curtailment of the powers of veto over tramway schemes was desirable. Only in one instance had the Hackney Borough Council thought fit to refuse consent. There was an absolute necessity for increased means of communication between the City and the North-East of London. Schemes such as that promoted by the City and North-East Suburban Railway would meet the want. The proposed line to Chequers-green would afford speedy access to the City, and the north-east branch to Waltham would provide for the districts around Victoria Park and Hackney Wick. He was directed by his Council to urge that powers should be given to construct such lines without delay.

Councillor Levy, of the Hammersmith Borough Council, gave evidence on behalf of that body. He stated that there was considerable congestion of traffic, both vehicular and pedestrian, in Uxbridge-road, due to the fact that the termini of the Tube Railway and the electric tramways were at the same point. The widening of Hammersmith-broadway was provided for in the London County Council's Tramways Act, 1903, and when effected it would doubtless afford relief under present conditions, but should any of the contemplated tube railways to Piccadilly be constructed, and the terminal station be placed in the Broadway, as had been suggested, a further widening to provide for the increased pedestrian traffic created thereby might be necessary, in which case the promoters of the railway should be required to bear the cost thereof. The congestion in Uxbridge-road might possibly be relieved by a rearrangement of the tramway terminus, and the pedestrian traffic would undoubtedly be lessened by the extension of the Central London Railway in a half-circle to near Hammersmith-broadway, with a station at an intermediate point at the end. An underground electric railway was much needed between Hammersmith and the City, *via* Kensington, Knightsbridge, Piccadilly, and Charing Cross; also a direct and improved service from Hammersmith Station of the North and South-Western Junction Railway to stations on the North London Railway and to the City, and an improved service to Waterloo, Ludgate-hill, and Clapham Junction on the London and South-Western Railway. At the present time both services were infrequent.

Mr. J. Patten Barber, borough engineer of Islington, gave similar evidence to that of the representatives of other borough councils as to powers of regulating the unloading of barrels and coal, the obstruction of streets due to street markets, and the breaking up streets by statutory companies. Much of the delay and danger now existing in crowded thoroughfares would be prevented by proper widenings and the provision of secondary streets.

Mr. William Eve, alderman of the borough of Stoke Newington, said that he and the Council he represented thought it was absolutely necessary that one authority should have full power of applying to Parliament for powers to construct tramways in London. No well-arranged scheme could be carried out whilst any one borough could prevent, by its veto, an application to Parliament for the construction of a tramway within its area. While any irresponsible person could apply to Parliament for authority even to alter the level of any main thoroughfare or to make a level crossing over it, the London County Council had no power to apply for authority to construct a new tramway unless the road authorities gave their consent. The result was that either good projects had to be abandoned or the London County Council had to consent to onerous conditions to the prejudice of other ratepayers.

The Commission adjourned.

LEGAL INTELLIGENCE.

GREAT NORTHERN AND CITY RAILWAY.

Mr. Justice Wright, sitting in the High Court on Tuesday, disposed of the case of Dawson *v.* the Great Northern and City Railway. The action was originally brought and judgment obtained by the plaintiff at an enquiry held for the purpose of assessing the damage caused to premises in the City-road and stock-in-trade as the result of subsidences consequent upon the construction by the railway company of tunnels for an underground railway; £2,100 was awarded for structural damage and £2,000 for the stock (drapery), and it was agreed that the total amount of £4,100 should be allocated in thirds to the parties interested. The question for the Court now to decide was whether the plaintiff could show title to the amounts which had been ascertained.

His Lordship found for the plaintiff sums amounting to £1,366; but the company having paid £2,000 into court, with a denial of liability, judgment was entered in their favour, with costs.

FERRANTI LIMITED.

On Saturday, in the Chancery Division, Mr. Justice Joyce had before him the action of Poole *v.* Stirling and Ferranti Limited, which came on as a motion for judgment.

Mr. Vernon, for the plaintiff, said the action was brought by debenture stock holders to enforce their security. The defendants (Stirling and Jones) were the trustees for the stockholders, and Parr's Bank were second encumbrancers, they holding a debenture for £30,000, ranking after the debenture stock. Stirling and Jones consented to judgment, and so did the bank, but the company had not put in a defence. The debenture stock, to the amount of £100,000, was issued in November, 1901. The security had not yet become enforceable, and noi nterest was in arrear, but the company was insolvent.

His Lordship made a declaration that the trusts of the debenture stock deed should be carried into effect, and directed the usual accounts and enquiries to be taken.

ALLEGED THEFT OF ELECTRICITY.

At Bow-street Police Court Sir A. de Rutzen heard a charge preferred against George Walter Lawrence, described as an electrical engineer, of stealing electricity to the value of 10s. from Messrs. Coon and Clarke, engravers, of 401, Strand.

Mr. E. Wilmot Seale watched the proceedings on behalf of the Charing Cross and Strand Electricity Supply Corporation.

Detective-Inspector Drew deposed that, in consequence of something which he heard, he went, with Detective-Sergeant Stephens, to 401, Strand, and there saw the prisoner in a top room, which he occupied. An electric lamp was burning in the room, and witness asked him where he got his light from. He replied that he had permission from his landlord to connect the lamp with his wire. The officer told the accused he had information that it was connected with the wire of Messrs. Coon and Clarke, who occupied the floor immediately below, and he admitted that that was true, saying that he did it about two months ago, as he had some bother with his lamp.

On this evidence the prisoner was remanded.

DAMAGES AGAINST THE DUBLIN TRAMWAYS COMPANY.

In the Nisi Prius Court (Dublin) Mr. Justice Madden and a city special jury heard a claim by Josephine O'Brien against the Dublin United Tramways Company to recover damages for injuries sustained by her while riding in one of the defendant company's tramcars on Aug. 23. The plaintiff claimed £1,000 damages. The defendant company denied negligence.

Sir Thomas Myles, ex-president of the Royal College of Surgeons, said the plaintiff was suffering from an internal injury, which he believed was incurable.

Mr. O'Brien, for the defence, admitted that the company were liable, but urged that the damages ought to be moderate.

The jury found for the plaintiff, damages £1,000, and judgment was given accordingly.

A TELEPHONE DISPUTE.

The case of the National Telephone Company *v.* Phelps was mentioned to Mr. Justice Farwell in the Chancery Division on Friday.

Mr. Upjohn, K.C., said an injunction had been granted *ex parte* to be continued until that day, and it was now proposed that it should be continued till the trial. In this case Mr. Phelps claimed the right to disconnect the cable of the National Telephone Company, which served some 66 subscribers, and if that were done considerable public inconvenience might arise.

Mr. Jenkins, K.C., said that the point between his learned friend and himself had been quite clearly defined, and he suggested that the case should be put in the witness list. The only issue was whether the plaintiffs were entitled to maintain a certain cable and any apparatus that might be connected therewith upon certain premises in Southampton-row.

The case was ordered to be set down in the witness list.

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COMPANIES' MEETINGS AND REPORTS.

NERNST ELECTRIC LIGHT.

The report of the directors for the year ended Sept. 30, 1903, states that the return of lamps sold in the Company's districts, as well as in England, during the period under review, shows an increase, and the working expenses have been further reduced. As the experimental shops and laboratory have been closed owing to the altered policy of the Company, the directors, acting on the advice of their auditors, have added the sum which previously appeared on the balance-sheet under these headings to the development suspense account, which thus stands at £17,355. As it is clear that a considerable proportion of the above will have to be met before future profits can be distributed, the directors are of opinion that the balance is not available for dividends. The Board consider that the shareholders would be acting wisely in reducing the capital of the Company so that it might represent more accurately the available assets. As already announced, the scheme formulated by a section of the shareholders commends itself to the directors as an equitable basis for distribution between the two classes of shares. The directors regret to announce the retirement of Mr. Hugo Hirst from the Board. Mr. R. J. Wallis-Jones and Mr. A. M. Oppenheimer have been elected as directors.

ISLE OF THANET ELECTRIC TRAMWAYS.

The report of the directors for the year ending Sept. 30 last shows a balance at credit of profit and loss account of £12,304. Traffic receipts amounted to £33,465, as against £35,088 for the corresponding period of last year, a decrease of £1,623, which was entirely due to the inclemency of the weather during the summer and autumn. To pay the debenture interest, dividend on preference shares, interest on loan, fees to debenture trustees and income tax, an additional sum of £3,403 was required, which has been taken from the unappropriated balance at the credit of last year's revenue account. From this balance also a sum of £1,853 has been written off for compensation for accidents, and for other charges in the previous year. These were only ascertained after last year's accounts were closed, and the further sum of £500 has been written off "improvement of cars." The balance of last year's revenue account now stands at £5,047, which is carried forward. The Company has been insured against accidents to third parties since June 16, 1903.

INDIA RUBBER, GUTTA PERCHA, AND TELEGRAPH WORKS.

The directors' report for the year ending Sept. 30, 1903, show, after provision for doubtful debts, a net profit for the past 12 months of £54,568. 16s. 3d. Adding £62,361. 11s. 7d. brought forward, and deducting £12,500 interim dividend paid in June, there remains a disposable balance of £104,430. 7s. 10d. The directors recommend the distribution of a dividend of 15s. a share, free of income tax, amounting to £37,500, making, with the interim dividend paid in June, a total payment of 10 per cent. for the year, and leaving £66,930. 7s. 10d. to be carried forward. The general business shows a falling off when compared with last year. To a great extent this is due to the general depression existing in trade, as a result of which competition has been, if anything, keener than usual. The cable to connect San Francisco with the Sandwich Islands, referred to in the last report, was laid for the Commercial Pacific Cable Company by the cable steamer "Silvertown" on Jan. 1 last. The "Dacia" and the "Buccaneer" have been employed in cable repairing work during the year. The works at Silvertown and Persan have been maintained in their usual state of efficiency, and extensions continue to be made. The Company's Act for the amendment of the memorandum of association received the Royal assent on June 30 last. The ground lease for a term of 28½ years of the Cannon-street premises has been purchased. The Company holds a considerable interest in the Palmer Tyre, Limited, and has designed a new motor tyre which attracted a good deal of attention at the recent Stanley Show.

NEW COMPANIES REGISTERED.

Electrophone, Limited.—Capital, £15,000. Object: to acquire and work the undertaking known as Electrophone, Limited.

Derby Electrical Company, Limited.—Capital, £1,000. Object: to acquire and carry on the business of an electrical engineer. Registered office: St. George's Engineering Works, Wood's lane, Derby.

B. B. B. Rubber and Gutta Percha Company, Limited.—Capital, £6,000. Object: to carry on in Great Britain and elsewhere the business of manufacturers of and dealers in rubber and guttapercha goods. Registered office: 8, Church-street, Coatbridge.

White and Hemphill, Limited.—Capital, £10,000. Objects: to acquire the business of William White and Son, of 34, Roxburgh-street, Greenock, and to carry on the business of iron and brass founders, mechanical and electrical engineers, boilermakers, etc. Registered office: 34, Roxburgh-street, Greenock.

Bukit Rajah Rubber Company, Limited (79,314).—Capital, £70,000. Objects: to acquire the estates in the district of Klang, in Selangor, Straits Settlements, known as Bukit Rajah, Sungei Binjai, New Eskdale, Delabole, Bukit Duku, and Booneans; to plant, grow, produce, prepare for market, and deal in indiarubber, guttapercha, etc.

British Johns-Manville Company, Limited (79,272).—Capital, £5,000. Object: to carry on the business of dealers in and importers, exporters, and manufacturers of all kinds of electric, magnetic, galvanic, chemical, and other machinery, apparatus, and appliances, materials, and substances used by electrical and other engineers, etc. Office: 81, Fenchurch-street, E.C.

CONTRACTS FOR ELECTRICAL SUPPLIES.

Preston.—The Corporation invite tenders for a traction switchboard and accessories. Tenders by Dec. 12. See advertisement in former issue.

London, N.—The Hornsey Borough Council invite tenders for the supply of 100 cast-iron lamp columns. Specifications from the Surveyor. Tenders by 14th inst.

Wiring.—The Scottish office of the May-Oatway Fire Appliances, Limited, invite tenders for wiring of buildings for the May-Oatway fire alarms. See advertisement.

Barcelona.—The Harbour Works Commissioners require tenders for installation of electric light and power by Feb. 15. Particulars may be obtained from the Commissioners.

Pontypridd.—The Urban District Council invite tenders for free wiring, and for Section O, the supply of tramcars. Tenders by 24th inst. See advertisement in last issue.

Stockton-on-Tees.—The Corporation invite offers for hiring or hire-purchase system for motors to be fixed on their mains. Tenders by 15th inst. See advertisement in last issue.

Govan.—The Corporation invite tenders for the supply, delivery, and erection of coal bunkers, conveyor, and electric capstan. Tenders by 28th inst. See advertisement in last issue.

Colchester.—Tenders are invited for erection of electrical works at Hythe Causeway, Colchester. Specifications, etc., from Mr. Ernest R. Beckwith, architect, 10, Trinity-street, Colchester.

Stockport.—The Electricity Committee invite tenders for supply of 3in. and 4in. cast-iron mains, and for irregulars from 3in. to 6in. Specifications from the Engineer. Tenders by 16th inst.

Peteringa (Croatia).—The Municipality require tenders for installation and working of electric lighting; 6 to 8 arc and 160 to 180 incandescent lamps are required for the street-lighting.

Greenwich.—The London County Council invite tenders for six electrically-driven three-throw boiler feed pumps. Specifications, etc., at the County Hall, Spring-gardens, S.W. Tenders by Jan. 19.

Plasencia.—The Municipality require tenders for electric lighting of the town for 12 years by 26th inst. Particulars from the above authority, Casas Consistoriales, Plasencia, Province of Carceres, Spain.

London, E.C.—The East Indian Railway Company invite tenders for the supply and delivery of electric plant for a lighting installation. Specifications from Company's Offices. Tenders by 12 noon on 23rd inst.

Hackney.—The Council invite tenders for feeding and distributing mains. Specifications from Mr. Robert Hammond, M.I.C.E., 64, Victoria-street, Westminster, S.W. Tenders by Jan. 4, 1904. See advertisement.

Sydney (N.S.W.).—Tenders are asked for the supply of continuous and alternating current meters. Specifications, conditions, and forms of tender are obtainable from Messrs. Preece and Cardew, 8, Queen Anne's-gate, S.W.

Warrington.—The Electricity Committee invite tenders for the supply of earthenware ducts for the drawing-in system of mains. Specifications from the Electrical Engineer, Howley, Warrington. Tenders by 14th inst.

Camberwell.—The Borough Council invite tenders for the maintenance of electric bells and private telephones. Forms of tender from Mr. W. Oxtoby, borough engineer, Town Hall, Camberwell, S.E. Tenders by 5.30 p.m. on Jan. 18

Bradford.—The Corporation invite tenders for an installation of electric lighting at the new district baths, Drummond-road. Specifications, etc., from City Architect, Whitaker-buildings, Brewery-street. Tenders by 12 noon on 14th inst.

Erith (Kent).—The Urban District Council invite tenders for the execution of all installation work required under their assisted wiring scheme for period ending Dec. 31, 1904. Specifications, etc., from Mr. Geo. E. Heath, electrical engineer. Tenders by 4 p.m. on 14th inst.

Christchurch (New Zealand).—Tenders are invited for the complete installation of electrical tramways, other than buildings. Specifications, etc., may be obtained from the Agent-General for New Zealand, Victoria-street, S.W. Tenders by March 17. See advertisement.

Culiacan (Mexico).—Tenders are invited for lighting the town by electricity: 60 arc lamps of 1,200 c.p. and 110 incandescents of 50, 30, and 16 c.p. will be required. Propositions will be received by letter until Dec. 31 in the Secretaria del Ayuntamiento, Culiacan, where further information may be obtained.

West Ham.—The Education Committee invite tenders for the electric wiring and fittings and for the hot-water heating apparatus required at the Whalebone-lane Higher Elementary School, Stratford, E., and Shipman-road School, Custom House, E., now in course of erection. Tenders by Dec. 14. See advertisement in former issue.

Leicester.—The Gas and Electric Lighting Committee invite tenders for the supply and delivery of the necessary cast-iron pipes

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and connections, from 2in. to 36in. in diameter, required during 12 months ending Dec. 31, 1904. Specifications from Mr. Alfred Colson, M.I.C E., M.I.E.E., engineer and manager. Tenders by 11 a.m. on 12th inst.

Enniscorthy (Ireland).—The District Lunatic Asylum Committee invite tenders for the following works: generator and motor-generator converter; motor and motor pumps; accumulators; main switchboards; overhead conductors and telephone; gearing and shafting; wiring asylum. Specifications, etc., at the Asylum Office. Tenders by Jan. 20.

Manchester.—The Tramways Committee invite tenders for the supply of electrical stores, etc., comprising cable; commutators, etc.; armatures, controllers, etc.; armature repairing material; fuses; ironmongery; rubber, etc.; trolley cord. Specifications from Mr. J. M. M'Elroy, Tramways Department, 55, Piccadilly, Manchester. Tenders by 10 a.m. on 15th inst.

London, S.W.—The London County Council invite tenders for the supply and delivery of about 6,850 tons of steel girder tramway rails, fishplates, and bolts and nuts, and for 4,100 tons of steel slot rails, and 1,490 tons of steel conductor tee rails required for electric traction on the Council's tramways. Specifications, etc., from Engineers' Department, and tenders to the Clerk, County Hall, Spring-gardens, by Dec. 15.

Sydney (New South Wales).—Tenders will be received at the office of the Deputy Postmaster-General, Sydney, New South Wales, up to 2.30 p.m. on Dec. 30, for the supply and delivery at the departmental stores, Sydney, of telegraph, telephone, and electric light material. Specifications, etc., may be seen and tender forms obtained at the General Post Offices, Sydney, Melbourne, Brisbane, Adelaide, Hobart, and Perth.

Harrismith (South Africa).—The Town Council invite tenders for high-tension concentric feeder cable, low-tension triple-concentric distributor cable, low-tension service and street-lighting cables, joint-boxes, service boxes, and other accessories, and the supply of five 30-kw. transformers, four transformer pillars, high and low tension switchgear, etc. Specifications from Messrs. Mordey and Dawbarn, 82, Victoria-street, Westminster. Tenders by Jan. 18.

Portugal.—The *Diario do Governo* of Dec 2 contains an announcement that the project presented by the United Gas and Electricity Companies for the establishment of electric light in the new highway surrounding Lisbon will be on view for 15 days from Dec. 2, within which time reclamations have to be made. The *Diario* containing the above notice may be seen by those interested on application at the Commercial Intelligence Branch of the Board of Trade, 50, Parliament-street, S.W., any day between the hours of 10 a.m. and 5 p.m. (Saturdays, 10 a.m. to 1 p.m.).

RESULTS OF TENDERS.

Leeds.—The Markets Committee have accepted the tender of R. Middleton, Leeds, at £457. 11s., for an electric lift to hotel at New Market Hall.

Whitehaven.—The tender of H. Burns and Sons, Duke-street, Whitehaven, has been accepted for installing electric light and bells in six houses in Wellington-row.

Todmorden.—The Corporation have accepted the tender of Bruce Peebles and Co., Limited, for one 150-kw. steam set, one 75-kw. steam set, and one balancing booster set.

Leeds.—The Street-Lighting Department have accepted the tender of V. Roberts, Skinner-lane, Leeds, at £220, for installing a heating plant at the new offices and workshops at Springwell.

London.—The tender of Bruce Peebles and Co., Limited, has been accepted by the War Office for two 400-h.p. slow-speed continuous-current generators, 100 revolutions, direct-coupled to Robey engines.

King's Heath (near Birmingham).—The Urban District Council have accepted the tender of W. H. Gibbs, King's Heath, at £3,185, for erection of waiting-room and car-shed to accommodate eight cars, etc.

Whitehaven.—The Guardians have accepted the tender of Ramsay Bros., Phœnix Works, Whitehaven, at £432. 10s., for wiring and fitting up for electric light the workhouse and new infirmary at Whitehaven.

Barrow-in-Furness.—The Education Committee have accepted the tender of W. R. Thornton and Son, Ramsden-square, at £15. 12s., for the electrical lighting of the chemical laboratory in the higher-grade school.

Whitehaven.—The tender of H. Burns and Co., Lowther-street, Whitehaven, has been accepted for an installation of electric light in the new Sunday school, classrooms, etc., connected with Hogarth Mission.

Newport (Mon.).—Messrs. W. A. Baker and Co., Limited, have accepted the tender of Messrs. Johnson and Philips, Limited, at £381, for the supply of motors for changing the voltage of the electric current.

Brighton.—The Tramways Committee have accepted the tender of Dick, Kerr, and Co., Limited, for 10 cars at £5,100, and of the Brush Electrical Engineering Company, Limited, Falcon Works, Loughborough, for 10 cars at £5,085.

Blackpool.—The British Westinghouse Electric and Manufacturing Company, of Trafford Park, have placed an order with Messrs. Browett, Lindley, and Co., Limited, of Patricroft, for a 650-h.p. triple-expansion engine, for the Blackpool Corporation.

Oldham.—The Electricity Committee have accepted the tender of E. Stephenson, Shield-street, for the construction of pump-house, lodge, and tanks in connection with condensing plant, the construction of mains tunnel, footpath, and railings round site at the generating station, Greenhill.

Wednesbury.—The Town Council have accepted the tender of the National Electric Construction Company, Limited, of London and Wolverhampton, for supplying and fixing the electric wiring and fittings in the Wednesbury town hall, the municipal offices, the art gallery, public baths, and free library, for £464. 18s.

Dudley Port.—The Power Gas Corporation, Limited, have placed an order with the British Westinghouse Electric and Manufacturing Company, Limited, for the supply of two 250-h.p. three-cylinder single-acting producer-gas engines, solid-coupled to direct-current generators of equivalent power, to be installed at Dudley Port.

Swansea.—The Tramways and Electric Lighting Committee have recommended that the whole contract for tramway extensions be given to Messrs. Dick, Kerr, and Co., the amount being £81,751. All additions and deductions to be at schedule rates, subject to 2½ per cent. The firm to accept such cable as may be accepted by the Corporation at makers' prices.

Middlesbrough.—The Corporation have accepted the tender of the Brush Electrical Engineering Company, at £3,488. 10s., for the engine-house plant. Since the recommendation of the acceptance of the tender for boilers, the Horsfield Company intimated that there had been a mistake, and that they should have quoted £100 more, consequently Messrs. Hewett and Kellet's tender has been accepted.

Maidstone.—The Corporation have placed an order with the British Westinghouse Electric and Manufacturing Company for two 150-kw. shunt-compound generators for coupling to Messrs. Davey-Paxman's engines. These generators will deliver 300 amperes at 460 to 500 volts as shunt machines, and 275 amperes at 500 to 550 volts as compound machines. They will thus be available for either lighting or traction.

Swindon.—The Electricity and Tramways Committee have accepted the following tenders: J. G. White and Co., Limited, at £4,164. 8s. 7d., for steel poles, overhead line, etc.; the British Westinghouse Electric Manufacturing Company, Limited, at £750, for traction switchboard; the British Insulated and Helsby Cables Company, Limited, at £1,190. 9s., for tramway feeders, etc., including a two years' maintenance.

Kilmarnock.—The following tenders have been accepted by the Electrical Committee for plant required in connection with the proposed new generating station at Kilmarnock: boilers, Yates and Thom, Blackburn, £1,765; engines and dynamos, Dick, Kerr, and Co., Limited, London, £3,855; overhead crane, Carrick and Ritchie, Edinburgh, £268; storage battery, Tudor Accumulator Company, Limited, London, £1,201; switchboard and boosters, Cox-Walkers, Darlington, £1,989.

Burslem.—The Electric Lighting Committee have received the following tenders for the erection and completion of the generating station at Longport:

W. Grant and Sons, Burslem (accepted)	£2,100
W. Cook, Burslem	2,160
Bennett Bros., Burslem	2,168
T. Godwin, Hanley	2,235

BUSINESS NOTES.

TRACTION.

Woking.—The estimated cost of the Woking and Bagshot Light Railway is £82,504.

Blackburn.—The tramway extension into the Audley district has been formally opened for traffic.

Hackney.—The Borough Council are recommended to approve the proposed tramway along Amhurst-road.

Dalton.—The Urban District Council are urging the Barrow Corporation to extend the tramways into their district.

Bournemouth.—The Corporation tramways show a net profit for the six months ending September last of nearly £7,000.

Hastings.—Estimates of the quantities of materials required for the construction of the proposed tramways are now being prepared.

Rome.—The electric tramcars in Rome are now fitted with postal boxes, the contents of which are collected every quarter of an hour.

Mearns.—At a public meeting held in Mearns, it was agreed to ask the Glasgow Corporation to extend their tramway system to that district.

Folkestone.—The Town Council will apply to the Board of Trade for an order amending the 1901 order for the construction of tramways in the town.

Bath.—The British Westinghouse Company have received a further order for a number of complete magnetic brake equipments for the electric tramways.

Dartford.—The Board of Trade have confirmed the Dartford light railway extension order, authorising the construction of a light railway in the rural district of Dartford.

Walker.—The Town Council have decided to obtain a *locus standi* relative to the Bills of the Tyneside Tramways Company and the Newcastle Corporation to be introduced next year.

St. Marylebone.—The Borough Council are recommended by their Parliamentary Committee to adhere to their previous decision not to consent to the proposed Tottenham Court-road tramway.

Portsmouth.—There is a prospect of the present fares on the Corporation trams being considerably reduced owing to overtures which the Horndean Light Railway Company are making to this end.

Stalybridge.—The Stalybridge, Hyde, etc., Tramways Board propose to extend the tramways from Millbrook to Mossley. A sub-committee is considering the question of lighting the car-sheds.

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Finchley.—It is believed that the power-house for supplying the trams with electric energy will be erected in the parish of Enfield. A sub-station will be established in Finchley on a site to be purchased.

Penarth.—The estimated maximum cost of the construction of a tramway between Cardiff and Penarth is put at £250,000. No decision has yet been come to either in favour or opposition to the scheme.

Leith.—At an extraordinary general meeting of the Edinburgh Street Tramways Company on Wednesday the shareholders confirmed the sale of the Leith tramways concern to the Town Council of Leith for £60,000.

Dunedin (N.Z.).—In connection with the electric tram service the City Council will instal another unit at the power-house at a cost of £1,400. This will ensure a continuous supply throughout the city and suburbs.

Preston.—The Hadfield's Steelfoundry Company, Limited, East Hecla Works, Tinsley, Sheffield, have received an order from Messrs. Dick, Kerr, and Co., Limited, for the points, crossings, etc, for the electric tramways.

Hove.—The Tramways Committee recommend the Council to refuse to entertain the proposal of the British Electric Traction Company to extend their tramways from the boundary of Hove and Aldrington to the railway station at Hove.

Rochdale.—The Corporation have authorised advertising on the electric cars. Some delay is likely to take place in fixing the value of the company's undertaking owing to the lamented death of Sir Frederick Bramwell, the arbitrator appointed.

Blackpool, St. Annes, and Lytham Tramways Co.—The directors of the Company report that the doubling of the line and its equipment for overhead traction has resulted in satisfactory receipts. It is proposed to carry the balance of £2,017 forward.

British Electric Traction Co.—The directors have declared the interim dividend to Sept. 30 last on the ordinary shares at the rate of 6 per cent. per annum, being at the same rate as in preceding years. The warrants will be payable on and after the 16th inst.

Perth.—The Town Council have definitely decided to appoint a consulting engineer to advise them in the reconstruction of the tramways system. The actual work of the reconstruction will be undertaken by the burgh surveyor and the electrical engineer.

Lowestoft.—The Corporation have ordered four more double-deck cars, equipped with motors and controllers of the Westinghouse 46 and 90 types respectively, from the British Westinghouse Company. The new cars will be similar to those already supplied by the company.

Bradford.—A committee has been empowered to negotiate for the purchase of 18,050 yards of land near to Foundry-lane and Bowling Back-lane, to be converted into a storeyard and sidings for trams. The Tramways Committee have approved plans and estimates amounting to £1,839 for the provision of special tramway facilities for the Cartwright Memorial Hall Exhibition.

Hull.—The Tramways Committee are experimenting with two collapsible car covers—one the invention of Mr. Kennington, the other known as the "Magrini," and built by Messrs. Milnes and Co. The Hedon-road route will be opened for traffic about the end of next week. There will then be six routes in operation in the city, exclusive of the section between Whitefriargate and Victoria Pier.

Liverpool.—The proposed tramway extensions, involving an expenditure to the Tramways Committee of £10,000, were under consideration at Wednesday's meeting of the Town Council, and a motion in favour of applying for a provisional order was negatived by 46 votes to 43. The necessary two-thirds of the members, however, were not present, and the proceedings are, therefore, abortive.

Derby.—There is a delay in the delivery of the rails for the tramways which the Corporation are getting from Belgium, and at the last meeting of the Tramways Committee it was asked whether any rails had been condemned. The official reply was to the effect that no rails had yet been delivered, and that the Corporation had a representative in Belgium who would not pass the rails unless they came up to the required standard.

Nelson.—A sub-committee has been appointed to consider the terms of lease of the Nelson section of the tramways to the Burnley Corporation. The Board of Trade have confirmed the order made by the Light Railway Commissioners transferring to the Corporation the powers conferred upon the Barrowford Urban District Council by the Barrowford Light Railway Order, 1901, and amending that order and the Nelson Light Railways Order, 1901.

Southport.—The Southport and Lytham Tramroad Company propose to deposit a Bill for a short extension of the time for constructing the proposed tramways, and also a clause empowering the Corporation, with other local authorities, to subscribe for shares or debentures in the company. The Corporation will support the application. Experiments are being made with a car which is so designed that a conductor is not required. It is popularly called the "one man car."

Yorks.—The Yorkshire Electric Tramways Construction Syndicate, Limited—a Wakefield company—intend to apply to the Light Railway Commissioners for powers to construct a light railway or tramway from Church-street, Dewsbury, along Vicarage-road and Long Causeway into Dewsbury Market-place, and then up Wakefield-road, through Bank Top, Chickenley Heath, Ossett-street Side, and Dale-street, Ossett, into Station-road, Ossett, with a junction into and along Bank-street, Ossett.

Cardiff.—Mr. Arthur Ellis, the electrical engineer, submitted to a special meeting of the Tramways Committee on Tuesday a revised list of fares which has been concerted with the object of equalising the distance[illegible]mmittee, after some discussion, adopte[illegible] into operation on Jan. 1, and will re[illegible] The electrical engineer depre-

cated the introduction of the transfer system, pointing out that it was very often abused.

Pontypridd.—At the last meeting of the District Council a letter was read from the British Electric Traction Company, stating their inability to accept the terms offered by the Council in regard to the horse tramway from Pontypridd to Hafod. It was resolved to apply to the Board of Trade to appoint a referee, and to ask for a more detailed report from the company of the property proposed to be purchased. The amount offered was £2,370.

Army Tractors.—Messrs. R Hornsby and Sons, Limited, of the Spittlegate Ironworks, Grantham, have received official information from the War Office that their engine has won the first prize of £1,000 and bonuses amounting to £180 in the open competition for military tractors. It is an oil tractor, propelled by an oil-engine of the Hornsby-Akroyd type, constructed on the lines of an ordinary traction engine, spring mounted at both ends, and fitted with the usual speed-change gears. Its weight with fuel and water does not exceed 13 tons.

West London.—The London United Tramways have given a further order to the British Westinghouse Company for sub-station plant, including two 250-kw. rotary converters, seven 100-kw. oil-insulated self-cooling transformers, a switchboard for the control of the above apparatus, and the necessary details. A large number of rotary converters are now going through the Westinghouse shops, including 500-kw., 800-kw., 1,200-kw., and 1,500-kw. units, for, *inter alia*, the District Railway, Metropolitan Railway, and North-Eastern Railway.

Walsall.—An official inspection of the new tramways constructed by the Corporation has been made by Lieut.-Colonel Yorke on behalf of the Board of Trade. The lines are to Walsall Wood, Willenhall, and along the Birmingham-road to the borough boundary. The working of the lines will commence at the beginning of the new year, when the Corporation also take over the tramways within the borough at at present let on lease to the South Staffordshire Tramways Company. Altogether rather over 12 miles of tramways in the district will be under municipal control.

Sheffield.—The Tramways Committee, with the assent of the Corporation, have recently made a grant of £5,000 out of their profits to the Sheffield University endowment fund. The construction of the single line in Shoreham-street is to be proceeded with at once, also along Suffolk road, Queen's-road, and Bridge-street. Alderman Clegg, at Wednesday's meeting of the Town Council, paid a tribute to the services rendered the Tramways Committee by Mr. Fell, who is about to vacate the position of tramways manager to take up a similar post with the London County Council.

Swansea.—The Tramways Committee propose to appoint two inspectors to superintend the laying of the rails and to continue the engagement of an assistant surveyor in connection with the new tramways. Major Druitt, who has been enquiring into the objections of the Oxford-street tradesmen to a tramway being laid through that street, has issued his report stating that the Board of Trade cannot interfere, having regard to the powers held by the Corporation, and leaving it to the latter to decide whether they, in the face of strong opposition, will construct the tramway in question.

Richmond.—After having debated the question at various meetings within the last few months, the Tramways Committee have decided to recommend the Town Council to give their consent to the company to construct lines over Kew Bridge connecting the authorised and constructed lines on either side of it. This the Council decided to do on Wednesday on conditions which include a bond of £10,000 to complete the line within 12 months. By a supplementary scheme, for which the company will seek parliamentary powers next session, it is proposed to link up Hammersmith with Barnes, Mortlake, and Richmond.

Eastbourne.—At the last meeting of the Town Council a councillor advocated the introduction of electric trams, and assured the Council that if they did not take the necessary steps the people in the east end would invite a company to introduce an electric tramway system. The motor 'buses had not begun to come up with the 'buses they had driven off the road. The 'buses rushed by without taking the slightest notice of would-be passengers, and it was very difficult, unless one had the agility of a hound, to overtake them. The Mayor ruled discussion out of order, but promised that the resolution of the recent mass meeting in favour of trams should be considered by the committee.

Wolverhampton.—A special meeting of the Town Council has been held to consider the details of a Bill proposed to be promoted in the next session of Parliament to empower the Corporation to construct tramways, and make further provision with regard to their electricity undertaking. It is proposed to make tramway extensions in the direction of Wednesfield, at a cost of £11,000, to reconstruct a bridge over the canal at a cost of £2,000, purchase land for shelters, etc., at a cost of £300, and widen Queen-square and Victoria-street and erect buildings at a cost of £30,000. The Council approved the preamble of the Bill, and also several clauses relative to the tramways.

Salford.—Complaints were made against the management of the tramways at the last meeting of the Town Council, and the Chairman of the Committee, replying, stated that they at the present time were studying economy in every possible direction, by reason of the fact that during the recent bad weather the receipts of the tramway undertaking had shown a decrease of £400 a week. He contended that the complaints that had been levelled against the management of the Salford tramways applied with equal force to the management of Manchester and other towns. He added that the committee had found from experience that the short routes did not pay so well as the long routes.

Bury.—The line in Bolton-road is to be doubled, and the Fairfield section from opposite the Brown Cow to the workhouse boundary extended. It is decided to proceed with the work of construction on those routes not interfered with by the present tramway company. Specifications have been prepared and tenders obtained for the supply

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and delivery of rails, fishplates, fishbolts, anchor plates, tiebars, points and crossings, and bonds. Various interviews have taken place with the authorities of Whitefield and Radcliffe in reference to the construction and working of the tramways within their districts in conjunction with the Bury Corporation tramways, but nothing has yet been decided.

North-Eastern Railway.—The North-Eastern Railway Company on Sunday carried out further trials on the newly-electrified line between Newcastle and Monk Seaton Station. The distance is about 10 miles, double track. The trials continued from morning until after darkness fell and were thoroughly satisfactory. The experimental train was made up of two motorcars and two trailers. Several runs were taken at both express and ordinary speeds, and a general test made of the braking and electric heating arrangements. A speed of nearly 45 miles an hour was attained, the rate being reached in 35 seconds from rest. A number of officials were present at the trial, including Mr. Chas. Merz, consulting engineer to the company.

Proposed "Tube" Extensions.—The Islington Borough Council have decided, after correspondence with Sir George Bartley, their representative on the Royal Commission on London Locomotion, to forward recommendations with respect to two new "tube" extensions in North London in connection with those nearing completion. The first scheme is for an extension from Highbury-corner to the tramway terminus at the Archway, and thence across the borough from east to west, giving greater facilities between the West-end, Islington, and Stoke Newington. The second scheme is to extend the "tube" of the Great Northern Railway, which terminates at Finsbury Park, to the Alexandra Palace, and so give greater facility for reaching London's municipal palace.

St. Pancras.—The town clerk has received a communication from the clerk to the London County Council expressing the thanks of the Highways Committee of the Council for the consent given to the construction of an electric tramway along Tottenham Court-road, and adding that the Improvements Committee have decided to recommend the County Council to proceed forthwith with the authorised widening of the southern end of Hampstead-road, the Highways Committee having concurred in this course. The Highways Committee confidently rely upon the Borough Council's aid in connection with the promotion of the Bill to authorise the Tottenham Court-road tramway. The Council on Wednesday confirmed their decision to sanction the proposed tramway.

Additional Traffic Returns.—Anglo-Argentine, £1,979 increase; Barcelona Ensanche y Gracia, £123 increase; Barcelona, £80 decrease; Brisbane, £18 decrease (month of November, £10,544, increase £253), British Columbia Electric (month of March), gross earnings £10,352, net income £2,659; Buenos Ayres and Belgrano Electric, £303 decrease (month of November, £14,142, increase £444); Calcutta, £272 increase; Cape Town (month of October), receipts £16,229, expenditure £9,044; Isle of Thanet Electric, £40 increase; Lisbon Electric (month of October), receipts 93,725 milreis, expenses 50,350 milreis; Mexico Electric (month of November), receipts £47,350, expenses £27,600; Perth Electric, £179 increase; Port Elizabeth (month of October), receipts £3,972, expenditure £2,879.

Dewsbury.—The Town Council have now decided to give the requisite notice to purchase the undertaking of the British Electric Traction Company within the borough. It is stated that the basis of purchase will be the full cost of the lines and equipment, including the parliamentary expenses of the traction company, plus 20 per cent. On the day that the purchase takes place the Corporation will grant a lease to the company for 28 years at a rent which will be equal to the price paid for the concern. The Corporation will not permit the traction company to assign their lines to a subsidiary company without their consent. At the end of the 28 years the traction company will have the option of entering into a further lease of seven years on the same terms. It is stated that the total price to be paid for the tramways on the above basis will be about £70,000.

Belgian Rails.—The *Daily Telegraph* had a long letter from its special correspondent at Liège on Monday discussing the question of Belgian tramrails, and giving as the reason why Belgian rails are produced more cheaply than the British-made article that the Belgian manufacturers use basic steel while the British firms mostly employ Bessemer steel in the manufacture of the rails. With this suggested solution of the problem we beg to most emphatically disagree. As a matter of fact, the British firms almost exclusively use basic steel, which has long been an important portion of the output of English steelworks. One of the chief reasons which we believe is responsible for the difference in price between the Belgian and British made rail is that in Belgium there is complete freedom from trade union rules, which allows of a lower rate of wages and longer working hours.

South London Tube.—The Southwark Borough Council are taking action against the original Baker-street and Waterloo (Extension) Railway Company on account of an alleged refusal on the part of Mr. Yerkes to carry out the agreements of the Act of Parliament under which the scheme was sanctioned. The Act provided for the provision of an underground station and subway crossings at the Elephant and Castle. The original company has, however, been bought up by Mr. Yerkes, who informed a deputation from the Council that owing to the number of electric cables, pipes, mains, etc., at the Elephant and Castle, it would be too expensive to carry out the undertakings of the old company in their entirety. He undertook to consider the question of providing crossings, but the station would be placed in the London-road. The Council do not consider this arrangement satisfactory.

Brighton.—The detailed accounts of the Corporation tramways undertaking for the year ended March 31 last are now available. The traffic receipts for the year amounted to £43,468. 17s. 4d., the number of passengers carried being 10,432,528, and an item of £231. 6s. under the heading of rents brought the income on the revenue account up to £43,700. 3s. 4d. The principal items on the paying-out side of the account were £13,036. 14s. 2d. for salaries and wages, £9,300. 16s. 3d. for electrical energy, £1,238. 5s. for miscellaneous traffic expenses, and £4,680. 8s. 11d. for repairs and renewals. The total expenditure on the revenue account was £31,615. 8s. 1d., leaving a balance of £12,084. 15s. 3d. to be transferred to the net revenue account to meet interest, sinking fund charges, etc. These absorbed £7,949. 16s. 2d., the deficiency on the previous year, amounting to £3,051. 5s. 11d., was repaid, leaving a credit balance of £1,083. 13s. 2d. The net expenditure on the capital account at the beginning of the year had been £177,870. 10s. 11d., and during the year this was increased to £205,041. 16s. 5d., the chief items being £15,707. 15s. 8d. for permanent way and overhead equipment, £6,285. 13s. 10d. for land and buildings, £9,827. 19s. 6d. for rolling-stock, and £1,250. 16s. 11d. on machinery and plant. Another attempt is to be made at the next Town Council meeting to take the necessary vote to approve the promotion of a provisional order for the tramway extension in Preston-road.

A Novel Form of Electric Railway Car.—A correspondent to the *Times* describes for the benefit of railway managers in this country an interesting endeavour which has recently been made by the Illinois Central Railway in Chicago to combine the good features of the corridor and side-door car in a new design of vehicle, which has side doors, but is not divided into compartments. There are gangways down each side of the car after the fashion of our corridor trains, and all the doors (which slide instead of opening outwards) can be manipulated by pneumatic power by a "trainman," who stands inside the car. This prevents the waste of time arising from porters and guards having to run alongside the train to shut the doors, as is done in this country; while the gangways enable passengers to find their seats after they have boarded the car, instead of occupying valuable time in searching for a compartment to their taste. The new type of car is stated to have given great satisfaction to the authorities of the Illinois Central Railway, who have found it preferable both to the ordinary American type (which is best exemplified in this country on the Central London Railway) and to the British type of side-door compartmental car which was given a trial in Chicago at the time of the World's Fair in 1893. It would be interesting to know whether the attention of our London railway authorities has been directed to this latest invention in suburban railway carriage construction, and, if so, whether they intend to take any steps to give it a trial. The Chicago cars have steel frames, which make them considerably lighter than wooden cars of the same size.

London Suburban Tramways.—Speaking at the ordinary meeting of the Lea Bridge, Leyton, and Walthamstow Tramways Company on Tuesday, the Chairman stated that the Leyton District Council gave the company the statutory notice of their desire to purchase the portion of the tramway which was situated in the Lea Bridge-road. The Walthamstow Council had the power to give the company notice to sell the portion of line which was within their district, but they failed to get the statutory number of members at their Council meeting, and they could not, therefore, give this notice. That portion of the line in the Lea Bridge-road would consequently remain with the company for six years from now. The remaining portion of the line in the Lea Bridge-road was in the county of London, but the London County Council had no power of purchase for some years yet, and that was the position of the remainder of the company's lines which were within the district of the Leyton Council—that was to say, they could not compel the company to sell those portions of the line. Having regard to the unsettled position and the possibility of an arbitration, it was not desirable to discuss the matter in an open meeting, but he might say that informal communications had passed between the Leyton Council and the company with reference to a sale of the entire undertaking to the former, and the Leyton Council had given notice of an application to Parliament for next session with reference to the tramways. At the ordinary general meeting of the Great Eastern London Suburban Tramways and Omnibus Company on Tuesday, the Chairman referred with satisfaction to the results of the year's working in view of the "inordinate time taken by the West Ham Corporation in constructing their tramways."

London County Council.—At the last meeting of the London County Council on Tuesday the Highways Committee were able to make the satisfactory announcement that it may be possible to commence the electrical working of the New Cross and Greenwich, etc., sections of tramways by the end of the present year. The reconstruction of the tramways is completed, and the electric cables are laid while the arrangements at the sub-stations and for the provision of the supply of power from the London Electric Supply Corporation's station at Deptford have reached an advanced stage. The committee think that the inauguration of electrical traction on these lines will naturally be an event of considerable interest to the districts concerned, and they have accordingly given instructions for an invitation to be extended to the members of the different metropolitan borough councils through whose districts the line pass to be present at the inspection by the Board of Trade. At an earlier stage of the meeting Mr. E. Collins called attention, on the reception of the report of the Finance Committee, to the fact that, judging by the present receipts of the Council's tramways, the receipts for the year would be short of the amount estimated by some £55,000, and he suggested that the business auditor be employed to audit the tramway accounts on business lines. Lord Welby, chairman of the Finance Committee, thought there was no doubt that, owing to the changes in the system, the receipts would not be as much as estimated, but it was too early to forecast what the deficiency might be. During the sitting a petition was presented from 200 medical men asking that the drivers and conductors of the Council's tramcars should be provided with seats on their cars. The Council received tenders for (*a*) the supply, etc., of three-phase generators at the Greenwich tramways electricity station; and (*b*) for electric light, wiring, etc., at tramways, car-sheds, and sub-stations. These were referred to the Highways Committee.

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LIGHTING AND GENERAL.

Bootle.—A number of extensions of distributing mains have been approved.

Stockton.—Efforts are being made to increase the day load by supplying motors.

Leyton.—The Urban District Council are about to borrow £5,000 for electrical extensions.

Spalding.—The proposal to apply for a provisional order for electric lighting has been postponed.

Dalkeith.—Messrs. Crompton and Co. have been authorised to erect the five additional arc lamps.

Folkestone.—The agreement with the electric light company for street-lighting will expire on July 30 next.

Paignton.—A special meeting of the ratepayers' association is to be held to discuss the electric lighting question.

Holyhead.—The Urban District Council have signed a contract with the National Electric Construction Company.

Dewsbury.—The electrical engineer is about to lay down 44 yards of electric main to the new circus in Foundry-street.

Elland.—The Urban District Council propose to apply for sanction to borrow £4,000 to carry out electricity extensions.

Watford.—The Urban District Council have decided to seek an offer for the purchase of the electric lighting undertaking.

Denny (Stirling).—The Town Council have postponed till June consideration of the advisability of applying for an electric power order.

Wednesbury.—The Council have authorised the expenditure of £464 in lighting the town hall and other public buildings by electricity.

Bolton.—The Electricity Committee have invited the Horwich District Council to confer with them on the question of supplying electric current in Horwich.

Sheffield.—An enquiry has been held into the City Council's application for power to borrow £10,000 for the purchase of electric motors to be let out on hire.

Andover.—The Council are in favour of the application of the Southern District Electricity Company, but will formally object so as to maintain their *locus standi*.

Loughborough.—The Town Council on Monday ratified their decision in committee to adopt the scheme for an electrical undertaking prepared by Mr. C. H. Gadsby.

Wrexham.—The borough electrical engineer in his last report states that the destructor worked satisfactorily during November, and had destroyed all the refuse delivered.

Keynsham.—The District Council have decided to apply next year for an order to supply the district with electric light, the current to be taken from the Somerset Electric Power Company.

Horwich.—The Lancashire Electric Power Company having informed the Council that they would be in a position to supply electricity in bulk by Jan. 1, 1905, an interview is to be arranged.

Kingskettle.—The National Telephone Company have introduced a line into Kingskettle, and most of the subscribers have now been connected with the exchange, which is at the post office.

Sleaford.—The Electric Lighting Committee's last report shows an additional 111 lamps connected during the quarter; 3,920 units were consumed last month, as compared with 2,408 last year.

Bury.—The extension of works for providing accommodation for the traction plant has been proceeded with. An application for current for motor power at 1d. per unit is being considered.

Middlesbrough.—The report of the Electric Lighting Committee, containing particulars as to the proposed extension of the existing plant, involving an outlay of some £15,000, has been confirmed.

Farnham.—At the last Urban District Council meeting the deputy clerk added that the Board of Trade had merely acknowledged receipt of the Council's application for extension of their order for 12 months.

Southport.—From Jan. 1, 1904, the charge for electricity for motors is to be 2d. per unit; where the consumption of current exceeds 36 hours per week per brake horse-power installed, the charge to be 1½d. per unit.

Kensington.—Notices from the Brompton and Kensington Electric Supply Company relative to proposed extension of their mains, etc., in Bute-street, Gloucester-road, and Harrington-gardens have been agreed to.

Ilfracombe.—Arrangements have been completed whereby a continuous night and day trunk service between the exchanges comprising the Barnstaple and Ilfracombe areas and any trunk centre in Great Britain has been opened.

Hereford.—We learn that the Corporation's electricity department have now over 11,000 lamps connected, and are just about to lay 250 yards of single cable laid solid at a cost of £225. Several other main extensions are being considered.

Stock Exchange.—The Stock Exchange Committee have appointed Dec. 16 special settling day for Havana Electricity Company's 15,000 shares of £10 each, £8 paid, Nos. 1 to 15,000, and have ordered the said securities to be quoted in the official list.

Long-Distance Telephone.—The Postmaster-General has notified the Liverpool Chamber of Commerce that arrangements have been made for telephonic communication between Lancashire and various French towns. The scheme only awaits French legislative sanction.

Blantyre.—It is proposed to form a strong electric power company which will erect premises on the site of the old Turkey-red dyeworks at Blantyre. The scheme contemplates drawing the company's water supply from the Clyde within the boundaries of the Blantyre estate.

Thirsk.—The work of laying the cables and fixing the posts has made good progress, and it is expected that the streets will be lighted by electricity on Jan. 1 next. The company have already lit the public streets of the neighbouring village of Sowerby with electricity.

Cardiff Docks.—The Cardiff Railway Company have distributed circulars amongst their tenants at the docks asking for certain information as to the extent to which they may be able to supply electric power and current under a scheme which they have had under contemplation for some time past.

Merton.—The Electric Lighting Committee of the parish are considering a letter from the Wimbledon District Council stating that they had received application from the owners of the Polytechnic and Raynes Park estates to light roads thereon with electric light, and asking if this authority had any objection.

Greenock.—Plans were lodged with the master of works on Tuesday for the Messrs. Wright's new theatre to be erected at the corner of Argyle and West Stewart streets, Greenock, and the architects for which are Messrs H. and D. Barclay, Glasgow. A complete installation of electric light will be provided.

Stroud.—The Council have consented to the application of the Gloucestershire Electric Power Syndicate, Limited, in respect of the application for a provisional order for lighting the area included in that rural district, on the understanding that they should grant similar rights to other companies which might apply.

St. Annes.—Application is to be made for sanction to borrow £4,000 for extension of mains and services. The engineer on Wednesday reported 22 applications for 1,010 lights, and for two convalescent homes. Units sold to Oct. 31 were 254,208, against 64,823 last year, and the number of consumers is 214, against 140.

Newport (Mon.).—The Council have adopted a report with reference to the decision to erect a sub-station on Cardiff-road, on which the borough electrical engineer reported that if the machinery for such sub-station were erected at the Llanarth-street works the building of the sub-station might be deferred for about 12 months.

Bramwell and Harris.—We are informed that, notwithstanding the recent loss which the firm sustained by the death of Sir Frederick Bramwell, the business of "Bramwell and Harris" will be carried on as heretofore at 5, Great George-street, Westminster, and also at Edinburgh and Cardiff. The name of the firm will remain unchanged.

Hastings.—The Electricity Committee are about to equip the three electric light sub-stations with the Andrews duplicate mains apparatus, and have accepted the offer of Cowans, Limited, Salford, for one complete set for a total current of 75 amperes for £126, with a 12 months' guarantee. The estimated cost of fixing and connecting up the same is £24.

Perth.—The Electric Lighting Committee seem to experience some difficulty in finding room—if any be required—for the alleged smoke nuisance at the electricity works, and they have requested the Sanitary Committee to meet them in conference and discuss the matter before any suggestion is adopted that would lead to the spending of money.

Salford.—The Town Council have resolved to take over the Prestwich electric lighting provisional order and to apply for sanction to borrow £5,000 to cover the cost of laying the necessary cables, etc. By agreement with Prestwich the Council will charge ½d. per unit more than the price in Salford. A consumption of about 40,000 units is expected.

Reading.—At the last Town Council meeting the following resolution was proposed and lost: "That this Council do now resolve to seek parliamentary powers for the purpose of lighting from their own works such streets and thoroughfares, as the Council may deem expedient, of the town as are or may from time to time come under its jurisdiction."

New Malden.—The Electric Lighting Committee have fixed the compulsory area, and have approved the form of the draft provisional order. The amount required to carry out the work is estimated at £20,000. At the last meeting the clerk reported that the Twickenham, Teddington, and District Electric Supply Association had given notice to apply for an order also.

Glasgow.—At the last Council meeting the minutes of the Electricity Committee were considered. They recommended the extension of the generating stations at Port Dundas and Pollokshaws-road. Objection was taken to the proposal, and the necessity for unification of the whole of the electrical departments was urged, and during the discussion the house was counted out.

Swansea.—The engineer's last report states that since his previous report the number of equivalent 8-c.p. lights applied for had been 1,074. The committee have decided to extend the electric lighting main, provided the Church Army Home authorities, who desired to instal the system in that institution, undertook to take a minimum supply for a period of not less than three years.

Newquay.—With reference to the notice of the Southern District Electricity Corporation *re* an intended application for an electric provisional order for Newquay, the Urban District Council have agreed to endeavour to obtain advice on the terms of the proposed order from Mr. Harold Dickinson, of the Leeds Corporation electricity works, and also from the Leytonstone Urban Council's electrician.

Merthyr.—The Lighting Committee have resolved in respect to the electric lighting of High-street, Merthyr, that the surveyor prepare a plan showing the sites of the proposed arc lamps, together with a comparative estimate of the cost showing the combined system of lighting by electricity and gas, and by the providing of extra gas lamps without arc lamps. It has also been resolved to erect four lamps upon another road.

Powis Castle.—The castle is now undergoing alterations. The contract was over £30,000, and the building alterations and renova-

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tions are now being proceeded with. Up to last week the castle was illuminated either with oil lamps or wax candles. Now, however, an electrical generating station has been built under the castle rock, and a few nights ago 600 electric lights were switched on for the first time in the ancient stronghold.

Elgin.—At a meeting of the South U.F. Church Literary Society last week, Bailie Davie made a most eloquent speech in favour of the introduction of the electric light. Other speakers followed, and a hearty vote of thanks was awarded the bailie, the chairman remarking that he thought the society had done a public service in taking up this matter, and hoped the Town Council would soon take up consideration of the lighting of the town.

Ealing.—The output of current for the half-year ending September shows a considerable increase over the corresponding half last year, and the total costs for the half-year are ·23d. per unit lower, despite the increase in rates from £193 to £617 for the half-year. A large proportion of this sum has been returned to the borough in the district fund. The financial result for the two summer quarters compares favourably with that for the corresponding period last year.

Yarmouth.—The electrical engineer on Wednesday reported as follows: there have been nine new consumers, representing 743 8-c.p. lamps, connected up during the month, making a total of 442 consumers, representing 21,718 8-c.p. lamps, now connected to the mains. The committee recommended that the arc lamps on the Esplanade be removed from the columns from Jan. 1 to the week previous to Easter, and that the incandescent lamps be lighted till 12 o'clock only.

Acton.—The District Council have decided to oppose the Metropolitan Electric Supply Company's application for a provisional order to supply electricity in the district, and they have appointed a sub-committee, consisting of Messrs. King, Jarratt, Poulton, Morris, Athawes, Monson, Ainsley Baldwin, and Hunt to consider Mr. Trentham's report. The chairman and Mr. Trentham are to seek an interview with the managing director of the Metropolitan Electric Supply Company.

Tottington.—The Parliamentary Committee of the District Council have under consideration a letter from the Lancashire Electric Power Company explaining the position of the company, which is about to commence the erection of a generating station at Outwood, near Radcliffe. The company saw no reason why an agreement should not be effected between the Council and themselves for the supply of electricity in bulk from a fixed date. Current could be supplied by Dec. 1 next year.

Electric Light for Vehicles.—Messrs. Wilson and Stockall, of the County Carriage Works, well known as makers of ambulance bronghams, have introduced electric light for illuminating the interior of their vehicles. The current is obtained from a dry battery, with a life of 60 hours, which can be placed in any part of the vehicle, and the lamp is so arranged that it can be fitted to either the roof, back, or sides of the interior of the vehicle. By means of a switch three grades of light can be obtained.

Destructors.—We are informed that the Horsfall Destructor Company, Limited, Leeds, have recently shipped two important destructor plants to South Africa for the cities of Bloemfontein and Durban. Among other new destructors upon which the company is at present engaged we note plants for Folkestone, Bromley, Chiswick, Swansea, Batley, Stourbridge, and Gosport. Several of these destructors will furnish power for electric lighting, sewage pumping, etc., in addition to the sanitary disposal of refuse.

Fulham.—The following meters are to purchased: 150 Ferranti 10-ampere meters for £365. 12s. 6d., 150 Westinghouse five-ampere for £566. 5s., making a total of £931. 17s. 6d. The borough electrical engineer has submitted the undermentioned statistics: connections—previously reported, 958, or 42,052 8-c.p.; from Nov. 13 to Nov. 26. 1903, 28, or 1,178 8-c.p.; making a total of 986, equivalent to 43,230 8-c.p. There are also 16 consumers not ready for connection and four who have not yet paid deposits.

Huddersfield.—At a special meeting of the Town Council on Tuesday the application to the Board of Trade for a provisional order in the next session of Parliament for power to supply the urban district of Golcar with electricity for public and private purposes was sanctioned. The Mayor (Alderman Inman) said that a similar scheme for Linthwaite cost £7,000. The whole of the contemplated scheme for Golcar would cost £25,000, but it would not be done all at once, and only in such portions as showed prospect of a profit.

Tonbridge.—The resident engineer in his last report states that three applications for light have been received since the last meeting. The number of consumers now totals 92, equivalent to 3,179 lamps of 8 c.p. The engineer has made photometric tests of the illumination of the footways with incandescent gas and electric lamps respectively, and has submitted in tabular form the result of his experiments. These appear to be in favour of electric lamps, but before making any recommendation on the subject further tests are to be made.

Topsham.—A meeting was held last week to receive the report from the committee appointed to enquire into the feasibility of providing an electric light installation for the town. The committee are convinced that the introduction of electric light is quite feasible, and that it would be a decided acquisition to the town. After a lengthy discussion, the meeting decided that the scheme should be proceeded with, and a provisional board of directors was appointed, with Captain T. Holman as chairman and Mr. H. C. Gould as secretary.

Willesden.—At Tuesday's meeting of the District Council the draft agreement for sale of the electricity works in Taylor's-lane to the North Metropolitan Electric Power Supply Company was approved, subject to such alterations as the solicitor and electrical engineer have already made or may consider necessary for protecting the interests of the Council, and subject to the insertion of a clause enabling the Council to require payment at any time in cash of any balance which may be due from the company on giving six months' notice to that effect.

Clacton.—The sub-committee appointed to wait on the Board o Trade with a view to obtaining a further postponement of the revocation of the electric lighting order has had an interview with Mr. Pelham, secretary to the Board of Trade, who said that he thought he might go so far as to say that the Board would not consider as to revoking the order for another 12 months, and they would not then revoke it without giving the Council ample notice.

St. Marylebone.—A long article in the *Times* of yesterday lays the views of a correspondent on the St. Marylebone deadlock before the public. The writer claims that if the Council get their Bill next year, the loan of two millions required will involve the ratepayers in an annual loss of £50,000. This figure is arrived at on the supposition that the profits from the electric lighting cannot be increased beyond the present figure of £51,000 per year. In conclusion, a compromise is recommended by which the St. Marylebone Council would pay the company to let them off the terms of the arbitration.

Electric and General Investment Co.—The directors have declared the following interim dividends: at the rate of 6 per cent. per annum on the Company's preference shares for the six months ending 31st inst., being 3s. per share, to the shareholders registered in the books of the Company on that date; at the rate of 10 per cent. per annum on the capital paid up on the ordinary shares of the Company, being 1s. per share, for the six months ended 30th ult., to the shareholders registered in the books of the Company on Nov. 30. Both dividends will be paid, less income tax, on Jan. 1, 1904.

Ventilation with Electric Heating.—The King's Room at the Criterion has been fitted up with a permanent installation of electric heaters and fans and screens and slotted panelling around the walls, which form the elements of the Glover-Lyon system of ventilating. A temporary installation of this system was demonstrated by Dr. Lyon last summer at the Camera Club, and then described by us. The installation was carried out by Dr. Lyon, under the supervision of the engineering firm of Shone and Ault, and when tested at a large dinner on Monday gave universal satisfaction. An elegant switchboard hidden in the lower panelling controls 10 rows of heaters, three ozone tubes, one supply blower, and one extractor fan. The air, purified and heated, passes through the slots, which commence at about 12ft. from the floor, and is extracted on the opposite side. The results were favourably commented on by those present.

Swansea Telephones.—At the Telephones Committee on Monday the manager reported that 456 subscribers' lines had been connected. Two hundred and fifty-two orders were still in hand, and 94 had been obtained since the opening of the exchange, while the prospects of obtaining new orders was encouraging. The subject of intercommunication arose. The chairman did not favour it, because, once demanded, they could not withdraw it. The municipal system was increasing by nearly 100 subscribers per month, and if an exchange of 2,000 could be obtained, and the National system diminished to 500, the Corporation would, if there was free intercommunication, have to give the National subscribers free intercommunication. The 500 subscribers necessary to place the Corporation in a legal position to demand intercommunication would probably be obtained within a fortnight. A sub-committee was appointed to go into the matter.

Eastbourne.—The Electricity Committee propose to supply energy at a charge of 3d. per unit for exhibition purposes only, subject to a minimum charge of £4 a year. With regard to the electrical exhibition, the *Eastbourne Gazette* says: "When it was announced on Saturday morning that owing to the 'great success' of the exhibition there would be free admission in the evening some sceptical people jumped to the conclusion that the true reason was the paucity of the attendance. The charge for entrance has been the very modest amount of 3d. On enquiry at the town hall on Saturday afternoon, about half-past four, I learned that some 2,000 people had already visited the exhibition; and, what was still more satisfactory, I ascertained from one of the principal local stallholders that he was gratified with the amount of business done and the number of enquiries received. The local tradesmen who were represented may be justly congratulated on the spirit, enterprise, and taste of which their interesting displays of lamps, radiators, and fittings gave evidence."

London County Council.—On Tuesday it was agreed to lend the Hampstead Borough Council £14,145; the St. Pancras Borough Council £10,000; and the Stepney Borough Council £1,902 for the electric light installations. The following notices to lay mains, etc. under Electric Lighting Acts and Orders were agreed to: from the Blackheath and Greenwich District Electric Light Company, along Humber-road and across Westcombe-hill; from the Brompton and Kensington Electricity Supply Company, along Bute-street and along portions of Gloucester-road and Harrington-gardens; from the Charing Cross and Strand Electricity Supply Corporation, under the St. Martin's Order, 1899, intention to build boxes at the corners of James-street and Haymarket, at the corner of St. Martin's-street and Whitcombe-street, and in Whitcombe-street opposite to the gallery of the Society of British Artists, the same company, under the Strand District Order, 1896, to lay mains along a portion of Tavistock-street, the Holborn and St. Giles's Order, 1898 (No. 2), to lay mains along a portion of Drury-lane; from the County of London and Brush Electric Lighting Company, a transformer box, Vernon-road; from the Metropolitan Electric Supply Company, under the Mid-London Order, 1889, along Lincoln's-inn-fields, Gate-street, New Turnstile, High Holborn, Southampton-street, Bloomsbury-square, Bedford-place, and Russell-square. Notices to lay mains under orders granted to local authorities were also received as follows: from the Hampstead Borough Council, along portions of Lincroft-gardens, Stanley-gardens, Eton-avenue, Upper Park-road, along Glenlock-road and Antrim-street, and across Haverstock-hill; from the Islington Borough Council, along portions of Blackstock-road and Mount-grove-road; and from the Stepney Borough Council, along Horseferry Branch-road and across Medland-street.

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Dunfermline.—The National Electric Construction Company do not now intend to proceed with their application for a provisional order for supplying the district with electricity, owing to the opposition threatened by the Town Council, who propose to apply for parliamentary powers.

Birkenhead.—After Jan. 1, 1904, the charges for electrical energy for power and heating purposes within the borough are to be at the following rates: for the first 500 units per quarter, 2½d. per unit; beyond 500 and up to 1,500 units, 2d.; from 1,500 to 5,000 units, 1½d.; from 5,000 to 10,000 units, 1⅜d.; in excess of 10,000 units per quarter, 1¼d. per unit.

Trowbridge.—At a recent special meeting of the Chamber of Commerce the future of Trowbridge with regard to electric lighting was discussed. It will be remembered that the Urban District Council, after advertising, received applications from companies who were willing to negotiate, and at the present time a draft agreement with a company is under consideration. After discussion, a resolution was passed favouring the leasing of powers under the provisional order, with the option of purchase by the Council at the expiration of a given time.

The Telephone at Railway Stations.—At the last meeting of the Newcastle Chamber of Commerce letters were read from the various railway companies, the National Telephone Company, and the General Post Office respecting representations made by the Chamber as to the desirability of fitting telephone boxes on railway station platforms. The North-Eastern Railway Company agreed to fit telephone call boxes at its most important stations, the National Telephone Company will instal the wires and instruments, and the system is to be ready for use early in the New Year.

Cupar.—Mr. Houston, Hillside Foundry, has just introduced electric lighting into his works at Cupar. A dynamo of 105 volts has been installed, which supplies two large Stewart arc lights and some 60 Ediswan lamps of 16 c.p. each throughout the works. The dynamo has been driven during the last few days by the ordinary 9-h.p. steam-engine which is used for the different machines in the works, but a smaller engine of higher speed is in course of erection, and will be used for the dynamo alone. Messrs. Lowdon Bros., electrical engineers, of Dundee, were the contractors.

Worthing.—The resident engineer's last report states that the number of applications is 264, of which 245 have been connected, that the number of 8-c.p. lamps applied for was 15,755, and that the number connected was 15,025. Various extensions of the mains were recommended. The receipts for the first six weeks of the present quarter were £791, as against £538 for the corresponding six weeks in 1902, or an advance of £253. On the other hand, the expenditure, including capital account charges, was £665, as against £588 for the corresponding six weeks last year. This year, as compared with last year, therefore shows a net profit of £176.

Bristol Channel Telephones.—The telephonic connection between lighthouses and the shore in the Bristol Channel has been extended by Braunton lighthouse and Braunton village being "wired"; the post office there is to be also switched on when necessary to the telephone wire connecting Appledore and Croyde coastguard station. The lighthouse keepers in the Bristol Channel will now be in a position to communicate direct with the several coastguard stations, and in this way much valuable time will be saved in coming into touch with ships in distress. Previously, in the case of Braunton lighthouse notifying to Braunton to communicate with other places, a foot messenger had to be employed.

Buenos Ayres.—In reference to the Buenos Ayres municipal lighting scheme and to the proposed loan of 16,000,000dol. gold, which sum is to be applied in the carrying out of the works, the municipality has received an offer on behalf of London bankers by the Corporacion Comercial Sud-Americana for an issue of the sum named, in bonds, bearing 6 per cent. interest and amortisation of 1 per cent., the issue price to be fixed at 85. The directors of the company are Messrs. J. S. Dillon, M. G. Fortune (of Fortune and Moncrieff), J. Etchegaray (general manager of La Acumulativa Savings Bank), W. C. Hoard, and W. T. Damon (legal representative of the Bahia Blanca and North-Western Railway Company).

Arcs on Tramway Poles.—We are informed that the Gilbert Arc Lamp Company have, as sub-contractors to Callender's Cable and Construction Company, Limited, designed and supplied the arc lighting equipment for Batley, Yorks. An interesting feature is the use of the Gilbert Arc Lamp Company's raising and lowering gear on the tramway poles, for which special boxes and winches had to be designed. The steel cord is carried up the outside of the post in ⅜in. pipe from the combined winch and gear box, which allows for the necessary lateral notion of the cord, and the whole has been so contrived that it is quite neat and unobtrusive. Messrs. Lacey and Sillar are the consulting engineers.

Leicester.—The Guardians have adopted a report from the North Evington Land Committee with regard to the heating and lighting of the new infirmary, recommending that the recent resolution adopting a scheme for the private supply of electricity be rescinded, and that the current be conducted from the cables of the Corporation. It was pointed out that the Corporation could supply the new building with electricity for lighting purposes at a much cheaper rate than the Board could manufacture a private supply. The cost of the Corporation supply would be about £425 annually, while the buildings and machinery for a private supply would entail an initial outlay of £7,000 or £8,000, without taking into account the cost of coal, oil, and labour.

Pitlochry.—At a recent public meeting to consider whether an installation of electric light for the district should take place it was explained that, provided the consent of the proprietors concerned could be obtained, a private company proposed to utilise the Falls of Tummel for the motive power; that the necessary 2½ miles of cable would be laid to Pitlochry—underground, so as not to interfere with the scenery—and that, further, wires would be put into houses and shops free of charge, the owners supplying the requisite fittings and lamps. The cost was given at an equivalent to a gas rate of about 3s. 3d. The company were also prepared to light the streets on the same terms. Should Pitlochry become a burgh, the community would have the option of purchasing the undertaking at certain times on certain conditions. The meeting approved of the scheme, and instructed the local District Committee to act in their interests, but without incurring any financial obligation.

Hornsey.—The Highways and Lighting Committee have received a letter from the General Post Office stating: "I am directed by the Postmaster-General to say that the question of extending the Post Office London telephone system to Hornsey has already been under his consideration, with the result that it has been decided to open an exchange at Crouch End, to serve the Crouch End, Hornsey, Highgate, and Muswell neighbourhoods, as soon as the districts now in hand have been dealt with. The Postmaster-General regrets, however, that he is not yet in a position to say when it will be possible to open the exchange. The extension of the Post Office London telephone system to the outlying districts of the London area can only be taken in hand after the more pressing needs of inner London have been met, and although it is hoped to begin operations in Crouch End early next year, a considerable time will necessarily be occupied in completing the underground system which it is proposed to provide, and in constructing and equipping the proposed exchange." Another letter is to be addressed to the Postmaster-General urging more prompt attention to the matter.

Brighton.—The year's income on the revenue account of the electricity works was £82,392. 19s. 10d., made up of the following items: electricity sales, £58,033. 4s. 6d.; public lamps supply, £10,351. 17s. 5d.; tramways electricity supply (November to March), £9,218. 6s. 3d.; meter rents and sundries, £4,789. 11s 8d. The expenditure came to £47,208. 13s. 11d., the chief items of which were: £20,432. 12s. 1d. for coal, £6,265. 14s. 4d. for wages at works, £2,492. 0s. 8d. for repairs and maintenance of machinery and plant, £4,295. 12s. 7d. on public lamps, and £3,466. 17s. 3d. under the head of salaries. This left a balance of £35,184. 5s. 11d. to be transferred to the net revenue account. Here interest and sinking fund charges accounted for £27,199. 12s. 2d., leaving £7,984. 13s. 9d. as the net profit to be carried to the next account. The capital account shows that the total expenditure up to the beginning of the year had been £404,858. 16s. 5d., and this was increased during the year to £463,764. 7s. 6d., the principal items being £30,675 on account of the new generating station at Southwick, £9,887. 9s. 10d. for machinery and plant, and £11,461. 0s. 3d. for mains.

Aberdeen Telephones.—We understand that the negotiations between the sub-committees of the Streets and Roads and Finance Committees of the Town Council and Mr. Gaine, manager of the National Telephone Company, have broken down, but the committee has yet to report to the Council. It appears that the Telephone Company were prepared to expend £60,000 on an underground system in the town, and to allow the Corporation to undertake all the work, under the superintendence of the city's engineer, and would pay all the costs. The committees, however, before allowing the company the privilege of opening their streets, wished to get a cheaper rate for the subscribers than the present sum of £8. 10s. They were anxious that the subscribers should get an unrestricted service for £7. It was pointed out to the committee that £8. 10s. was a cheaper rate than that given in most other cities in the United Kingdom, and as the Telephone Company had only a license from the Postmaster-General up to 1911, it would not pay the company to give a cheaper rate. They were prepared, however, to give other facilities—to introduce what was called the omnibus rate. For large groups of subscribers the rate would be 25s. for 600 calls per annum, and ½d. per call afterwards. Different groups were then dealt with, when it transpired that four subscribers on one wire would get a service at the rate of £4 per annum, and two subscribers at £6. The committee decided to recommend the Council not to accept these terms, whereupon, it is reported, Mr. Gaine withdrew his offer. There are about 1,800 subscribers on the Aberdeen section of the telephone.

Chesterfield.—The Town Council have adopted the estimate of the electrical engineer (Mr. Acland) for an extension of the works at a cost of £5,680. The extensions are made necessary by the continually growing demand for current. On the corresponding Saturday last year the maximum turn-out on the feeders was 266 kw., while last Saturday they turned out 325. Mr. Acland estimates that the Council might soon expect it to be 350. The units generated on the Saturday in 1902 were 1,919 and this year 2,774. The units sold in November last year were 31,000, while this year they were 50,000 in round figures, which showed the great advance made at the station. The total sales in units for the year ending last March came to 209,000, while this year, Mr. Acland estimated, they would amount to 350,000. In the ordinary course of things, if they had not had to consider the tramways, they would probably have recommended the provision of a 200-kw. extra plant—always striving to keep 200 kw. ahead. Seeing that they had the trams as now proposed, they had decided to recommend putting down a 400-kw. plant, and it was a great deal cheaper per kilowatt to put down that than a 200-kw. plant. Earlier in the year he was asked if they would require further plant for the tramways, and he then stated that they would not for the present line, which would take about 100 kw.; but, of course, that was all altered now, and that was why they had to say that other plant would be required. They were now proposing to run the tramway from the top end of Brampton right away to Whittington Moor. It was also proposed to combine Nos. 1 and 2 dynamos at a small cost. If they put down the proposed plant, the plant at the station would be 1,000 kw., and would have cost them about £50,000, which worked out at £50 per kilowatt.

Blairgowrie Telephones.—Mr. W. F. M'Alpine some time ago was negotiating with the National Telephone Company for the introduction of telephones into Blairgowrie, Rattray, and Coupar Angus.

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The company could not get the permission of the Post Office authorities to use the trunk line in connection with Blairgowrie. Mr. M'Alpine forthwith applied to the secretary of the General Post Office, London, who was willing to accede to the request. It would be necessary to erect a circuit from Dundee or Perth, for the cost of which they require a guarantee calculated at the rate of £5 per annum per mile of line in respect of fees for trunk calls. The circuit could be carried by way of Coupar Angus, which could share in the guarantee. The charge for communication between Coupar Angus or Blairgowrie and Dundee or Perth would be 3d. for each three minutes' conversation. The rates for a connection with an exchange within half a mile of subscribers' premises would be £3 per annum, which includes cost of instrument, with message fees as follows: 1d. for each local call originated over the circuit up to 1,500; ½d. from 1,501 to 3,000; and ¼d. from 3,001 and upwards; the minimum yearly amount payable by each subscriber for messages, 30s. The rates would cover communication between Post Office subscribers at Blairgowrie and Coupar Angus, and subscribers would be entitled on payment of the appropriate trunk fee to communicate with all towns of the United Kingdom connected with the trunk system. Subscribers could use their circuits to forward messages to the Post Office for onward transmission as telegrams, etc. The charge for use of call office for local calls is 1d. for each three minutes' conversation. The proposal has received such cordial support that Mr. M'Alpine is quite confident that the required number of subscribers will be forthcoming. Were the project once matured into concrete form 60 is not too many to anticipate. At Alyth, it is understood, the National Telephone Company failed to induce the requisite number of subscribers to come forward. The terms offered by the Post Office may induce that burgh to join in the circuit if the line be between Dundee and Blairgowrie, which is probable.

PROVISIONAL PATENTS, 1903.

Nov. 30.

26074. Improvements in sound-conveying apparatus applicable to speaking tubes, telephones, and phonographs. Inez Belle Hogan, 27, Chancery-lane, London.

26082. Means for automatically preventing the speed of electric cars from exceeding any predetermined limit. E. F. Kent and F. Rogers, 17, Causeway, Cambridge.

26083. Improvements in electric furnaces. William Cardno and Joseph George Dalton, Dunmore, Kirkhill, Cambuslang.

26124. Improvements in apparatus for controlling and operating the points of electric railways and tramways. Thomas Bell Stewart, William Herbert Turner, and Rowland Edward Dixon, 8, Quality-court, Chancery-lane, London.

26144. Electromagnetically-operated apparatus for controlling the inlet devices of steam and gas turbines. Theodor Reuter, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

26165. Improvements in electrical elevators. Rudolph Charles Smith, 55, Chancery-lane, London.

26170. Improvements in or relating to electric switches or controllers and magnetic blow-outs employed therewith. Philip Kirkup and William Alderson, 70, Chancery-lane, London.

26174. Improvements in couplings for electric cables. Franklin Wise Howorth, 46, Lincoln's-inn-fields, London. (Franklin Everhart and John Dossert, United States.) (Complete specification.)

26180. Improvements in electric fuses. Alexander Hepke and Heinrich Ascher, Norfolk House, Norfolk-street, Strand, London.

Dec. 1.

26185. A new or improved adaptation of electric bells to musical purposes. John Howarth, Commercial-street, Halifax.

26200. Improved electric generator. David Burns and James Macarthur Fleming, 37, West Nile-street, Glasgow.

26208. J. E. Jaggar's cover for electric tramcars and others. Joseph Ernest Jaggar, 6, Granby-grove, St. Michael's-road, Headingley, Leeds.

26211. Multiplex telephony. Wallace Fairweather, 65, Chancery-lane, London. (Willard M. Miner, United States.) (Complete specification.)

26230. Improvements in or relating to combined trolley arm and brake controllers for electric tramcars. International Trolley Controller Company and James Kynoch, 11, Southampton-buildings, Chancery-lane, London. (Complete specification.)

26241. Improvements in electrodes for secondary batteries. Henry Leitner, Lynton, Dartnell's-park, Byfleet.

26242. Improvements relating to telphers partly applicable also to vehicles propelled electrically from a distance. Siemens Bros. and Co., Limited, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (The United Telepherage Company, United States.) (Complete specification.)

26247. Improvements in and relating to electrically-operated driving mechanism for centrifugal machines. William L. D'Olier, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

26248. Improvements in telephone transmitters. Philip Green Randall, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

26255. Improvements in attachments to desk telephone instruments. Henderson Pierce Childress and Nathaniel Miles Sauls, 18, Southampton-buildings, Chancery-lane, London. (Complete specification.)

26259. Improvements in apparatus or means for regulating or governing the speed of engines employed in driving electric current generators. James Yate Johnson, 47, Lincoln's-inn-fields, London. (The Elektrizitäts-Aktien-Gesellschaft vormals W. Lahmeyer und Co., Germany). (Complete specification.)

26261. Improvements in or relating to magneto-electric igniting devices for internal-combustion engines. Camille Bailly, 111, Hatton-garden, London. (Complete specification.)

26264. Improvements in or connected with mechanism for electrically winding up springs or weights. Edward Du Bois, Norfolk House, Norfolk-street, Strand, London.

26267. Improvements in and relating to electric measuring and recording devices. Claude William Atkinson, 1, Queen Victoria-street, London.

26268. Improvements in and relating to electrolytic meters. Claude William Atkinson, 1, Queen Victoria-street, London.

26269. Improvements in or relating to switches for electric currents. William Phillips Thompson, 322, High Holborn, London. (Hermann Schor, France.)

26271. Improvements in cohering receivers used in space telegraphy. Frank Emuel Peters, 6, Lord-street, Liverpool. (Complete specification.)

26273. Improvements in controlling devices for electric motors. Gustavus Adolphus Edward Kohler, 46, Lincoln's-inn-fields, London. (Complete specification.)

26274. Improvements in means for ventilating electrical machines. The Actiengesellschaft Brown, Boveri, et Cie., 46, Lincoln's-inn-fields, London. (Date applied for under Patents Act, 1901, Dec. 16, 1902, being date of application in Swizerland.) (Complete specification.)

26276. Improvements in or relating to electricity meters. William Geipel and Frederick Montague Townshend Lange, 46, Lincoln's-inn-fields, London.

26291. Safe and improved method of attaching detonators-caps, or exploders to fuse tape, or electric wires, making the same water and air tight. William Henery Edwards, 79, Pitt-street, Sydney, New South Wales.

Dec. 2.

26307. An improved electrical connection for electro-chemical apparatus. Frederick James Turquand and John Frederick Wakelin, 5, Tottenham-street, London.

26352. Improvements in or relating to vacuum arc lamps with external air-cushioned regulating device. Hubert Emonds, 5, Hatton-garden, London. (Complete specification.)

26372. Improvement connected with cells for storage and other batteries. Henry Soar and William Holloway Fellows, 173, Fleet-street, London.

26378. Improvements in and means for effecting the regulation of asynchronous alternating or three-phase current electric motors. James Yate Johnson, 47, Lincoln's-inn-fields, London. (The Elektrizitäts-Aktien-Gesellschaft vormals W. Lahmeyer und Co., Germany.) (Complete specification.)

26380. Improvements in safety fuses for electric circuits. James Yate Johnson, 47, Lincoln's-inn-fields, London. (The Elektrizitäts-Aktien-Gesellschaft vormals W. Lahmeyer und Co., Germany.) (Complete specification.)

Dec. 3.

26427. Improvements in electromagnetic controlling gear for electric arc lamps, electric circuit breakers, and the like automatic mechanism. August Ecksteln and Arthur Ernest Angold, Peel Works, Adelphi, Salford, Manchester.

26435. Improvements relating to electrically-actuated mechanism. Louis Jacot, 18, Southampton-buildings, Chancery-lane, London.

26449. A new form of ammeter and voltmeter. William James Bell, 15, Vanbrugh Park-road, Blackheath, London.

26455. Improvements in and relating to elastic fluid turbines. The Warwick Machinery Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

26456. Improvements in insulated electric conductors. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

26457. Improvements in insulated coils for electrical apparatus and process of making the same. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

26458. Improvements in insulating electric conductors. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

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26459. Improvements in brake systems. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

26460. Improvements in electric rheostats. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

26461. Improvements relating to rotary electric converters. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

26462. Improvements in electric arc lamps. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

26463. Improvements in and relating to air-brake systems and valves therefor. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

26464. Improvements in static influence electrical machines. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

26465. Improvements in systems of electric motor control. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The General Electric Company, United States.)

26476. Improvements in or relating to electric incandescent lamps. Percy Joseph Handford Driscoll and Harry Sleeman, 322, High Holborn, London.

26488. Improvements in and relating to electrical ignition apparatus. Montague Stanley Napier, 18, Southampton-buildings, Chancery-lane, London.

DEC. 4.

26513. An improved canopy trolley for electric tramcars driven on the overhead systems. Joaquim Antonio de Macedo, Leventhorpe Hall, Swillington, Yorks.

26533. Electric heaters and improvements relating thereto. William Krause, 70B, Rye-lane, Peckham, London.

26537. An improved conduit for containing electric cables and wires and pipes and tubes and the like. W. Hepworth-Collins, 17, Nicholas-street, Manchester.

26538. An improved conduit for containing electric cables and wires and other wires, tubes, and the like, primarily intended to be carried along thoroughfares. W. Hepworth-Collins, 17, Nicholas-street, Manchester.

26553. Improvements in or connected with apparatus for electrically igniting miners' safety lamp. William Best, Albert Best, and Robert Octavius Best, 33, Chancery-lane, London.

26577. Improvements relating to field magnets for electrical machines. Georgio Finzi, 45, Southampton-buildings, Chancery-lane, London.

26589. Improvements in incandescent electric lamps. August Bourdos and Henry Cecil William Gibson, 24, Southampton-buildings, Chancery-lane, London.

26595. Electric igniting apparatus. Konrad Schaffler (*recte* Glössl) and Emanuel Jilck, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

DEC. 5.

26603. Improvement on electric motors and dynamos. Hans Faerber, "Hillside," Lower Weston, Bath.

26607. A new combined electric switch, wall socket, and plug. Herbert Robertson, 7, Leamington-terrace, Edinburgh.

26618. A mechanical switch for electric installation of motor cycles. Ralph Child Meredith, Urswick, Maryvale-road, Bourneville, near Birmingham.

26659. Improvements in magneto-electric ignition devices for internal-combustion engines. Paul Masson, 111, Hatton-garden, London. (Complete specification.)

COMPLETE SPECIFICATIONS ACCEPTED.

To be published Dec. 24, 1903.

1902.

24013. Attachment of carbon filaments in incandescent electric lamps. Fanta and Butler.

26386. Electrical synchronism indicating apparatus. British Thomson-Houston Company, Limited, Clinker, and Wedmore.

26416. Railway and tramway points operated by or from the vehicles and points or switches for use upon overhead conductors of electric railways and tramways furnished with points. Zylberlast.

26640. Electrical apparatus for automatically actuating signals on and stopping railway engines and trains. Gerstmann.

26870. Alternating-current motor. Deri.

26970. Electrical apparatus for registering the discharge of liquids by pumps. Liquid (Electric) Register Syndicate, Limited, and Cassal.

27322. Electric switches. Pieper.

28858. Electric rheostats. Pieper.

1903.

159. Electrically-operated bells. Barber and Larmuth.

322. Storage batteries and apparatus employed in the manufacture thereof. Edison.

1993. Thermo-regulating apparatus suitable for controlling the temperature of water and for other purposes. Brooke.

2189. Electric switches. Bray, Markham, Reiss, and Bray, Markham and Reiss, Limited.

2277. Arc lamps. Ridings.

7608. Continuous-current arc lamps. Evans. (Allgemeine Elektricitäts-Gesellschaft.)

11304. Control of electric motors. Johnson-Lundell Electric Traction Company, Limited. (Lundell.)

12189. Wall plugs and similar electrical fittings. Hunter.

14542. Controlling devices for electric motors. Lindquist.

20405. Method of producing rapid electrical oscillations and system of devices therefor. Schrottke and Gesellschaft für Drahtlose Telegraphie M.B.H.

20572. Electric induction device for medical and like purposes. Reichenberger and Weiersmüller.

20889. Process and apparatus for the electrolysis of chlorides of the alkalies. Kellner.

21592. Electromagnetic signalling apparatus. Siemens Bros. and Co., Limited. (Siemens und Halske Actien-gesellschaft.)

22486. Electrical range finders. Shoemaker. (Date applied for under International Convention, Jan. 10, 1903.)

23224. Electrically-illuminated signs. Goehst.

23285. Telephone relays or repeaters. Sundquist and Wahl.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.	Last price
Commercial and Industrial.—	£	£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1 ..	½-¾
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1 ..	3/16-5/16
British Insulated and Helsby Cables, Ord., 1-103,000	5 ..	6-6¼
—— 5 per cent. Cum. Pref., 1-100,000	5 ..	5¼-5¾
—— 4½ per cent. Mortgage Debentures	100 ..	103-108
British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red.	100 ..	103-105
British Westinghouse Elec. and Manuf., 6 per cent. Pref., 275,001-375,000	5 ..	4¼-5
—— 4 per cent. Mortgage Debenture Stock	100 ..	100-102
Brush Electrical Engineering, Ordinary, Nos. 1-105,731	2 ..	¾-1¼
—— Non. Cum., 6 per cent. Pref.	2 ..	1¼-1¾
—— 4½ per cent. 1st Debenture Stock	100 ..	97-100
—— 4½ per cent. 2nd Debenture Stock	100 ..	84-89
Callender's Cable, Debentures	100 ..	106-110
—— Ordinary	5 ..	11-12
—— 5 per cent. Pref.	5 ..	5¼-5¾
Crompton and Co.	3 ..	1¾-2¼
—— 5 per cent. Debentures	100 ..	98-103
Edison and Swan United, "A" Shares, 1-98,251	5 ..	¼
—— "A" Shares, 01-017,139	5 ..	1-2
—— 5 per cent. Debentures	100 ..	76-81
—— 4 per cent. Deb. Stock, Red.	100 ..	72-77
Electric Construction, Limited, Nos. 1 to 112,100	2 ..	1¼-1¾
—— 7 per cent. Cumulative Pref.	2 ..	2¼-3
—— 4 per cent. Perp. 1st Mort. Deb.	100 ..	98-101
Ferranti Limited, 5 per cent. 1st Mort. Deb. Stock, Red.	100 ..	90-95
General Electric Company (1900), 5 per cent. Cum. Pref.	10 ..	9¾-10¼
—— 4 per cent. 1st Mort. Deb. Stock	100 ..	96-98
W. T. Henley's Telegraph Works, Ordinary	5 ..	14-15
—— 4½ per cent. Preference	5 ..	5-5¼
—— 4½ per cent. Debentures	100 ..	108-112
India Rubber, Gutta Percha, and Telegraph Works	10 ..	18¼-19¼
—— 4 per cent. Debentures	100 ..	100-103
Parker, Thos., Limited, Ordinary	10 ..	14¼-15¼
Telegraph Construction and Maintenance	12 ..	34-37
—— 5 per cent. Bonds	100 ..	101-104
Electric Lighting and Supply.—		
Blackheath & Greenwich District Ordinary 1,201-101,200	1 ..	⅝-¾
—— 4½ per cent. Deb. Stk. Certs., Red. and Conv.	100 ..	116-119
Bournemouth and Poole, Ordinary	10 ..	12¼-13¼
—— 4½ per cent. Cum. Pref., 7,501-15,000	10 ..	10-11
—— 6 per cent. Cum. Second Pref., 15,001-22,500	10 ..	11-12
—— 4½ per cent. Debenture Stock, Red.	100 ..	103-106
Bromley (Kent) Electric Light and Power Co., 4½ per cent. 1st Debenture Stock, Red.	100 ..	100-103
Brompton and Kensington, Ordinary	5 ..	10¼-10¾
—— 7 per cent. Preference	5 ..	10-10¼
Calcutta Electric Supply Corp., Ordinary, Nos. 1-40,000	5 ..	6¼-7¼
—— Nos. 20,001-30,000	5 ..	7-8⅛
Cambridge Electric Supply Company, Ltd., £10 Ord.	8 ..	14¼
—— ,, ,, ,, £10 Ord.	6 ..	10⅜
Central Electric Supply, Ld., 4 per cent. Guar Deb. Stock	100 ..	105-108
Charing Cross and Strand, Nos. 1-70,000	5 ..	8¼-9¼
—— 4½ per cent. Cum. Pref.	5 ..	5¼-5¾
—— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000	5 ..	4¼-5
—— 4 per cent. Debenture Stock, Red. (Prov. Certs.)	100 ..	105-107
Chelsea Electricity Supply	5 ..	5¼-6
—— 4½ per cent. Debentures	100 ..	107-110
City of London, Ordinary	10 ..	10¼-11
—— 6 per cent. Cumulative Pref.	10 ..	13-14
—— 5 per cent. Debenture Stock	100 ..	122-127
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100 ..	102-105
County of London and Brush Provincial, Ordinary	10 ..	7¼-8¼
—— 6 per cent. Cum. Pref.	10 ..	11¼-12¼
—— 4½ per cent. Debentures Prov. Certs. All pd. Red.	100 ..	108-111
Edmundsons' Electricity Corporation, Ordinary, 1-50,000	5 ..	6¼-6¾
—— 6 per cent. Cum. Pref.	5 ..	6-6¼
—— 4½ per cent. First Mort. Deb.	100 ..	104-107
Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-30,000	5 ..	5¼-6¼
—— 5 per cent. Debenture Stock, Red.	100 ..	95-98
Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000	5 ..	5¼-6
—— 4½ per cent. First Deb. Stock, Red.	100 ..	100-103
Hove Electric Lighting, Limited, Ord., 1-13,000	5 ..	7¼-8¼
Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000	5 ..	10¼-11¼
—— per cent. Debenture Stock Red.	100 ..	100-105

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Name.	Amount paid. £		Last price. £
Kensington and Knightsbridge and Notting Hill	100	..	101-104
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	..	9⅜-10¼
London Electric, Ordinary	3	..	1⅜-2¼
—— 5 per cent. Pref.	5	..	5-5¼
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	..	98-101
Metropolitan, Ordinary	10	..	17½-18¼
—— 4½ per cent. First Mortgage Debenture Stock	100	..	110-114
—— 3½ per cent. Mortgage Debenture, Red.	100	..	96-99
Newcastle-upon-Tyne Electric Supply, Ordinary	5	..	8-8101
—— Preference	4	..	100-103
Notting Hill Electric Lighting	10	..	12½-13⅝
—— 4 per cent. First Mort. Debs., Nos. 1-500 (Reg.)	100	..	98-101
Oxford Electric, Ordinary, 1-96 and 407-14,310	5		5¼-5⅜
—— 4 per cent. Debenture Stock	100		98-101
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	10	..	98-102
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5	..	3-3¼
—— 4 per cent. Debenture Stock	100	..	85-90
South London, Ordinary		..	3¼-3⅜
St. James's and Pall Mall, Ordinary, 101-20,080	5	..	14¼-15½
—— 7 per cent. Pref.	5	..	7½-8¼
—— 3½ per cent. Deb.	100	..	98-101
Urban Electric Supply Co., Ordinary, 8-30,007	5	..	4⅞-5⅛
—— 5 per cent. Cumulative Preference, 50,001-80,000	5	..	4⅞-5
Westminster, Ordinary	5	..	11½-12½
—— 5 per cent. Cum. Pref., 110,101-138,251	5	..	6-6½

Electric Railways.—

Central London, Ordinary	100	..	93-96
—— 4 per cent. Pref.	100	..	99-102
—— ,, ,, deferred	100	..	96-99
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100	..	115-118
City and South London, Consolidated Ordinary	100	..	47-50
—— 4 per cent. Debenture Stock	100	..	109-112
—— 5 per cent. Pref. Stock '91	100	..	126-129
—— ,, ,, ,, '96	100	..	123-126
—— ,, ,, ,, '01	100	..	120-125
Liverpool Overhead, 5 per cent. Pref.	—	..	13-13½
—— Ordinary, 1-50,000	—	..	7⅛-8
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	—	..	102-104
Waterloo and City, Ordinary	100	..	91-94

Electric Tramways.—

Anglo-Argentine, 1-250,007	5	..	4¼-4⅜
—— Permanent 6 per cent. Debenture Stock, 1888	100	..	125-130
Blackpool and Fleetwood Tramroad	10	..	13½-14¼
Brisbane Tramway Invest., Lim., Ord., 1-75,000	5	..	2-3
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5	..	3¼-4¼
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100	..	99-104
British Columbia Electric Railway Co., Ord., Nos. 1-20,000	100	..	79-82
—— Non-Cum. 5 per cent. Pref., Nos. 25,001-38,600	10	..	10-10½
—— 4½ per cent. 1st Mt. Debs., Nos. 1-6,250, of £40 each	40	..	102-104 p.c

Name.	Amount paid. £		Last price £
British Electric Traction, Ord. 1-300,000 & 60,001-80,000	10	—	11⅜-12¼
—— 6 per cent. Cm. Pf., 30,001-60,000	10	—	11¼-11⅜
—— 5 per cent. Perpetual Debenture Stock	100	—	120-123
Buenos Ayres and Belgrano Tram., Ord., 1-100,000	5	—	3-3½
—— "A" 6 per cent. Cm. Pf., 1-40,000	5	—	5½-5⅝
—— "B" 6 per cent. Cm. Pf., 1-27,500	5	—	4⅜-5¼
—— 5 per cent. Deb. Stock, Red.	100	—	106-109
—— Prov. Cert., all paid	100	—	98-101
Cape Electric Tramways, Nos. 1-480,000	1	—	1⅛-2⅛
City of Birmingham Tramways, 5 per cent. Cum. Pref.	5	..	5-5¼
—— 4 per cent. 1st Mortgage Deb., 1-3,000 (1917)	100	..	99-102
Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red.	100	..	100 103
Cork Electric Tramways and Lighting Co., Ordinary	10	—	13-14
—— 5 per cent. Cum. Pref.	10	—	11-12
—— Debentures	100	—	96-99
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10	—	12-13
—— 6 per cent. Pref., Nos. within 1-60,000	10	—	15-16
—— 3½ per cent. Mort. Debs., 1-3,000, Red.	100	—	94-97
Imperial Tramways Ordinary	all	—	22-22½
—— 6 per cent. Cum. Pref.	all	—	14½-15½
—— 4½ per cent. Deb Stock	100	—	112-114
Isle of Thanet Electric Tramways and Lighting, 5 per cent. Cum. Pref., Nos. 30,001-60,000	5	..	3⅜-4¼
—— 4 per cent. Debenture Stock	100	..	92-96
Kidderminster and District Lighting and Traction, Pref.	5	—	3¼-4
London United Trys. (1901), 5 per cent. Cum. Pref.	10	—	11¼-11⅜
—— 4 per cent. 1st Mt. Db. Stock, Red	100	..	104-106
Metropolitan Electric Trams., Deferred, 1,000 001-1,314,016	1	..	3/16-5/16
—— 5 per cent. Cum. Pref., 500,001-814,016	1	..	⅝-1⅛
New General Traction, Ordinary	5	..	¼
—— 6 per cent. Cum. Pref.	5	—	1¼-2¼
—— 5 per cent. Mortgage Debentures, 1-1,715 (Regd.)	100	..	89-94
Oldham, Aston, and Hyde Tramway, Ordinary	10	—	10¼-10⅜
—— 5 per cent. Cum. Pref.	10	..	11¼-12⅛
Perth Elec. Tramways (W.A.) 5 per cent. 1 Mort. Deb. Stk.	100	..	100-103
Potteries Electric Traction, Ordinary, 20,001-40,000	10	—	8¼-9¼
—— 5 per cent. Cum. Pref., 1-20,000	10	—	8¼-8⅜
—— 4½ per cent. Debenture Stock	100	—	102-105
South Lancashire Electric Traction and Power Company—			
—— £250,000 Ordinary	1	—	1
—— £101,132 6 per cent. Preference	1	—	1
—— £528,093 4½ per cent. Debenture Stock	100 p.c.	—	100 p.c.

Telephones.—

National Telephone, Preferred	100	—	101-103
—— Deferred Stock	100	..	76-79
—— 6 per cent. Cum. First Pref.	10	—	13-14
—— 6 per cent. Cum. Second Pref.	10	—	13-14
—— 5 per cent. Non. Cum. Third Pref.	5	—	5¼-5⅜
—— 3½ per cent. Deb. Stock, Red.	100	—	96 98
—— 4 per cent. Deb. Stock, Red.	100	—	102-104
Oriental Telephone and Electric Company	1	—	13/16 15/16

TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line	Traffic Returns for week			Increase or decrease.		Miles of single track open.		Accounts for past year.						Cost per car mile.
	Ending	1903.	1902.	Week.	Current year.	1903.	1902.	Ending	Total receipts	Passengers carried.	Car miles run.	Receipts per Pas-s'nger	Car mile.	Mile of track.	
		£	£	£	£				£			d.	d.	£	d.
Aberdeen Corporation	Dec. 5	1,065	815	+ 251	+ 5,756*h*	19½	17½	May 31	37,931	9,099,715	794,641	0·98	13·02	1,970	6·1
Ayr Corporation	Nov. 21	170	166	+ 4	+ 52	8	6	Sept. 25	12,503	2,979,276	290,099	1·00	10·34	1,560	4·7
Birmingham Tramways	Dec. 5	4,890	4,814	+ 76	+ 9,717	6½	6½	—	—	—	—	—	—	—	—
Blackburn Corporation	,, 4	695	699	− 4	+ 891	24	24	March 25*a*	40,964	7,234,105	826,558	1·36	11·87	1,705	7·44
Blackpool Corporation	,, 3	269	247	+ 2	− 184	17½	16½	,, 31	211,168	6,169,121	784,443	1·52	10·8	—	—
Blackpool-Fleetwood Tramways	,, 5	182	170	+ 12	− 125	16½	16½	Dec. 31	30,923	2,049,677	584,989	3·62	12·68	1,932	6·99
Bolton Corporation	,, 6	1,566	1,467	+ 99	+ 7,957	38	25	March 31	85,704	17,761,605	1,896,247	1·15	10·75	3,430	5·87
Bournemouth Corporation	,, 2	734	—	—	—	10½	—	—	—	—	—	—	—	—	—
Bradford Corporation	,, 6	3,255	2,928	+ 348	—	41	—	—	—	—	—	—	—	—	—
Brighton Corporation	,, 6	696	640	+ 56	— *h*	6½	—	,, 31	—	—	10,432,508	1,031,928	1·00	10·10	—	—
Bristol Tramways Company	,, 4	4,273	4,129	+ 144	—	51½	51½	Dec. 31	223,480	41,192,899	5,724,114	1·30	9·38	4,348	—
Burnley Corporation	,, 5	774	632	+ 142	—	—	—	—	—	—	—	—	—	—	—
Burton Corporation	,, 6	268	—	—	—	—	—	—	—	—	—	—	—	—	—
Cardiff Corporation	,, 5	1,700	1,407	+ 292	+19,443	—	—	—	—	—	—	—	—	—	—
Carlisle Tramways Company	Nov. 23	158	124	+ 34	+ 721	—	—	,, 31	—	2,216,583	320,129*h*	—	—	—	—
Central London Railway	Dec. 5	7,091	7,141	− 50	− 6,910*h*	6	—	,, 31	367,225	45,305,110	1,276,971*a*	1·87	66·6*a*	59,076	35·6*a*
City and South London Railway	,, 6	3,187	3,551	− 364	− 9,330*h*	6⅜	—	,, 31	165,003*a*	19,069,319*a*	—	—	—	—	—
Cork E. T. and L. Company	,, 3	357	380	− 23	− 3,404	—	—	—	—	—	—	—	—	—	—
Darwen Corporation	,, 4	203	217	− 14	− 2·0	7·23	—	March 31*g*	12,341	2,360,735	254,279	1·25	11·65	1,707	9·36
Dover Corporation	,, 5	166	159	+ 7	+ 55	3	—	—	—	—	—	—	—	—	—
Dublin & Lucan Electric Railway	,, 6	84	83	+ 1	+ 174*h*	—	—	Dec. 31	5,796	364,796	102,087	3·81	13·62	359	7·68
Dublin U. T., electric cars	,, 4	3,408	3,470	− 62	} —	46	46	March 31	126,121	24,553,133	3,429,356	1·23	8·82	2,741	5·06*h*
Dublin S. District, Electric	,, 4	650	669	− 19											
Dundee City Tramways	,, 3	775	814	− 39	—	22	22	May 15	35,874	9,084,522	752,814	0·93	11·276	1,630	—
East Ham Corporation	,, 5	529	406	+ 123	+ 7,175	10·75	7·52	March 31	25,341	9,971,337	650,224	0·61	9·35	2,357	—
Farnworth U.D.C.	Nov. 18	133	126	+ 7	—	—	—	—	—	—	—	—	—	—	—
Glasgow Corporation	Dec. 5	13,142	12,109	+1,033	+38,116*h*	124	101	May 31*g*	656,572	177,179,549	14,008,750	0·88	11·25	5,489 *b*	7·40*d*
Halifax Corporation	,, 2	2,158	1,963	+ 195	+ 5,531	30½	27⅜	—	—	—	—	—	—	—	—
Huddersfield Corporation	,, 5	1,140	907	+ 233	—	34	35	March 31	56,631*h*	9,738,213	1,218,539	1·4	11·14	1,618	6·38
Hull Corporation, E. S.	,, 5	1,804	1,657	+ 147	+ 3,856	19	19	,, 31	87,707*h*	21,065,999	2,218,696	1·00	9·49	5,004	5·07
Ilkeston Corporation	,, 2	121	—	—	—	—	—	—	—	—	—	—	—	—	—
Kirkcaldy Corporation	,, 2	184	—	—	—	—	—	—	—	—	—	—	—	—	—
Leeds Corporation	,, 5	4,855	4,518	+ 337	+12,112	77	—	March 25	252,656	57,239,779	5,773,651	1·11	10·91	3,283	—
Liverpool Corporation	Nov. 28	9,582	9,164	+ 418	+15,970	101	95	Dec. 31	504,304	108,906,472	11,705,425	1·11	10·34	5,000	6·88
Liverpool Overhead Railway	Dec. 6	1,504	1,470	+ 34	+ 2,462*h*	15½	15½	June 30	79,252	10,466,726	986,185*a*	1·82	19·30*a*	5,110	— *a*
London County Council	Nov. 22	9,105	6,227	+2,878	+63,648	40	26	—	—	—	—	—	—	—	—
Lowestoft Corporation	Dec. 5	119	—	—	—	—	—	—	—	—	—	—	—	—	—
Nelson Corporation	,, 5	92	—	—	—	3	—	—	—	—	—	—	—	—	—
Newcastle-on-Tyne Corporation	,, 5	3,336	3,011	+ 325	—	38½	36	March 25*g*	150,334	33,474,122	3,379,119	1·08	10·93	4,175	6·17
Portsmouth Corporation	,, 5	1,210	1,165	+ 36	+ 4,265	29	29	Sept. 30	47,651	9,168,137	868,157	1·24	13·17	1,643	—
Rochdale Corporation	Nov. 2	117	121	− 4	—	4½	--	March 31	5,416	925,281	127,456	1·38	10·27	—	7·66
Rotherham Corporation	Dec. 3	385	—	—	—	—	—	—	—	—	—	—	—	—	—
Salford Corporation	,, 7	3,464	2,697	+ 767	+40,788	—	—	—	—	—	—	—	—	—	—
Sheffield Corporation	,, 6	4,056	—	—	—	53½	46½	Mar. 25*g*	216,309	56,812,049	4,926,083	0·904	10·428	7,510	7·0
Southampton Corporation	,, 3	808	895	− 87	—	11	11	,, 31	35,874	9,084,522	752,814	0·946	11·436	3,760	—
Sunderland Corporation	,, 6	1,046	976	+ 70	+ 2,137	18·48	17·18	,, 31	59,930	13,987,121	1,270,957	1·03	11·3	3,243	6·43
Wallasey U.D.C.	,, 5	569	512	+ 57	+ 3,226	10·5	10·5	,, 31*g*	31,474	5,685,182	654,742	1·30	11·53	3,593	7·03

a Includes maintenance of permanent way and proportion of profits paid to the tramway companies for term of unexpired lease. *c* Train mile. *b* per mile of single track. *e* Include rail and tram. *d* including depreciation. *f* Including one section of horse traction. *g* 1903. *h* Half-year's figures.

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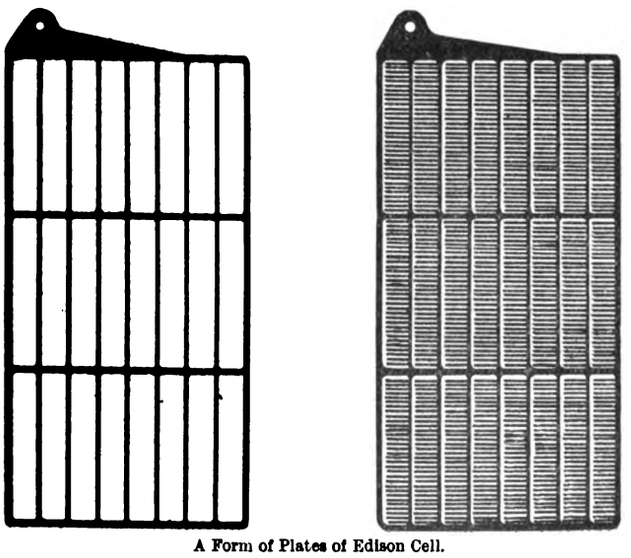
THE EDISON ACCUMULATOR FOR AUTOMOBILES.*

BY W. HIBBERT, ASSOCIATE-MEMBER.

The problem of making an accumulator with an alkaline electrolyte has been before the world for many years, and has been attacked by a fairly numerous body of workers. It is known that Mr. Edison is one of this number, and various public statements have appeared as to the results of his labour. Most of these can be neglected as void of authority, but the account published by Dr. Kennelly before the America Institute of Electrical Engineers was evidently based on carefully executed work. From this paper we learned the general nature of the cell, together with certain useful numerical data. Fourteen watt-hours were obtained from 1lb. weight of the cell, the average E.M.F. being about 1·25 volts. It is not necessary to repeat here the other data from Dr. Kennelly's paper, as they will be brought up to date by the facts to be quoted from my own tests. It is sufficient to say that very little was done during the next year. The matter seemed to fall into the background, and public opinion settled down to a vague belief that the cell had not yet reached the commercial stage. Indeed, I have heard doubts expressed as to the very existence of the cell. To some extent I shared this scepticism, not because I doubted the existence of the accumulator, but because of its constitution. I doubted (and expressed my doubts in print) whether the plates would be altogether free from local action, and whether a very small amount of this weakness would not be sufficient to destroy the plate. These fears were based on the data afforded by Dr. Kennelly's paper, more especially the thinness of the plates, and also the probable results of mixing graphite with the active material. Such anticipations were, I suppose, quite legitimate as anticipations, but they have not been justified by the results of actual trial. It is one of the striking features of the cell that it recommends itself by work more than can be done by any verbal account.



A Form of Plates of Edison Cell.

In the early part of this year I obtained three of Mr. Edison's cells of small size, and in early June was provided with a standard automobile cell. Finally, during part of my summer vocation I was able to run about 500 miles on an automobile driven by 38 Edison cells. The general results of the work done on all these will be described in this paper. I shall confine myself to a somewhat simple statement of the facts verified by myself, feeling sure that these will be most acceptable to the members of the Institute. But it may be worth while mentioning that well-known men at Milan, Paris, etc., have obtained laboratory results which agree in all the main particulars with my own. They have not as yet had the opportunity of testing on the road. A brief description of the cell will be advantageous.

Standard Automobile Cell.—This contains 14 positive and 14 negative plates. Each plate is made of sheet steel, nickel plated, punched with 18 holes of rectangular shape. In each of these holes is inserted a flat pouch or pocket containing the compressed active material. The walls of these pockets are perforated by exceedingly fine slots or holes, through which the liquid can penetrate. Thus the current can easily pass to and from the active material contained in the pockets.

Active Materials.—Both positive and negative plates are alike, except in respect of the active material. The pockets on the positive plate contain nickel peroxide; those on the negative plate contain finely divided iron. Each of these active materials is, I understand, mixed with flake graphite.

Electrolyte.—The liquid is a 20 per cent. solution of potash.

Arrangement.—The plates are fixed very near each other. Yet there does not seem to be any danger of short-circuits. The plates are thin, it is true, but being made of steel, they are thick enough to give rigidity. As a further precaution, vulcanised-rubber separators are put between the plates, making the whole a compact mass, whose stability is calculated to resist all the ordinary mechanical shocks it is likely to undergo.

External Arrangements.—The cell is sealed in its steel case, the top being fixed on by a special solder not acted on by the potash. Two stout connecting pins (from the positive and negative plates respectively) come through liquid-tight bushes of vulcanised rubber. These pins are made slightly conical, as are also the connectors which fit on them, and the mechanical finish and easy grip of this terminal add to the value of the battery. The connector is further secured by a screw nut and fastening pin. The connector has a much higher conductivity than those of the ordinary type of accumulators. On the top of the case there are also (*a*) a spring stopper with rubber flange, covering the hole by which the electrolyte is introduced or distilled water added from time to time; (*b*) a venthole guarded by a gravity valve. This provides for the escape of the gas evolved during charge. The hole and valve are covered by a gauze nipple, which prevents escape of spray while allowing gas to pass. It also prevents any flame finding access to the interior of the cell through the stream of evolved gas.

The complete cell stands 13in. high (over all), and measures 5·1in. by 3·5in. horizontally. It weighs 17·8lb. A large part of the external steel case is corrugated to increase its rigidity. An immediate consequence of examining these features of the cell is to impress the observer with their admirable fitness—perfection is hardly too strong a word. That which is so lacking in ordinary accumulators—mechanical strength or design—is here in obvious and large measure. The general mechanical

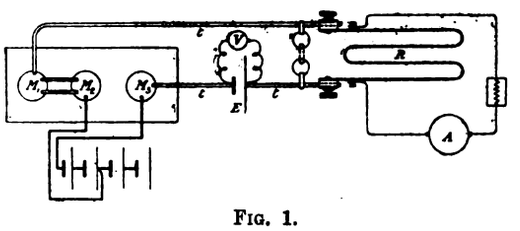


FIG. 1.

structure of the cell is well calculated to remove or to diminish any antecedent adverse opinion.

Electrical Data.—The E.M.F. is 1·33, though, as there is a very persistent gaseous polarisation effect, the figure cannot be regarded as quite rigid. For a long time after charging it is much higher. The internal resistance is 0·0013 ohm. The output at 60 amperes is 210 watt-hours = 11·8 watt-hours per pound. The diagram (Fig. 1) shows the arrangements used for charging and discharging. E is the cell under test; *t t t*, pieces of trolley wire used for connections; M_1, M_2, M_3, mercury cups standing in a large tank full of oil; R, a standard resistance = 0·01009 ohm, verified by the Board of Trade; V and A, voltmeter and ammeter, both recalibrated for these experiments. Large lead accumulators were used for charging E. For the purpose of charging, constantan resistances of varying value and diameter were used to bridge M_1 M_2. For discharging, it was necessary to bridge M_2 M_3 as well. The control of

* Paper read before the Institution of Electrical Engineers.

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either strong or weak currents was quite easy and rapid by putting constantan wires in parallel across the mercury cups. In very few of the experiments did the current vary as much as 1 per cent. The average variation was probably about 0·3 or 0·4 per cent. The curves in Fig. 2 tell their own story. A striking feature of the curves is the relatively high value of the capacity at the higher discharge rates. The difference in ampere-hours at 30 and 60 amperes is almost negligible. Even at 120 amperes the capacity is 93 per cent. of the maximum, and at 200 amperes is still as high as 82 per cent. These results at once indicate a valuable feature of the cell for many of the emergencies of engineering. That the quantity obtainable at the high rates should be such a large proportion of that possible at low rates is both surprising and agreeable.

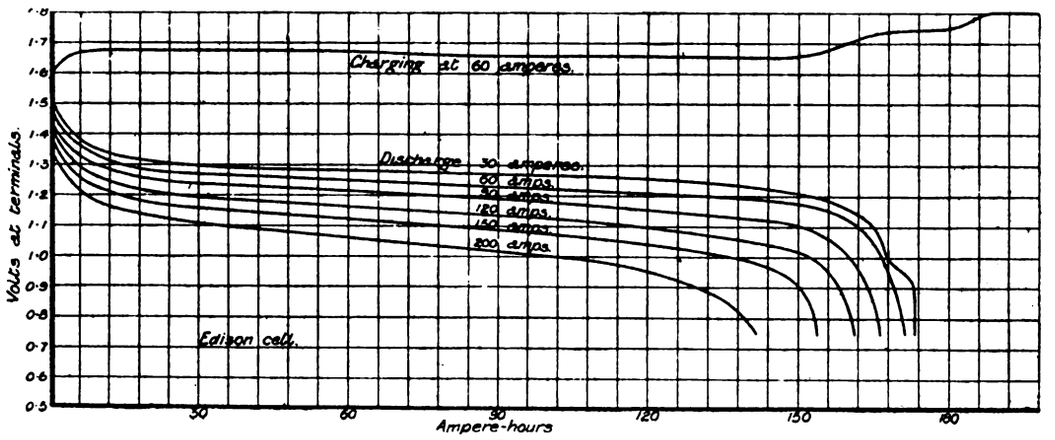

FIG. 2.

Output.—In relation to the weight of the cell the work done is higher than usual. Taking the output at 210 watt-hours,* and the weight at 17·8lb., the specific output amounts to 11·8 watt-hours per pound of cell. This must be regarded as a high figure. It is true that nearly equal figures have been obtained with other cells, but confessedly at considerable risk. The weight of lead cells is reduced by making the supports very thin, but this shortens life. Output can be increased by using stronger acid, but this leads to rapid loss of charge if the cell stands idle. These serious risks do not accompany the method of getting high specific output in the case of the Edison cell. It is, as we shall see, able to retain a large proportion of its charge for a long time, and its relation to "life," although not yet fully verified by my work, is one of very considerable security as far as can be judged by the results already obtained. In relation to volume, the specific output is 88 watt-hours per cubic foot.

Influence of Temperature on Output—In the case of lead cells this is very marked. With the Edison cell no definite series of experiments has been made, but accidental circumstances afford evidence of some interest. Some discharges were taken on two of the few very hot days of last summer. The high temperature of the air, added to the heating effect of the currents, caused the temperature of the cell to rise very high. With a current of 150 amperes it reached 54deg. C. The output rose to 163 ampere-hours, some nine ampere-hours more than were obtained at a temperature of 33deg. This is an increase of 5·5 per cent. in capacity for a rise of 21deg., or an increase of 0·26 per cent. per 1deg. rise.

Other experiments, not specially designed to test the point, indicated a detectable but small increase. The effect is, however, very much less than with the lead cell. With them it may be 2 or 3 per cent. per degree Centigrade. With the Edison cell, a few degrees difference in temperature would produce hardly any change in the quantity output. This difference in the effect of temperature doubtless arises from the difference in the nature of the actions going on in the respective electrolytes. The continued working of the lead cell demands a continued supply of the acid at the internal working faces of the porous materials on the plates, and a rise of temperature helps to provide this by increasing the rate of diffusion of acid from the outside. In the Edison cell there appears to be practically no need for diffusion or circulation of the liquid. It is not an active material in the ordinary sense; it acts only as a conductor. Hence a higher temperature cannot change the action except by diminishing the internal resistance of the cell. Even here the action must be differential. For the liquid will diminish in resistance as the temperature goes up, while that of the plates themselves will increase. The first of these, however, being the greater, will determine the resultant change, with a consequent increase in chemical action before the pressure falls to a limiting value. For example, in the experiment described, which led to a final temperature of 54deg. C., the resistance of the electrolyte would be about 30 or 40 per cent. less than in the corresponding experiment at 33deg. It is also of interest to note that these experiments at higher temperatures were the earliest. The other experiments described in this paper were all done subsequently, and therefore show that no injury had resulted from the heating due to higher external temperature and also to the excessive currents passing through the cell.

* This is at 60 amperes; at 30 amperes the output is somewhat higher.

INTERNAL RESISTANCE.

It is not easy to determine this except at times when the pressure curve is tolerably flat. Attempts were made, however, to get an approximation by opening the circuit for a moment or two and noting the rise in volts at the terminals. The value $\frac{E-V}{C}$ comes out as a tolerably constant figure from the various curves in Fig. 2. It rises from 0·0013 ohm with the lower currents to 0·0016 with the higher. The value does not vary appreciably over the greater part of the discharge. But towards the end, where the pressure begins to fall quickly, the resistance rises at a fairly rapid rate. At the end it may approach 0·004 or 0·005 ohm.

SHORT-CIRCUIT.

With the object of testing the power of recovery, one of the small cells was partially discharged, and then short-circuited for 48 hours. After a subsequent long charge it gave the discharge curve, B (Fig. 3). Compared with

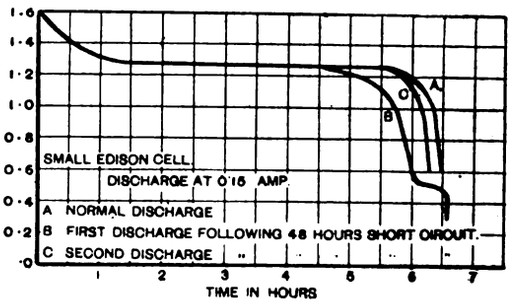

FIG. 3.

the normal discharge curve, A, B indicates a deficiency. It is evident that the cell has not yet recovered. On charging again, however, and taking a second discharge (curve C), the deficit hardly appears; the cell has

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practically recovered from the harsh treatment to which it had been subjected.

High Rate of Charging.

The foregoing experiments prove conclusively that the Edison cell can maintain a high rate of discharge. The interest of this question hangs on its maximum charging rate, and this I have not been able to reach. The following curves (Fig. 4) show the course of an experiment made to test this point. The cell was first carefully discharged at 30 amperes down to 0·75 volt. It was then charged for one hour, 177 ampere-hours being put in. The current was not quite steady, varying from 180 to 176 amperes over most of the time. Near the close of the hour it fell to 166 amperes. The subsequent discharge shows that 124 ampere-hours were delivered, which equals 70 per cent. of the charge. Further experiments on this point appear in the later section dealing with the

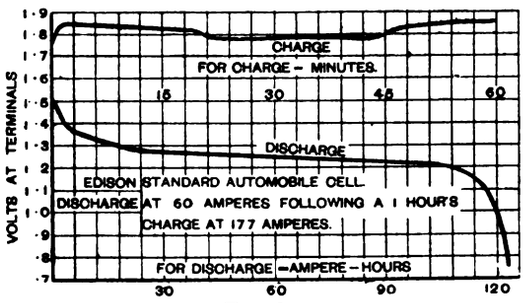

Fig. 4.

motorcar work, proving that the cell can be charged at over 200 amperes.

Flexibility of the Cell.

The new cell will probably be called upon to stand very rapid and large fluctuations in the value of the current. The following curve (Fig. 5) shows that it behaves like an elastic structure, its pressure rising and falling with varying demand, but responding at such a rapid rate that the lines of changing pressure appear vertical on the diagram. The change to and from 230 amperes will appear more trying if the weight of the cell be kept in view.

Continued Discharge at Lower Voltage.

In most of the experiments so far described the discharge was stopped when the terminal voltage fell to 0·75. At this point, as all the curves show, the pressure is falling rapidly, and would lead to the assumption that it must speedily reach zero. But this is not the case. At

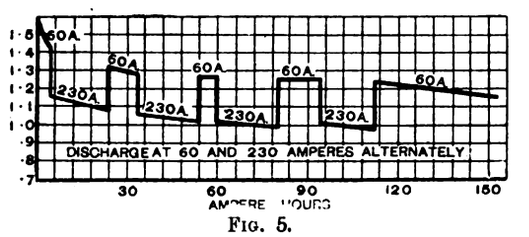

Fig. 5.

a still lower pressure the rate of fall suddenly alters, and the curve becomes flat again. Presumably this is due to a secondary chemical action arising when the active materials have been more or less changed by the ordinary discharge. The curves given below (Fig. 6) indicate the extent and variation of this prolonged discharge. They were given by one of the small cells containing four pockets—two positive and two negative. The currents are small, but the indications are typical of the behaviour of larger cells.

Effect of Rest.

There are many experiments in my notebook which show that the cell does not suffer when allowed to stand discharged for fair lengths of time. A very good illustration will be given when dealing with the motorcar trials. A parallel question arises as to how far the cell can retain its charge when allowed to stand idle. Various trials have been made, two of which may be mentioned. A cell was charged fully, and allowed to stand 48 hours before discharge began It then yielded 155 ampere-hours = 91 per cent. of the full discharge. Part of this deficiency is undoubtedly due to the fact that a discharge commencing immediately is enriched by the gases contained in the pockets along with the active material. The experiment just alluded to was, therefore, regarded as giving an idea of the immediate value of this gas effect, along with the 48 hours' action due to a short rest, such as the experiment was intended to detect. To get a better estimate of the effect of rest on the active materials, the cell was now charged up again and allowed to rest for 26 days. The discharge which followed gave 124 ampere-hours. Com-

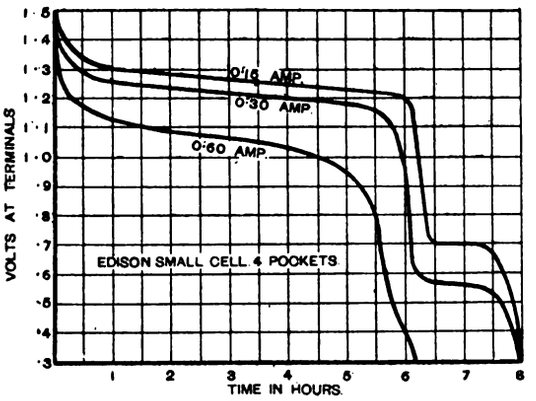

Fig. 6.

pared with the full discharge—170 ampere-hours—this is equal to 73 per cent. But compared with the discharge taken after two days' rest, we have an efficiency of 80 per cent. after 24 days' rest. That is to say, the active material lost only 20 per cent. of its charge in 24 days. The reference here made to the effect of rest on a charged cell makes this a convenient place to say how persistent is the effect of the electrolytic gases on the E.M.F. When charging is complete the E.M.F. is about 1·6 volts, and if the cell be left on open circuit the value falls very slowly to about 1·35. It may be interesting to give a curve showing the time change in the E.M.F. when the charged cell is allowed to stand.

Efficiency.

Efficiency is not very much considered in the present methods of working traction cells. A laboratory experiment is of much less use on this point than on many others. The strength of acid employed enjoins on the user the advisability of charging up when the car comes in, and of giving the cells a "buck-up" charge if much time elapses before the car is used again. This reduces efficiency.

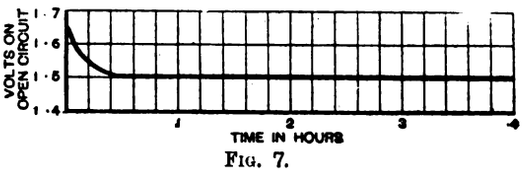

Fig. 7.

Tested on the bench, the Edison automobile cell has an efficiency varying from 66 to 50 per cent. Charged and discharged at 60 amperes, I found it to be just about 60 per cent. Charged at 100 amperes and discharged at 60, the efficiency was 56 per cent. Charged for one hour at 177-ampere rate and discharged at 60 amperes, the efficiency was 50 per cent. The highest figure (about 66 per cent.) was obtained at 30 amperes. These figures are lower than would be found with good lead traction cells under the same condition of discharge following immediately after charge; but the experiment before described, in which a cell was kept charged for nearly four weeks, proves that under garage conditions the Edison cell would have a much higher efficiency than the cells now used. The point is of secondary importance only, as the total cost of keeping a car in running order is so high in relation to the cost of energy that variations in the latter are of small moment.

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Observations on the Road.

In considering the conclusions which could legitimately be drawn from the foregoing laboratory experiments, it was obvious that the results might be objected to on the ground that an accumulator intended for automobiles ought to do its work on the road, subject to all the irregular vibration which travelling entails. The force of this objection is obvious, and I was anxious to get some chance of watching the battery under running conditions. Fortunately, some 40 cells arrived from America in July last, and Mr. Dick had 38 of these placed on a runabout, and gave me the chance of observing their behaviour. To this opportunity I could devote only a part of my summer holiday, and, therefore, the observations do not cover such a long run as is desirable. But they were long enough and varied enough to show that the laboratory results are still obtained when the work is done on the road. A brief description of the car will suffice. It was a runabout made by the Stadebaker Company, of Indiana, weighing, when fully loaded and carrying two persons, about 1,950lb. Of this 700lb. was due to the 38 cells and their wooden frames. Unfortunately, the battery and motor were unhappily mated, the latter being a Westinghouse 40-volt 24-ampere machine, while the cells gave an average pressure of about 48 volts. The motor was, therefore, overloaded all the time, and if it had been a point of importance to investigate the motor and car as well as the battery some changes would have been necessary, but as the battery could by careful observation be tested independently, and as time was not too plentiful, the car was accepted as it stood. It is not necessary here to describe any of the mechanical details. The controller had four stops with four speeds, but the first and second were hardly ever used except momentarily. It remains now to state the results of the tests. The form in which this is done is of some importance, because it ought to deal with the battery side of the investigation. Traction questions proper are subsidiary. A brief statement will clear them out of the way.

Tractive Effort.—On good level road the speed was close to 14 miles per hour, and the power about 1,920 watts, which is practically equal to 2,200 watts per ton. These figures indicate about 79lb. per ton for the tractive effort. Allowing for the motor efficiency, and putting it at 85 per cent. (probably not so good because of overloading), the tractive effort is 67lb. per ton. The work appears to be about 135 watt-hours per ton-mile, a higher figure than is usually taken in America. This is not astonishing, considering the want of balance between battery and motor.

Cost of Power.—Fourteen miles meant nearly two Board of Trade units. If we take the efficiency of the cells as low as 50 per cent. (it is always low in electric tration as usually carried out), the charging would be four units. At 2d. per unit the cost would be 8d., or 0·57d. per mile. Turning to the battery. The programme I drew up was intended to yield answers to the following questions: (1) Is the capacity of the cell the same when running on the road as when discharging in the laboratory? (2) Will the battery stand excessive discharge rates on the road? (3) Will it take a rapid charge and utilise it on the road? (4) Will it recover after lying discharged for some time? (5) Does the capacity change in any detectable degree by reason of the mechanical agitation? (6) What attention is required? When the car was handed over to me it had already been driven by the battery a distance of about 400 miles. This work was done in Paris, the charging being arranged by M. Gadot. This part of the work, however, I do not describe, the purpose being to exclude all but my own work.

The following is a diary of our runs:

		Miles.
Aug. 29.	Standing discharge: 159 ampere-hours.	
,, 30.	Paris to Versailles and back, through the park of St. Cloud. Good climb. Run about Paris	39
,, 31.	Eighteen miles towards Rouen and back. About Paris	48
Sept. 1. to ,, 4.	Journey to London. Car ran across Paris, then train to Havre; train also from Southampton to Waterloo. Motor overhauled at Niagara Garage, and then finished the discharge by running round London. At Southampton the battery had to be partially discharged through wire.....	29½
,, 5.	London to Northampton, stopping at Dunstable for a partial charge. Part of the discharge was taken next day round about Northampton	77½
Sept. 7.	Northampton to Leicester. One stiff climb at Hopping Hill	32
,, 8.	Partial charge at 100 amperes for 90 minutes = 150 ampere-hours. Leicester out towards Nottingham	
16	miles and back through Loughborough	38
,, 9.	Charge 225 ampere-hours. Repeated yesterday's run with extension. Discharge 150 ampere-hours	
,, 9.	Charged 1 hour 55 minutes, 219 ampere-hours. Repeated the Loughborough run	77
	Last six miles run out next morning..	
,, 10.	One hour's charge, 150 ampere-hours. Same run. Discharge, 107 ampere-hours. (32 miles.)	
,, 10.	Charged 1 hour 20 minutes = 242 ampere-hours, and started off for Northampton. Storm all the way. Wind dead ahead. Most excessive discharge	65
,, 11.	Northampton to London, with partial charge at Dunstable. Run about in London	71
	Allowed to stand discharged for 10 days.	
,, 20.	Charged for one hour. 186 ampere-hours. Run round London	31
,, 29.	Standing discharge: 158 ampere-hours.	

The total distance run is 508 miles while under my control. Adding the 400 miles run before that time gives 908 miles. It will be observed that several runs were made from Leicester. This was due to the fact that Mr. Hales, the engineer to Mr. Wathes, was kind enough to arrange that he would be ready to assist in charging just as I liked, and at any hour. Mr. Hales also chose for me the route followed, my request being that it should be a fairly typical English road. The conditions of each run were decided not by the desire to make so many miles, but to solve one of the six questions already mentioned.

1. Is the capacity on the road equal to that found in the laboratory? In order to answer this and some other questions, I determined to eliminate the influence of car and motor, and to record observations of voltmeter and ammeter while discharging, just as is done in the laboratory. It seemed to me that the trouble involved (travelling with watch and note-book in hand) was worth facing, and it certainly taught me a great deal which could not have been definitely known in any other way. As will be seen in the Section 5, a preliminary experiment proved that the battery had a capacity of 159 ampere-hours at 60 amperes.* The question was, would the same quantity be available on the road? From the many observations, I choose the record of Sept. 9 as one of those most closely watched. The run was from Leicester to some miles beyond Loughborough and back, with a final run round Bradgate Park-road; distance = 40 miles. Eighty observations of current during the 3½ hours make the ampere-hours 150. As the discharge was not then quite complete—the volts being above 0·75 per cell—it is evident that the quantity delivered in one complete discharge was practically the same as that found in the laboratory.

2. Will the battery stand excessive discharge rates on the road? The original intention was to allow this to be determined by choosing stiff gradients for the car to negotiate. Accidentally, however, and most unpleasantly, we had a better test than that The return journey from Leicester to Northampton was commenced in the afternoon of Sept. 10, the day of the great cyclonic disturbance which spread over England and the West of Europe. That 32-mile run will not easily be forgotten. My ordinary observations were impossible. Recording was a failure; but I mentally noted that the current on the level rose to 55 or 60 amperes instead of 40, the wind being dead ahead and roads greasy. On the slopes the current was frequently 90 and 100, and on one hill the index passed out of my sight, and must, therefore, have been momentarily more than 150 amperes. The journey took four hours, as compared with 2·5 hours on our outward course. The last six or seven miles were covered at a slow pace, and an interesting point crops up in that connection. Although I could not make a written note of the instrumental readings, I kept a pretty constant eye on the ammeter. While these data were fresh in my mind I calculated the discharge from the cells, and made it close to 190 ampere-hours. I regard this as a figure which errs on the side of deficiency rather than excess. If it be asked how this

* This is somewhat lower than I found in the laboratory. Detailed examination of the 38 cells proved that two cells were of decidedly low capacity—probably from the beginning. This would account for the deficit.

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excessive quantity could be obtained, the answer must be found in that extra delivery at lower voltage. For many purposes this low-pressure discharge is useless, but for an emergency like that of this stormy afternoon it is a great consolation! It helps to carry the car home, although not counted in the normal capacity of the cell. It is noteworthy that the cells deliver the normal current with this lower voltage for quite an appreciable time.

3. Will the battery take a rapid charge (say one hour) and utilise it in discharge? Several experiments of this sort have been recorded. A one hour's charge was tried at Leicester. Unfortunately the supply station belonging to Mr. Wathes was in a state of transition, but his chief engineer, Mr. Hales, took considerable trouble in giving us special facility; 150 amperes was the maximum current we could get at the time, owing to the unfinished state of the new building and machinery. The cells received 150 ampere-hours in the hour, and in the subsequent run delivered 107 ampere-hours = 71 per cent. of the charge. This is exactly the figure found in the laboratory test, and also in the standing discharge test described in (4) and (5). From these three experiments it is clear that with currents of 200, 175, and 150 amperes continued for one hour each, the cell absorbs about 70 per cent. of the charge. I have not had facility for trying a still higher current, but it seems probable that the same proportion would hold good even with a higher current. In Leicester, as in London, the run obtained from a one hour's charge was quite satisfactory.

4. Will the battery recover after standing discharged? The car was run about until its speed, and also the voltmeter, indicated that we were on the final slope of the discharge curves. The car was then allowed to stand 10 days in the discharged condition. At the end of that time it was charged as follows: For 44 minutes at about 200 amperes = 156 ampere-hours; for 16 minutes at about 120 amperes = 30 ampere-hours—total = one hour's charge = 186 ampere-hours. The car was then run round London, and covered 31 miles, yielding 134 ampere-hours. This figure for the discharge was found by numerous observations taken during greater part of the run, combined with less numerous readings for the rest of the time. The efficiency is $\frac{134}{186} = 72$ per cent. From these data it is obvious that the behaviour of the 38 cells after 10 days' idleness in a discharged condition is very similar to that observed in the laboratory when quite new, and also very similar to that observed at Leicester under high charging rate. It was thought that the combination of harsh treatment due to standing discharged followed by excessive charging current would prove specially trying, but the cells behaved very well even under these circumstances. The test now recorded was followed by the final test on capacity as recorded under (5), the two tests taken together giving a decidedly affirmative answer to the question now under discussion. As the question respecting the wisdom of leaving a discharged cell idle is one of great importance, I will make one other remark. No injury appears to arise—the cell works as well after as before. But it is advisable to charge for a longer time after such an idle time. The chemical actions — the absorption changes — are a little slower than usual; or perhaps it is more accurate to say that a greater proportion of active material is in need of restoration by the charge.

5. Does the capacity change in any detectable degree by reason of the mechanical agitations due to running? Accumulators used for automobiles always deteriorate in capacity after a longer or shorter time. Roughly speaking, even a good battery of the lead type shows a diminished capacity after about 600 miles run, even by the crude test of miles per charge. Such a test must always be crude, because of the influence of the road, wind, and gradient on the distance covered, even while the battery is still fresh. As other duties prevented me taking charge of the car for more than 16 days, with no possibility of running anything like 1,000 miles, it was necessary to arrange for an accurate test of capacity at the beginning and end of the trials. A standing discharge was therefore taken at Paris on Aug. 29, and gave 159 ampere-hours. This is slightly less than that found for a single cell in the Polytechnic laboratory, but on examining each cell two were found to be decidedly low, and these two brought down the pressure to the final limit rather prematurely. However, as this figure was to act merely as a standard of comparison for a similar final test, it was accepted, with all the disadvantage of two somewhat inferior cells. On Sept. 29, after running 508 miles, the final standing discharge was taken, and gave 158 ampere-hours. In these experiments the errors of observation may exceed 1, but do not rise to 2 per cent. The result may be regarded as showing that the capacity remained intact during the 500-mile run. Remembering that there were two cells in the 38 which were obviously low—probably from the beginning—it is doing no violence to accept the capacity as normal at the end of my trials, and therefore at the end of something like 900 miles run since they were put on the car. Fig. 8 gives the discharge curve. The observations at Paris and at London

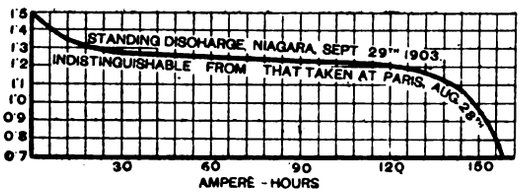

FIG. 8.

are indistinguishable on the scale to which this curve is drawn.

ATTENTION REQUIRED.

To practical men this is a most important point. They have not generally done justice to accumulators, because they have been unwilling to give them that unceasing examination which is devoted to the other parts of their mechanism. If the Edison cells needed more attention than that now given to lead cells, the need would be an objectionable feature to the men who have most to do with them. It was for this reason that I was so anxious to add to my laboratory work a series of trials from the garage point of view. For example, the laboratory could never decide one most simple question. The terminals and connections of the new cell cannot be "burned" in any way comparable with the method adopted for lead cells. Would the mere surface contact and screw nut adopted by Mr. Edison make a lasting connection? Laboratory trials were useless for answering this question, even though it was obvious that the design of the terminal was exceedingly good from the mechanical standpoint. However, my 500 miles on the road were sufficient to test them. Not one of them failed or became weak. Not one of the terminals proper had to be touched from the beginning to the end of the run. We had rough roads and rough weather, so that the motor was seriously overloaded, and the car was so strained that it had to go into serious repair as soon as our run was finished, but the battery and its terminals endured it all. I was especially pleased to see that in the last charge but one, with a charging current of 200 amperes, the contacts were still so good that not one of them became unduly warm. Considering what they had gone through, this was a very good testimonial. Another point about which I had some misgiving, and one that had been mentioned in the American papers, was the question of frothing. It was said that in charging, the evolved gases caused so much frothing that the liquid would soon be run out at the venthole.

During my laboratory experiments, extending over two months' continuous work, frothing occurred on two separate occasions. But on each occasion it lasted for about one minute only. In both cases it occurred at the end of a long charge. On the road frothing occurred with one or two cells on two occasions. Even these did not persist, and their evidence was rather in favour of the result being accidental. It is true that on the Continent I came across a cell which was said to froth rather persistently. But this probably arose from a very simple fact. A workman is very apt to treat the one kind of accumulator as he would the other. I found one of them even using oily

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waste to polish the cap which covers the vent-hole. It is obvious, however, that many kinds of grease will be objectionable, seeing that with the alkali they readily form soap solution, with a consequent tendency to froth. Soap, grease, and all other colloids ought, of course, to be excluded, and are excluded rigorously from the cell. As the 38 cells on the car were practically free from any degree of frothing worth mentioning, although they were put together by men who had never seen the cell before, and as this agrees with my own experience in the laboratory, I think that the objection made on this ground cannot be substantiated. The point which requires attention, and which cannot be neglected with impunity, is the necessity for adding distilled water from time to time. As far as my own experience went, this was needed after about five or six chargings. This meant after each 160 to 170 miles run with our car. The frequency of the water addition cannot, however, have any settled relation to miles run. It depends on the number of times the cells are charged, and especially if overcharged. As different cars equipped with variable relative weight of battery run different distances on one charge, it is desirable to get this matter put into the right form at once. The men working at garage charging stations are apt to interpret everything in miles.

Life.

Respecting life, there is the general favourable tendency of the evidence already adduced. The cells used in the car had not changed by a detectable percentage of their original capacity at the end of my contact with them. That is the most direct testimony I can offer at present. Chemical examination is proceeding, but has not as yet reached a stage at which I can add to the present knowledge. The chemical changes may be summed up in the following equation:

After charge — After discharge

$$\left\{ NiO_2 \;\middle|\; KHO \;\middle|\; Fe \right\} \text{ becomes } \left\{ NiO \;\middle|\; KHO \;\middle|\; FeO \right.$$

But it is better to write the equation in a manner which, though less simple, will be more in accordance with the practical requirements. Thus:

After charge

$$n \,.\, NiO_2 \;\middle|\; \begin{matrix} KHO \\ 12\ H_2O \end{matrix} \;\middle|\; m \,.\, Fe,$$

After discharge

$$\begin{matrix} (n-p)\ NiO_2 \\ p \,.\, NO \end{matrix} \;\middle|\; \begin{matrix} KHO \\ 12 \,.\, KHO \end{matrix} \;\middle|\; \begin{matrix} (m-p)\ Fe \\ p \,.\, FeO. \end{matrix}$$

If I am asked my opinion as to the probability of life, the reply is definite enough. Having had these cells under close observation now for some months, I believe they will live in working order for much longer time than is usual. How much longer I cannot say, but I look forward with some confidence to such a duration as will make the Edison cell a permanent and valuable addition to the resources of electrical engineers.

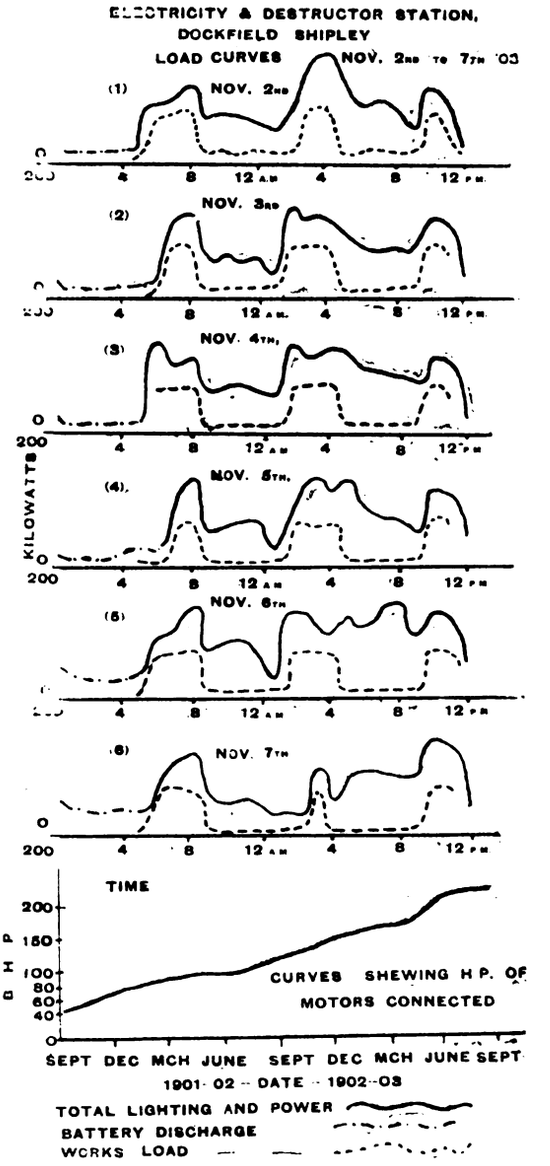
DESTRUCTOR AND ELECTRICITY STATIONS IN SMALL TOWNS.*

BY S. D. SCHOFIELD.

(Concluded from page 809.)

Herewith will be found load curves showing the output for lighting and power at Shipley for the six days ending Nov. 7, 1903, and these have a vastly greater influence on the reduction of costs than any assistance given by the destruction of refuse. Curve No. 7 shows the increase in brake horse-power of motors supplied with current from the same station, quarter by quarter, from September, 1901, to September, 1903 A traction load is no doubt an advantage to a station, but in this case it takes second place to the advantage obtained from a motor load.

The writer considers that whilst economies may be effected in combined stations, it is often at the expense of the electricity undertaking It is a significant fact that the best results are obtained at electricity stations. Obviously the site for a destructor station will be where the cost of carting the bulk of the refuse will be reduced to the lowest figure. The site for an electricity station is in the centre of the area of supply, so that there will be a minimum of expense in laying feeder cables and a minimum loss in supply. If these two coincide, and sufficient land can be acquired to allow for the destructor, clinker yard, mortar-grinding machinery, etc, incidental to a destructor plant, then this is one point in favour of combining the two stations.



With regard to financial arrangements with the Health Committee and the Electricity Committee, the following is a suggested basis worked out on the costs already quoted: The value of 40 units per ton of refuse (less 10 per cent. for cost of keeping coal-fired boiler banked up, ready to take the load when refuse is burnt up, less 10 per cent. for unreliability of supply and varied character of the refuse, less 5 per cent. for management and supervision), at a fuel value of ·266d. per unit, is equal to 8·1d. per ton of refuse. The cost of labour alone in destroying is 1s. 1½d., so that a bonus of, say, 4d. per ton would meet the case. The Health Committee to find interest and sinking fund on the plant, and be credited with any by-products, such as clinker, etc., the Electricity Committee to find all labour, supervision, etc. Repairs to be charged to the Health Committee. This would leave a net cost to the Health Committee for labour of 4d. per ton, which is about equal to the cost for rental of tips. With this payment the destructor would not overburden the electricity supply undertaking, particularly in the early days of the station. Where a sufficient outlet for the power can be found in

* Abstract of paper read before the Leeds Local Section of the Institution of Electrical Engineers.

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driving mortar mills, sewage pumps, tools, and machinery in a central depôt, then it is preferable to use it in that manner. In adjusting the arrangements, care should be taken that neither side should be making an illegitimate profit at the expense of its partner.

APPENDIX.

The Shipley destructor station was originally coupled to the sewage outfall works, but at a later date it was considered that it would be an advantage to have the electricity works also on the same site in order that the steam raised by the destruction of refuse (over and above that required for sewage pumping) might be used in that department. The result is that sewage pumping and outfall works, refuse destructor, and electricity supply for lighting and tramways are all on the same site. The destructor is of the Meldrum regenerative type, consisting of furnace, combustion chamber, Lancashire boiler, and regenerator. Refuse is tipped into the adjoining hoppers, then withdrawn from the bottom by hand, and fed into the furnace opposite. The cells are so arranged that the fire is continuous over the whole of the grate, the forced draught being localised by closed ashpits. By this method any part of the grate can be worked singly, or any part shut off while the remainder are in use. The air for blast is heated by being passed around cast-iron pipes, through which the gases from the boiler flues are directed. The temperature of the air as it enters the destructor varies from 280deg. F. to 350deg. F., 320deg. F. being the average. One advantage of the open grate is the mingling of the gases from the duller and brighter portions of the fire, thus giving a better and more even combustion in the furnace itself. After passing over the furnace bridge the flames and gases enter the combustion chamber, and the temperature obtained therein is so high that the deposited dust is fused into solid clinker. The maximum capacity of the destructor, with average ashpit refuse, is 50 to 55 tons per 24 hours. At Shipley there is not more than an average daily supply of 25 tons, and this, of course, is easily disposed of. The boiler-house equipment includes a Green's economiser of 192 tubes and two 30ft. by 8ft. Lancashire boilers, with superheaters, these boilers being fired by coal. The generating plant consists of three Parsons turbines direct-coupled to three 240-kw. compound-wound direct-current dynamos, suitable for either traction or lighting; a Tudor battery of 260 cells; a 50-kw. traction motor direct-coupled to two 25-kw. lighting generators, which are used for supplying tramway current from the lighting side, and lighting current from the tramway side, and also running as an ordinary balancer; a reversible battery booster, driven by a motor off the traction 'bus bars, for equalising the load on the traction generators. The sewage pumping plant consists of a 9in. "Gwynne's" centrifugal pump, direct-coupled to a 60-h.p. compound motor, and a 7in. pump coupled to a 30-h.p. compound motor.

DISCUSSION.

Mr. W. Emmott said the author had not placed the destructor in too favourable a light, as evidently if he could do without one he certainly would, but he gathered from the past history of the Shipley station that it was very much indebted to the destructor in its early days. Of course no one would adopt a destructor with the pure object of saving coal. The destruction of refuse in a town was an absolute necessity, and under the circumstances the municipal authority had to get rid of this refuse: then every penny earned by that means was of value, and credit should be given. The difficulty was generally with the Sanitary Committee in that they often wanted the refuse taken and destroyed whilst they were to be charged nothing for the same. Regarding the dust from the destructor, the only way to get over it was to place the electricity station and the destructor back to back. One point about a combined station was that better destruction of the refuse was obtained, because steam was bound to be kept within measurable limits of the standard pressure in order to keep the engines going, especially with a choppy load. If, however, the destructor was simply generating steam for pumping purposes, the steam pressure might be varied 30 per cent., or even 40 per cent., but by so doing there was a risk of the refuse not being so well destroyed as would be the case under a combined electricity and destructor station. He then alluded to the variation in the height of chimneys used in connection with destructor stations, and would like to raise the question as to the average height of the chimney necessary. He maintained that 90ft. to 120ft. was quite enough, but there seemed to be a tendency to carry the chimneys to 150ft., and even higher. He supposed the idea was that the further the chimney was carried the further away the noxious fumes were sent, but, as a matter of fact, there were none. It was said that the firebrick lining of a destructor chimney should go to the top. If there was occasion to turn the gases through the by-pass and regulate this, there was no reason why two-thirds of that lining should not be enough. On a plant with which he was concerned a preliminary test had been made, and he might say that they destroyed 15 tons of refuse in eight hours, the refuse being a combination of sludge which had left the sewage works where the deposit was very rich. The staple trade being woollens, it was noticed that when the sludge was dried down to, say, 60 per cent. of moisture there was a lot of oil, and in order to roughly test the value of this stuff firing-up was done with varying ratios of refuse and sludge. First 2 to 1, then 1 to 1, and, finally, steam was kept up with sludge alone. He saw clearly that there was a great deal in the stoking. The sludge was accumulating at the rate of 60 tons per week, and could not be given away, so that it was necessary to destroy it. Generally, he might say that when the plant was properly working they would be able to get 1·25lb. of steam gross from 1lb. of mixed sludge and refuse in the ratio of 2 to 1.

Mr. W. B. Woodhouse said that he entirely agreed with the author as to the destruction of refuse being purely a sanitary matter, but he was afraid that that was not always believed. Although the question of cartage was important, he thought it was more important to consider the sensibility of the people, and therefore the destructor should be away from the dense portions of the town, and, therefore, hardly the best position for a power station. Barging away to sea was an obsolete method, although there were a great many places favourably situated on Tyneside where the cost of barging the refuse was at the most 5d. per ton, and he did not think any burning could compete with that. Another point was that where coal was cheap refuse was good, and *vice versâ*, and that was where a destructor was useful. Regarding the table given, he noticed that Shipley had a very good load factor, and presumed that the 66·8 included charging battery, etc., and was not the load factor on the running power. He would like some idea as to how many pounds of water per unit generated, and, generally, as to whether the conditions in the various tests were the same; but certainly, with a fair price for coal, 7·1 per unit with a load factor of 66 per cent. was quite absurd. He could generate a unit from 3½lb. to 4lb. of coke, and he was sure that with that load factor he could generate very much more cheaply. The omission of water per unit generated made it difficult to criticise the table, and that rather serious point—namely, the capital cost—was overlooked; also he thought that the lighting and destructor stations should be kept separate, because, if the generating station was put in the centre of the town, where it would feed the area most economically, then that was the wrong position for the destructor, which should be away from the centre of the town. If, however, the destructor was put in the wrong place, then, when the load came on the station, it would be found that the destructor was quite insufficient to deal with the demand, so that actually a combined station was only useful in the early years of an electricity station.

Mr. Pickersgill said that he quite endorsed the previous speaker's remarks. In a short experience he would say this in favour of destructors, that on a low load factor he could generate all the energy necessary for driving nine miles of tramway through one Meldram furnace, although if the load was anything like an average of the maximum he could not do so. There was a great difference of opinion as to the arrangement of destructor boilers, and he had arranged the steam-pipes at Cleckheaton with automatic valves, which were really back-pressure valves, in between the main valve and the steam valve, so that when the steam was highest in the destructor boilers it shut down the check valve on the coal-fired boiler even when the fires had just been blown. As soon as the clinkering process took place the temperature in the combustion chambers fell and thus steam was lost, and as soon as the other boiler got a rush of steam it closed the check valve on the destructor, thus giving time to get the steam up, and thus did not cause the destructor boiler to act as a drag. The refuse that was obtained at Cleckheaton averaged over 70 units per ton destroyed. The figures given by Mr. Schofield were actually taken by watt-meters, and include current for tramway purposes, the load being so arranged on the charging battery on the other generators that the steam was kept practically constant the whole of the time. Had the tramway load been higher, no doubt they could have got more units per ton, as for a considerable time steam was blowing off at the boiler, and the batteries could not take a larger rate of charge.

Mr. A. B. Mountain said that, with respect to the load factor at Shipley, it had probably been taken on the hours that the plant was running and not on the total for the year. He thought that the total cost given—namely, ·26—was too low, as there were few places in England having a lower cost than ·4, and, therefore, the comparison was hardly a fair one. There was a very great discrepancy in published figures as to the actual cost of destroying refuse, and what was really required was some definite figures on capital outlay, interest, special fund charges, and repairs.

Mr. Meldrum said that it would be agreed the author had not put too favourable a construction on the destructor, and he thought he was right, because there was a great danger of people running away with the idea that a destructor was a gold mine. As an instance of the unfavourable comparison in the case of the destructor no superheating was done, and that alone would make a very marked difference, particularly seeing that he had a Parsons turbine which would stand any amount of superheat with distinct advantage. He thought that the 49 units given would have more nearly reached 60 units had superheating been carried out, in which case the balance-sheet would have been more in favour of the destructor. Again, he said that in September he got the best results and that he considered this month one of the best. From a very wide experience, however, he (the speaker) would say that July, August, and September were practically the worst months in the whole year, because during that time very little coal was used in

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domestic fires, and also that was a period when most vegetable refuse was found. During that period the calorific value of the refuse fell in some places 50 per cent., but on an average it would be from 15 to 25 per cent., and consequently if the author had made a test in November or December under the same conditions he would have obtained very much better results, which, however, were very satisfactory In corroboration of what he had just said, he would mention that tests had been carried on in the London districts for several months past, and during November almost 50 per cent better results were obtained than in September, partly due to the late tremendous rains, and partly due to the fact that more coal and less vegetable matter appeared in the refuse. The author said that the value of refuse was in inverse proportion to the price of coal, but he did not quite agree with him. He had before him tests of a station at which coal cost about 25s. per ton, and the evaporation was 1·41b. of steam per pound of refuse. Again, at Grays, in Essex, where coal was 21s. per ton, the units produced were 42; and at Sheerness, where the price of coal was very high, the evaporation was approaching 1·5 per pound. Again, at Hereford, with coal about 18s. per ton, results had given 1·5 or 1·6 per pound of fuel, whereas the author gave a figure of 1·7 with coal at about 7s. per ton, so that he did not agree with the author's conclusions. In giving the balance-sheet in favour of the Corporation he mentioned £270 clear gain, but did not give the value of the clinker, although he believed that the whole of it was used, and questioned if it were to be bought whether it could be got for less than 2s. 6d. per ton. If this item be added (say, 2,000 tons), there was a further sum of £250 in favour of the destructor, making a total of something like £520 clear gain. To get over the difficulty of putting a destructor in the centre of a town adjacent to the electricity works, some corporations were now putting the destructor at the most convenient point for its purpose whilst putting the electricity works at the most economical point, putting down at the destructor a generator large enough to utilise the whole of the heat, and carrying the current from there on a feeder either to the switchboard of the electricity station or else on to the cables at the nearest point. One place where that was done was near London, and in that case the Electricity Committee received ·75 of 1d. per unit, which was quite a liberal allowance, the whole of the capital charge being placed to the debit of the whole committee. It was rather astonishing to find that, in spite of all that was said against destructors, four out of every five destructors ordered from Meldrums had been in connection with electricity works. With regard to the question of the height of chimneys very much depended upon the locality, but about 80ft. would be found a fair average height, and that met the requirements of any by-laws. With reference to the question of firebrick lining, he thought that two-thirds or even one-half was, as a rule, ample, and in some cases where there were no by-passes there was no necessity to line at all. As regarded barging to sea, it should not be overlooked that it frequently happened, especially in time of storms, that refuse had to lie about the quays, causing a nuisance, and even when it was got to sea a great deal of it was washed back again on to the shore. He knew of cases in New York in which refuse had been taken out 10 miles to sea, and yet large quantities of it had been washed up on the shores.

Mr. Melvin said that a question had been asked about the capital charge and expenditure in various ways, but it was not possible to give reliable figures, the only ones being those which referred to the cost of handling the refuse and turning it from the condition in which it was obtained into harmless products. The cost of labour varied very considerably, but he thought a reasonable figure for men handling refuse and disposing of it would be 9d. per ton. With respect to the question of smell, since the introduction of forced draught destructors had been constructed in which the chimney gases were entirely odourless. He fully agreed as to the height of chimneys mentioned by the previous speaker, and thought that 80ft. or 90ft. were quite sufficient. With respect to the figure of 49·8 units per ton, he was of opinion that if the boiler had been fitted with a superheater this figure would have been increased considerably. On looking up the fuel cost for various towns he found that there were only three places where fuel cost was ·26d., and when it was remembered that the figures obtained at Shipley were being compared with some of the lowest coal-firing stations, he thought it spoke exceedingly well for the destructor. The author did not appear to have included anything for labour in firing the coal-fired boilers, and it appeared that the cost of destroying the refuse would be 1½d. per ton. The cost on that basis, including the labour ·04d., would be ·306d. The cost for coal firing would then be 14·74d., instead of 13·5d., as mentioned, thus leaving a saving in favour of the destructor of 1·24d. The author had not said much as to what the destructor was doing, and the information as to how many kilowatts the destructor was capable of producing, and also if it generated the bulk of the day load, and the coal boilers had to assist it or put on after the refuse was burnt, would be interesting. A 10 per cent. reduction was mentioned for keeping steam up in the second boiler, but it was quite usual to keep a second boiler as a stand-by, and therefore he did not think the 10 per cent. should be put on.

Mr. H. N. Leach (communicated) gave particulars of a test which Mr. Hammond had carried out on plant erected by Messrs. Heenan and Froude at Gloucester. The furnaces consist of two grates, the boiler being a cross type of Babcock and Wilcox's, mounted over the furnaces with a separate combustion chamber intervening. The grate area is about 66 square feet, and the rate of burning throughout the test was about 50lb. per square foot per hour, making a total of about 1¼ tons of refuse consumed per hour. The actual evaporation was 1·76lb., the feed being at a temperature of 55deg. F., and for the first six hours of the test the load was an artificial one, giving an average of 140 kw. On two occasions the load fell to 100 kw., half an hour being the period of the fall and rise. Steam blew nine times for continued periods during the first six hours of the test, the forced draught being cut off during such periods, whilst during a subsequent six hours the destructor carried about 50 kw. on the tank, the street-lighting of the city amounting to about 40 kw. He thought that these figures constituted a record performance, more especially for the South of England.

Mr. Frank Broadbent (communicated) stated that the conclusion arrived at in the paper bore out his own views, and, except in special cases, he could see no advantage to the electrical side from the combination of the two. There were considerable advantages to the sanitary side of the undertaking, not the least of which was the higher economy and efficiency of the destructor, due to its being under the control of an electrical engineer whose training ensured that nothing was lost.

Mr. Schofield, in reply, said that most of the questions had been replied to by other speakers. With regard to the question of barging refuse to sea, he quite agreed that it was an obsolete method. The capital cost had been overlooked in the paper, as he was only anxious to find out the fuel value of the refuse. With regard to the load factor, one set was running on tramway load the whole day and another set on lighting, and it would be seen from the paper that the load factors were given separately for the two outputs, whilst, in addition, no sets were running at full load. The load factor was taken on a basis of 20 hours a day, which was approximately the number of hours current was required for the cars. With regard to capital outlay, if a destructor plant was put down for destroying refuse alone, it would not be so great as in the case of a combined station, because no very expensive boiler or economiser would be necessary, and, therefore, the figures varied enormously. What was meant by the statement that the value of the refuse varied according to the price of fuel, was that the price of household coal, as a rule, would determine the fuel value of refuse. If household coal was obtained at 10s. to 15s. a ton it was not so carefully burnt as was the more expensive coal, and consequently the fuel value of ashpit refuse was higher in the first case than in the last. With regard to the value of clinker, that did not concern the electricity department, nor was it an essential factor in the consideration of the two stations, as it was purely a sanitary matter. As a matter of fact, the clinker at Shipley was used for bacteria beds, and before the destructor was started thousands of tons were carted at a cost of 10d. per ton, so that the figures divided by 3 would give the results at Shipley if all the clinker was valued at 10d. per ton. It had been said that the cost of coal—namely, ·266—was very low, but it would be noticed that he had not taken the units sold, but generated, the figures taken from that and other sources giving the cost of coal. With the load at Shipley ·266 was not a very low figure, and he was inclined to think that it might be reduced. It should always be borne in mind that the steam-raising plant must be capable of taking the whole load of the station, as, after heavy rains, the refuse was saturated with moisture, and in winter the fall of snow would prevent the collection of refuse for probably three or four days.

HOT-WATER HEATING FROM ELECTRIC STATIONS.

Heating from central stations constitutes a topic which is of ever increasing importance to the central-station engineer. There are several systems which may be employed, falling into the broad divisions of steam and hot water. If the latter be chosen, the one-pipe or two-pipe method of distribution may be used. In a recent issue of the *Western Electrician* Mr. Alton D. Adams discusses these two systems of hot-water heating at some length and shows their relative advantages and disadvantages. Two interesting examples of hot-water heating are quoted by the author in order to illustrate some of the differences between the one-pipe and the two-pipe system—*i.e.*, the Toledo Heating and Lighting Company at Toledo, Ohio, and the Miami Light, Heat, and Power Company at Piqua, Ohio. The Toledo plant is on the double-pipe system, and in 1900 had 16,776ft. of double mains, covering probably that length of street, and containing 33,552ft. of single pipe. In the single-pipe system at Piqua the total length of pipes in street mains is about 9,650ft., and these pipes cover practically an equal length of streets. At Toledo the most distant part of the mains is about 0·75 mile from the station, and at Piqua the corresponding distance is 0·7 mile. The Toledo system had been in operation about five years up to 1900, and then had radiating surface to the amount of 175,000 square feet connected in 199 buildings. In the Piqua system, with less than 0·3 of the length in main pipes at Toledo, the capacity is 115,000 square feet of radiating surface, and 120 service connections are provided. The Toledo system lighted 450 houses and heated 199 buildings during the six months ended Jan. 1, 1900, with the following satisfactory results: income from lighting, £1,813; income from heating, £1,980—total income, £3,793; fuel expenses, £1,008; salaries and wages, £565; all other expenses, £379—total expenditure, £1,952; leaving a handsome balance of £1,841.

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NOTES.

Surface Contact for Railways.—Mr. L. W. Pullen's surface-contact system of electric traction as applied to railways was put on trial last week in America on a mile of experimental track on the Pennsylvania Railroad. Report states that a speed of 85 miles an hour was attained, and that in other respects the results were successful.

Cable Transmission Record.—The all-British cable has accomplished another record in the transmission of news from Australia to Great Britain, the close of the Australian innings in the test match this week having been sent by the Pacific-Anglo in the time of 3½ minutes from the Sydney cricket ground. Considering the number of retransmissions that take place, this is a highly creditable performance.

Telegraphic Charges to France.—A strong committee of French Deputies has been formed to carry out a proposal for reducing the telegraphic rates between England and France. As the telegraph rates are now ½d. per word throughout each country (London to Ireland, or Paris to Algeria and Tunis), 1d. per word in place of the present rate of 2d. per word is advocated between Great Britain and Ireland and France.

The Electro-Harmonic Society.—To-night this society will hold the third concert of its present season in the King's Hall of the Holborn Restaurant, Mr. A. P. Trotter being in the chair. Mr. Dalton Baker and Mr. Whitworth Mitton are the vocalists, and, as usual, Mr. Alfred E. Izard will be found at the pianoforte. Mr. T. E. Gatehouse is down for a couple of violin solos, and an orchestra will play selections. There are also some humorous turns, which altogether make a very attractive programme.

"African World" Annual.—For their first Christmas number the proprietors of the *African World* have brought out an exceptionally attractive issue. Its excellent get up leaves nothing to be desired, and the contributors to its columns include such writers as Sir Harry Johnston, Mr. W. T. Stead, Mr. F. C. Selous, Dr. Carl Peters, and Prof. Ronald Rons. The mining section of the annual has been compiled on somewhat original lines, and is as up-to-date and comprehensive as possible. The complete issue runs into some 170 pages.

Automatic Lubrication.—Before the Dundee Institute of Electrical Engineers, Mr. David Scott read a paper last week in which he described several devices for the automatic lubrication of electrical machinery. He emphasised the importance of the subject by speaking of the losses caused by bad lubrication, and stated that with good automatic lubrication wear and tear could be reduced to a minimum. He was not an advocate of high-priced oils as lubricants. If the bearing surfaces had been made ample, ordinary mineral oils of 907 specific gravity were quite good enough; and for cylinders and valve faces, unless very highly superheated steam were used, ordinary cylinder oil did very well. Mr. Scott concluded by enumerating and describing the various lubricating devices on the market, and offered some good advice drawn largely from personal experience.

New Books.—"The Electro-Chemist and Metallurgist" (Sherard Cowper-Coles and Co., Limited, Westminster); 2s. This publication—the organ of the Faraday Society—contains one or two interesting papers, among which we notice the following: "Some Notes on the Welding of Aluminium," by Mr. S. Cowper-Coles; "Practical Notes on the Electro-Depositing of Copper on Iron, Carbon, and Zinc," by Mr. S. Cowper-Coles; and an article describing the impingement processes in the rapid electro-deposition of copper.—"L'Electricité dans les Mines en Europe," by Emile Guarini (Ramlot Frères et Sœurs, 25, Rue Grétry, Brussels); 5fr.—"The Miller Signalling System" (The British Miller Signal Syndicate). This is a technical description of the system, with detail drawings, and is of considerable interest. It will be remembered that the system was fully described in a recent issue of this journal.

Wireless Telegraphy.—The other day an illustration of the practical value of wireless telegraphy at sea was afforded by the case of the steamer "Kroonland," which was partially disabled when 1,730 miles west of the Fastnet. The wireless telegraph apparatus with which the ship is equipped was immediately brought into use, and the captain opened up communication with the Marconi station at Crookhaven, whence messages were sent to the agents of the boat. In this way the captain received his instructions, and the "Kroonland" put back into Queenstown. Many of the passengers on board also sent messages to their friends on shore, and in some cases were received not only from England but from the Continent before the Fastnet was sighted. It is announced that the German Wireless Telegraph Company is endeavouring to establish communication between Berlin and the Swedish coast near Stockholm, a distance of 650 miles.

Electrical Machinery in Russia.—As we have pointed out in these columns quite recently, a great part of the electrical machinery and plant being used in Russia was imported mostly from Germany and Switzerland, and some from England and America. It seems likely, however, that a restriction will sooner or later be imposed on the electrical imports, in order, if possible, to increase the consumption of home products. The matter has been taken up by an organisation of some 14 of the leading electrical manufacturing establishments, and a petition has been addressed to the Minister of the Interior and to the Minister of Finances at St. Petersburg, in which the Government is asked to require the Municipalities of St. Petersburg and Moscow to buy all their electrical machinery and apparatus in the country. This is the thin edge of the wedge, and the manufacturers hope that other municipalities who may be carrying out electrical schemes will be obliged to cease importing from foreign houses, and to purchase only in the home market. Should the policy indicated meet with the approval of the Russian Government, the German, Swiss, English, and American houses will all be affected in a greater or lesser degree, although the biggest loss will fall on Germany, which at present supplies most of the electrical plant imported into Russia.

Electrically-Driven Looms.—It is gratifying that in the struggle going on between factories and domestic industries in some parts of Germany, the latter should occasionally have its share in the achievements of modern engineering. A co-operative enterprise with a view to supplying the domestic weavers (of the silk ribbon trade) in the Southern Black Forest with electric power has lately been started in the Hotzenwald district, it being contemplated to drive by electricity the looms of 500 weavers living in 28 different localities. The first cost of the whole of the power plant is estimated at about £17,000, this sum to be supplied by the Wald-Elektra Säckingen-Waldshut Power Company, apart from a grant by the Government. The significance of this enterprise is its enabling the above branch of textile industry to be preserved as a house industry, securing a yearly income of about £15,000 to the poor inhabitants of that part of the forest. Moreover, the diminution of strain on the physical strength and health of

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the weavers will allow of people of even moderate strength devoting themselves to domestic weaving without endangering their health, so that a rational division of work can be made between the members of the same family, especially during the season of rush in the silk trade. Moreover, weavers will be in a position to deal with stouter goods, securing them higher profits, apart from the sanitary advantages attendant on electrical operation and lighting.

"The Electric Museum."—The third number of this paper, which is edited and published by Mr. A W. Hill at Colombo, has just reached us. The interesting matter given in this issue covers quite as wide a range as that in the preceding numbers, and is remarkable for the personal comments of the editor. Scorning the editorial "we," Mr. Hill writes in the first person, and gives his opinion and advice on subjects ranging from lynching to the scaring of locusts by electric sirens. The Russian electric notes give a very poor account of the electrical industry in that country. The following extracts from the editorial note columns will interest our readers, and show the general type of the information given by the only electrical journal in the East: "In view of the somewhat frequent fires in coal sheds in Colombo due to spontaneous combustion, I would suggest that a thermostat, or mercurial thermometer, be fixed inside sheds, provided with electric alarm contacts which would cause the electric bell to ring, thus indicating a possible outbreak of a serious fire on the premises." "I find that some native storekeepers in Colombo—usually Sinhalese and Tamils—may be regarded as disciples of the electric science. It is true that they have not the remotest idea as to what volts, amperes, and ohms really signify; but they know to a nicety how to prepare electro-plating solutions for nickel-silver-gold plating spoons, forks, rings, candle-holders, etc. Smee's primary cells are usually used. Most of these electricians cannot talk English; but, fortified with a rather ancient electric battery, they make, I guess, good profits out of this particular application of electricity."

A Protected Third Rail.—The idea of a protected third rail in electric railway operation has only lately been put to practical use in the States, and it is believed to be the first instance of the kind. Mr. J. E. Wallace, in the course of a long article in the *Street Railway Review* describing the Wilkesbarre and Hazelton Railway, refers to it as a novelty. Of course, the objects of a protected conductor rail are twofold—first, to prevent the formation of ice on the rail; and secondly, to prevent personal injury by accidental contact with the rail. The protection consists of a 2in. by 6in. pine plank held directly over the rail at a distance of 2½in. This pine plank is supported every 8ft. by 3in. by 4in. oak posts, cut out to clear the side motion of the shoe when journals and track become worn. In places which are not subject to severe snow and sleet storms the usefulness of this protection may perhaps be questioned, but in the test runs described in the article, where part of the third rail was exposed and part protected, the difficulty of running a car along the exposed portion after a sleet storm was in marked contrast with the ease and smoothness with which it ran after reaching the protected part. Another arrangement for keeping the third rail clear of ice has been devised by Mr. F. Hedley, the chief superintendent of the Interborough Rapid Transit Company of Chicago. It consists of scrapers which can be lowered on to the contact rail in front of the collecting gear. The actual scrapers are made of thin plates of steel cast into a block, which is suspended from the car truck, and which can be raised and lowered at will by the motorman. The individual plates are placed at an angle across the rail so that they are oblique to the same, and hence able to ride over the joints without trouble. The inclination of the plates also serves to clear off the ice as it is straight from the rail surface. It is proposed to add one of these scraping devices in front of each of the contacts. The system is to be tried extensively this winter.

Oxidising Action of Radium Rays.—Mr. Wm. B. Hardy and Miss E. G. Willcock have been jointly studying the oxidising action of the rays from radium bromide as shown by the decomposition of iodoform. Their conclusions have now been published, and are abstracted in the current issue of the Chemical Society's *Journal*. A solution of iodoform in chloroform rapidly becomes violet on account of the decomposition of the iodoform with liberation of free iodine. The decomposition only takes place if oxygen is present, but the amount necessary is exceedingly minute, and is induced by a radiant energy. The decomposition is accelerated by the presence of sodium chloride, potassium chloride, potassium nitrate, lead nitrate, barium nitrate, and barium chloride, but is retarded by potassium sulphate, calcium carbonate, barium sulphate, and magnesium carbonate; the influence of these salts seems to be a surface action entirely. The influence of the radiations from radium bromide in promoting the decomposition has been studied. By suitably screening the tube containing the radium salt, it was found that the β rays are mainly effective in causing the decomposition, but the γ rays are also endowed with chemical activity. The Röntgen rays also cause the change to take place. The authors conclude that the physiological action of radium rays is due to their power of penetration rather than to the fact that they exert any novel or very intense chemical action. They reach parts which are shielded by a cuticle very impervious to light waves, and in the subjacent tissues they induce some process of oxidation which does not take place without radiant energy.

Architects and Electrical Contractors.—Before the Leeds and Yorkshire Architectural Society recently Mr. Edwin C. Wallis gave a lecture on electrical work as affecting architects. He observed that electric hoists were coming more and more into use, working either with continuous-current, single-phase, or two-phase current. They were in some respects superior to the hydraulic hoists, and the cost of operating the electric hoist was less when a cheap supply of energy was available. Remarking on the progress of the electric light in the last few years, the lecturer pointed out that Leeds began with a plant of 500 h.p., which had now been increased to 14,000 h.p., with 4,000 h.p. more in view. In no department of civil life had greater advances been made than in electrical work and its accessories, and still the advance went on. He took the opportunity of expressing an opinion as to the attitude of architects towards electrical contractors. To the contractor worth his salt no one had been a better friend than the architect, and the profession had welcomed gladly every worthy service that the electrician had been able to render. Architects had found time to make the setting of the light worthy of its surroundings at a time when the electrician had but one idea, such as used to be termed "a bottle on a string." Men of education and taste devoted time and attention to enhancement, and referring incidentally to the electric lighting of the Rylands Library at Manchester and St. Paul's Cathedral, he mentioned as a contrast the present art gallery and reading-rooms connected with it at Bradford. He said it should not be in the power of any man or any committee to make hideous public rooms, whose influence should rather be to gladden and refine the thoughts of men who resorted there. If the profession did no other public service, it at any rate strove to protect the world from constructive vandalism and furnished ideals for the men and women that were to be.

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Gloucester Electrical Undertaking.—Mr. W. J. Bache, the city electrical engineer of Gloucester, gave a lecture at the Municipal Schools last week on the provision of generating plant for the city tramways. These lines, it should be stated, are not yet electrified, although the Corporation bought them from the company for £26,000 in 1901 with that object. The work of converting the system to electrical working, however, was recently commenced, and is going on encouragingly, and Mr. Bache, in his lecture, showed what steps had been taken to provide a sufficient supply of electric energy for the trams when they start running. It seems that a service of 20 cars was originally decided upon, and to deal with these Mr. Bache explained that about 250 kw. of plant are required. The lighting plant at present installed at the electricity works consists of two 300-kw. sets and one 150-kw. set. One of the former sets is installed as a stand-by, and in deciding on the arrangements to be made for a traction supply, the Electricity Committee considered the possibility of utilising at least some portion of the lighting plant. The number of connections to the lighting mains at present is equivalent to 26,000 8-c.p. lamps, and less than half—some 10,000 or 11,000 lamps—are burning at the one time. As a matter of fact, the two working sets at the works are capable of furnishing current for 15,000 lamps, so that there is still a useful margin before the plant is fully loaded. True, that margin is being continually encroached upon by the increasing demand for the electric light, and in a short time it will probably be necessary to extend the lighting plant. For the present two 200-kw. traction sets are to be installed, one of which will act as a stand-by, and both be suitable for working either a traction or lighting load. Although the original intention was to give a seven-minute service with 20 cars, another 10 cars have since been ordered, but it is estimated that the provision of plant at the generating station will be ample for the present to meet the increased demand. At the conclusion of his paper Mr. Bache was accorded a hearty vote of thanks.

Stationary Electric Waves.—A meeting of the Dublin Local Section of the Institution was held on the 10th inst. at the University College, Dublin, when a most interesting lecture, illustrated by experiments, was delivered by the Very Rev. Monsignor Molloy on "An Experimental Study of Stationary Electric Waves," with special reference to the phenomena of electric resonance and overtones. The lecturer pointed out the close analogy between the resonance of an electric circuit and the resonance of an organ pipe The apparatus consisted of a pair of Leyden jars, which could be joined in series or paralled as desired, and an adjustable self-induction, by means of which the period of an oscillating discharge between two zinc balls could be varied at will. The jars were charged by means of a powerful induction coil. The resonating electric circuit consisted of a wire wound round a vertical rod one end of the wire, terminating in a ball mounted on top of the rod, the other end being attached to the inner coating of one of the Leyden jars. When the period of the oscillating discharge was made the same as the natural period of the wire, brush discharges and sparks issued from the knob attached to the free end of the wire and vacuum tubes held near it were lit up. The possibility of operating two different wireless telegraph circuits simultaneously and independently by means of resonance was very prettily shown by using pairs of circuits of the same period as sender and receiver, each pair being tuned to a different pitch. The signals were made visible by means of a vacuum tube placed near the free ends of the receiving wires. In order to show overtones a long rod some 10ft. in height was over-wound with a considerable length of wire. The oscillating circuit attached to the lower point of this wire was then adjusted to give first the fundamental and then the harmonics of the wire, the electrical oscillations being made visible by the brush discharges between the rod and a fine vertical wire connected to earth and stretched parallel to the rod at a distance of about 2in.; also by moving a vacuum tube up and down beside the column. A hearty vote of thanks was passed to Monsignor Molloy at the close of the lecture.

St. Marylebone Electric Light.—By the decision of the High Court in last Friday's proceedings, which will be found reported elsewhere in this issue, the Borough Council of St. Marylebone have to find a sum of £60,000 to pay to the Metropolitan Electric Supply Company in connection with the extension of so much of its business as is within the St. Marylebone area. This is the condition on which the Court has allowed an extension of time for completing the purchase until Feb. 29, and the Council would have to levy a 9d. rate in order to raise this preliminary amount. What the Council propose to do is, of course, to promote a Bill in the ensuing parliamentary session to constitute themselves an electric lighting authority, which would remove the difficulties in the way of borrowing the whole of the purchase money; but they must obtain the consent of the ratepayers before this can be done, and the ratepayers, generally speaking, are not in favour of the scheme. At the Council meeting on Thursday last week a most influential deputation waited upon the Council, strongly urging them to endeavour to come to an understanding with the electric light company to relieve the borough from the present arrangement, and complaining that before entering into any undertaking of the sort the Council ought to have consulted the ratepayers. In spite of this, the Council affixed their seal to the petition to Parliament, but at the same time agreed to the appointment of a committee "to confer with the Metropolitan Electric Supply Company, and to report to the Council the terms and conditions on which it will agree to set aside the award." If the negotiations with the company should come to nothing, the Bill will have to be proceeded with, and in that case Mr. Justice Buckley has said he would be willing to further extend the time for the completion of the purchase. We understand that the preliminary payment of £60,000 has to be handed over to the company before Jan. 31 next. The Council, at a special meeting held yesterday, were advised by their Finance Committee that it would be better to borrow the sum from their bankers and to leave the question of the extra rate until the usual time for fixing the amount of the next half-year's rates.

Treatment of Slimes by Electrical Precipitation.—In a paper read by Mr. F. T. Mumford before the Australasian Institute of Mining Engineers, and reprinted in the *Transactions* of the society, there is an interesting discussion of the treatment of slimes by cyaniding and electrical precipitation on mercury. The Riecken process, which employs this method, has been in use at the South Kalgurli gold mine since the end of 1900, and about 3,000 tons per month are treated. The advantages claimed for electrolytic precipitation of gold on mercury are numerous. First, extraction and precipitation may be effected without filtration, and the solution need not be clear for precipitation. The precipitation is equally good whether from strong or very weak cyanide solutions, and the presence of copper salts is not detrimental. The gold is recovered as an amalgam, which only requires retorting and melting. Amalgamation of slimes before is unnecessary, as any coarse gold present is amalgamated during precipitation. The essential features of the mercury cathode is that the

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surface of the mercury should be as large as possible and be kept in perfect condition by some simple means; the minimum quantity of mercury should be used, and the right current density employed. Mumford's electro-cylinder consists of a steel-plate cylinder lined with amalgamated copper, and with wooden ends. It is supported on rollers and rotated at five revolutions per minute. The anodes are 2in. round iron bars, supported from end to end of the cylinder, and making electrical contact by means of brushes outside the cylinder at one end. In use, mercury is poured in until it is ½in. deep on the bottom and the cylinder is filled with charge to within a few inches of the top. The current density to be employed depends largely upon the condition of the surface of the mercury. When the cylinder is maintained in rotation, a current density of 0·8 ampere per square foot can be used as a maximum, but any higher density leads to a partial surface deposit of gold which does not amalgamate, and which is mechanically retained in the pulp. At two amperes per square foot it is found that none of the deposited gold amalgamates, and all is lost. With weak solutions the weight of gold deposited is not in proportion to the current density, and a current density of 0·5 ampere is practically as good as one of 0·8 ampere per square foot. Generally speaking, the potential difference may be from three to five volts.

New Type of Transformer.—An article recently appeared in the *Elektrotechnische Zeitschrift* describing a new type of transformer, of which Mr. E. Ziehl is the inventor. The construction adopted in this case differs from the usual arrangement, which is to have the three cores of a three-phase transformer on one plane, or at the angles of an equilateral triangle, with two yoke pieces in common to all three. The new arrangement consists in the superposition of two or more cores, each forming a closed magnetic circuit. The author states that this construction has the advantage of considerably simplifying the manufacture, inasmuch as for single, two, and three phase transformers, equal cross-sections for the iron sheets, equal patterns for the magnet coil, and equal armature parts can be used. Comparing three individual transformers with a three-pole transformer of the new construction, the latter shows under otherwise equal conditions a considerably reduced weight of iron, inasmuch as the number of iron yoke pieces is only six instead of eight. With the same magnetisation the losses are, therefore, diminished. Also, when the heat radiation of the new type is compared with that of the three-core type it is found that the former has a considerably larger cooling surface, and a considerably greater capacity to dissipate the heat. The difference between the maximum inner and outer temperature of the iron will be about one-quarter of that in the old construction, which means that the maximum induction in the new type can be chosen higher. The case is similar with the coils, and another advantage in this connection is the division of the copper coils into as many parts as possible, thus getting a large cooling surface. From the possibility of a higher magnetism of the iron and a larger cooling surface there results naturally the possibility of a higher current density in the copper, and, therefore, saving in copper and iron. An influence of the magnetic fluxes upon each other cannot take place, as the middle yoke pieces between two phases bring about an equalisation of a one-sided load, because an excess of lines of force of one phase cannot enter into another phase winding, but has to travel through the intervening yoke piece. The loss of potential from no load to full load caused by the leakage and the ohmic loss has with equal load on the phases the same percentage value in each of them, because, apart from the ohmic loss, the lines of leakage, or the leakage potentials, which appear on short-circuit of the transformer are equal in each phase. A transformer of 25 kw. capacity, running at 2,200/210 volts and 50 cycles, has a total weight of about 776lb., including the oil, of which weight 113lb. were for copper and 256lb. for the iron sheets.

Nickel Nitrate.—In the last number of the *Physical Review* Mr. Wm. McClellan gives the results of a research he has made in the Randal Morgan laboratory at the University of Pennsylvania into the thermo-electric behaviour of nickel nitrate, thus continuing the earlier work on the subject of Walker, Faraday, Gore, Ebeling, Hagenbach, and Bouty. In the arrangement of the apparatus the solution, made with Kahlbach chemicals in pure distilled water free from ammonia, was contained in small beakers, about 3cm. deep and 3cm. in diameter, connected by a tube of 15cm. bore. The electrodes were of platinum wire, the ends being connected to copper wires which went to the potentiometer. Measurements of E.M.F. were made with a Leeds potentiometer, which was calibrated by means of a Weston cadmium standard cell, with practically zero temperature correction. From the final curves plotted from the experiments, it is reasonably certain that the thermo-electric power of the electrolyte used was nearly zero. There was some trouble in the measurements, but this is explained by the extreme sensitiveness of the cell to polarisation. This accounts for the presence of positive and negative curves, although the greatest care was taken in the observations. It was found absolutely necessary to have the electrodes in a definite condition at the start. In order that the potential difference should be constant at constant temperature, the author says it is absolutely necessary that the electrodes should be subjected to a prolonged bath in strong nitric acid. The effect of vibration of the electrodes was not entirely settled by the experiments. It is true, however, that in a solution which contains air, the vibration has a steady effect if the vibration does not stir more air into the solution. If any good is to be obtained, the electrodes must be arranged with nodes at the surface of the electrolyte. A number of interesting effects might be obtained if a cell were designed in which the vibrations could take place without vibrating the surface, or if the part vibrating at the surface were insulated so that it did not form part of the electrode proper. The experimenter found that the presence of air in the solution caused great irregularity. Therefore boiling the solution free from air had a marked effect on the potential difference. Here the removal of the air showed the masking effect of the polarisation much more easily. If the thermoelectric power amounts to anything, it is probably positive—that is, it flows from cold to hot externally. In this connection it may be mentioned that the curves of sulphates and chlorides as shown by Hagenbach in 1894 show changes in potential difference of from 0·01 to 0·15 volt for a temperature rise of 60deg. C., whereas the author found that in the case of nickel nitrate the effect would not be over 0·001 volt, even with polarisation effects added on or subtracted, as the case might be. It is purposed to go on with this work until, if possible, an exact value is obtained for this effect, whether zero or otherwise.

Electrical Progress in Italy.—In its industrial development, Italy as a country has suffered largely from having no coal supply of her own, and consequently having to import her fuel from foreign countries. The trend of electrical progress in Northern Italy especially is, however, rendering that country every day more independent of foreign supplies of coal, and its effects have been particularly noticeable in one of the principal coal-mining districts of England—viz., in Durham and Northumberland. The exports of coal from Newcastle-on-Tyne to Italy have been falling off

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very considerably in the last few years, and this to a large extent is undoubtedly due to the development of water power by the Italians, particularly in connection with the more extended use of electricity as a motive power. This is strikingly illustrated in a report which has been prepared by the Chevalier V. A. Montaldi, the Italian vice-consul at Newcastle. Up to a very few years ago the distribution of electric energy in Italy was solely confined to illuminating purposes, that devoted to motive power was insignificant. Since then, however, the transmission of electric power over long distances has been accomplished, and no later than three years ago there was in North Italy over 65,000 h p. of hydraulic force being converted into electrical energy—*i.e.*, 16,000 h.p. in Piedmont, 35,000 h.p. in Lombardy, and 12,000 h.p. in the province of Venice. At the end of last year it is calculated that 37,000 h.p. was used in Piedmont, 45,000 h p in Lombardy, and 22,000 h.p. in Venice, a total of 104,000 h.p., whilst machinery was under construction to produce a further 1,006,000 h.p. in the same districts. Lombardy especially gave a great example to the various countries to run their industries nearly independent of coal. Engineers are familiar with the large electric works at Vizzola, on the River Tessin, developing 20,000 hydraulic horse-power. They are the biggest electric works for the transmission of electric power that exist in Europe, and further enormous additions are to be added in order to increase the output to 25,000 h.p. The energy is distributed in the Milan district alone, and represents a diminished coal consumption valued at about £80,000 sterling. In Italy all waters belong to the Government, and from official statistics published in 1899 the minimum hydraulic force during summer is estimated at about 2,654,000 h.p., and by constructing some small canals this power could be increased to 4,600,000 h.p. In the electrification of steam railways it is known that the Italians have been particularly active, and the results have been significant. In one striking instance—*i.e.*, the electric lines from Milan to Varese, which is about 47 miles long—the receipts have more than doubled under electric traction, and the profits of the line in 1902 were half as much again as in 1897, when steam power was used. The lines now worked by electric energy in Lombardy alone are the Milan and Varese Railway, 47 miles long; the Lecco, Colico, and Sondrio Railway, 67 miles in length; and the Milan and Mauza Railway, 7½ miles long—making a total mileage of about 121½. The lines which are about to be electrified have a total mileage of about 445—*i.e.*, 385 in South Italy and 60 in North Italy. The prices per horse-power of electric current generated by hydraulic power vary according to the distance from the generating station to the place of consumption. In the districts where water power exists the cost is about £2 per horse-power per annum, increasing up to as high as £5 per annum, according to the distance from the generating plant.

An Electromagnetic Theory of the Aurora Borealis.—In a paper previously read before the French Academy of Sciences, Mr. C. H. Nordmann had shown theoretically that the sun must emit Hertzian waves, the intensity of which is a maximum in the regions and at times of greatest solar activity. From this proposition an explanation of the solar corona and its peculiarities, as well as of the spectra of comets, was derived. Now, in a recent note presented to the Academy the author tries to show that the same explanation would elucidate the nature of the aurora borealis, as well as the origin of the oscillations and disturbance of terrestrial magnetism. Previous investigations have shown a close connection to exist between the spectrum of the aurora borealis and that of the light surrounding the cathode of a tube containing oxygen and nitrogen. It is hence inferred that the aurora borealis is a cathodical phenomenon occurring in the upper exhausted atmosphere. Some special properties of the aurora borealis are explained by the well-known property of cathode rays to range themselves along the lines of force of a magnetic field. As regards the only difficulty left by the explanation—viz., the origin of the cathodic phenomena giving rise to the aurora borealis—the author solves this question by means of the following proposition. Tubes containing sufficiently exhausted gases will, as shown by Ebert and Wiedemann's work, become illuminated under the influence of Hertzian waves, the luminous phenomena thus produced being identical with the cathode phenomena of Geissler tubes. The author, therefore, thinks auroræ boreales to be caused by cathodical phenomena produced in the atmosphere under the action of the Hertzian waves emanating from the sun, according to the well-known property of these waves. On this explanation the different periods of the auroræ boreales will easily be accounted for. The fact that the greatest frequency of the auroræ coincides with the greatest frequency of sun spots is due to the greater intensity exhibited by the Hertzian waves given off from the sun during the maximum of sun spots. The period of the auroræ seems to correspond with the period of rotation of the sun. This is accounted for by the fact that the regions of maximum activity of the sun performing a complete rotation in about 26 days, the aurora borealis must of necessity possess an identical period. The diurnal period of the phenomena is equally explained by this theory, though the maximum production should correspond with the maximum of solar radiation in a given point—*i.e.*, the passage of the sun through the meridian—the apparent maximum of the auroræ cannot be observed until in the early hours of the evening, in accordance with experimental facts, as the brilliancy of daylight at the instance of the real maximum will hide the phenomenon. The oscillations of the magnetic needle, as is well known, exhibit a period closely corresponding to the period of sun spots, like that of aurora borealis It thus seems as though the variations of terrestrial magnetism should be due to the same cause as auroræ boreales. On the other hand, it is generally presumed that the intensity of terrestrial magnetism and the variations of this intensity are in close connection with the general electric currents in the atmosphere, produced mainly in the upper exhausted layers of atmosphere, being relatively conductive, under the influence of the unipolar induction of vaporisation. Prof. Righi has finally shown the conductivity of an exhausted gas tube to be notably augmented under the influence of Hertzian waves, the tube thus behaving like a coherer. Now, the theory of the author will readily account for the period in terrestsial magnetism. At the time of the maximum of the spots the more intense Hertzian waves of the sun will give rise to a relatively large diminution in the resistance of the upper atmosphere, resulting in an increase in the intensity of the electric currents in the atmosphere, and accordingly in an increase in the intensity of terrestrial magnetism. The occasional sudden production of auroræ boreales, as well as the variations in the intensity of terrestrial magnetism, may equally be explained on the theory of the author. Many examples are known of magnetic thunderstorms attended by auroræ boreales and coinciding with a violent disturbance of a solar spot, as detected by means of the spectroscope. The best instance for the truth of this theory is, however, derived from the fact observed by Young as far back as 1883, that any considerable disturbance of the solar surface will be transmitted to our terrestrial magnetism with the speed of light. Now, this is just the velocity of Hertzian waves.

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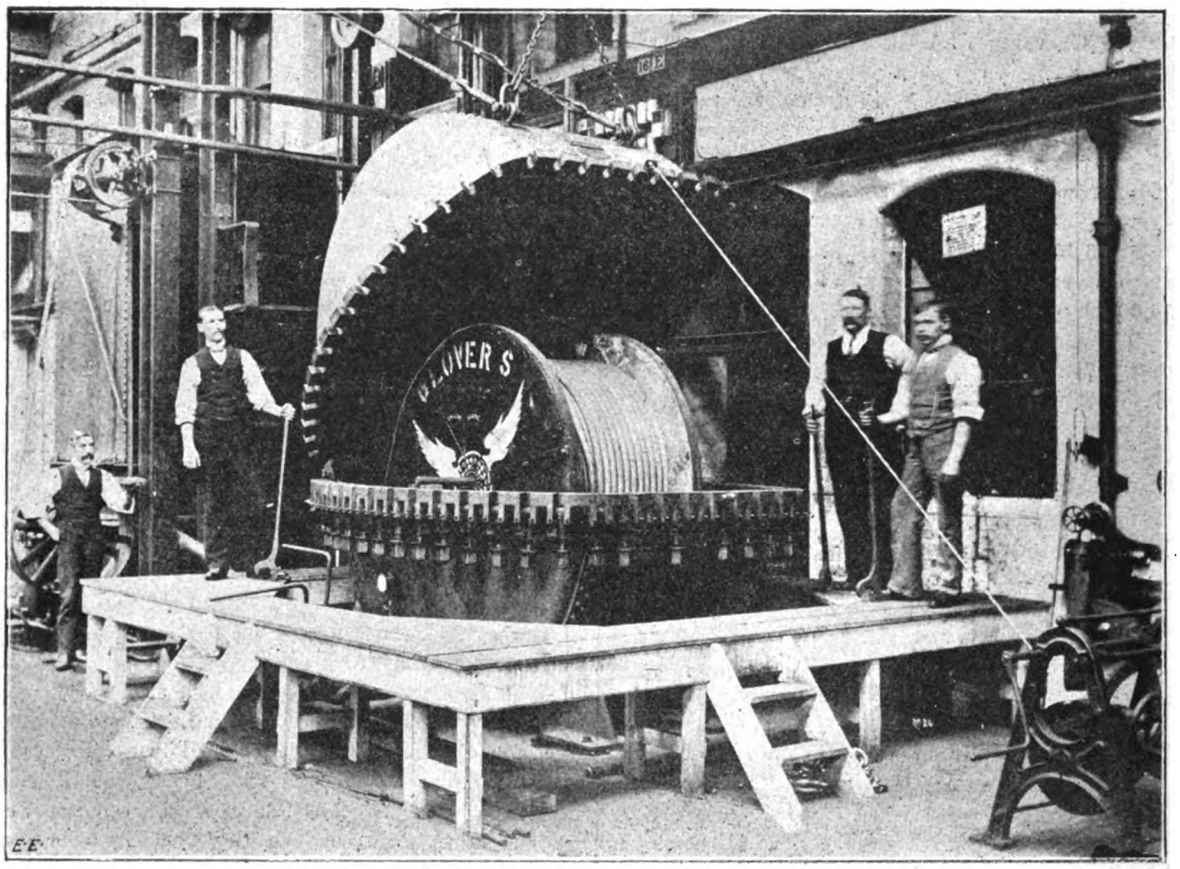
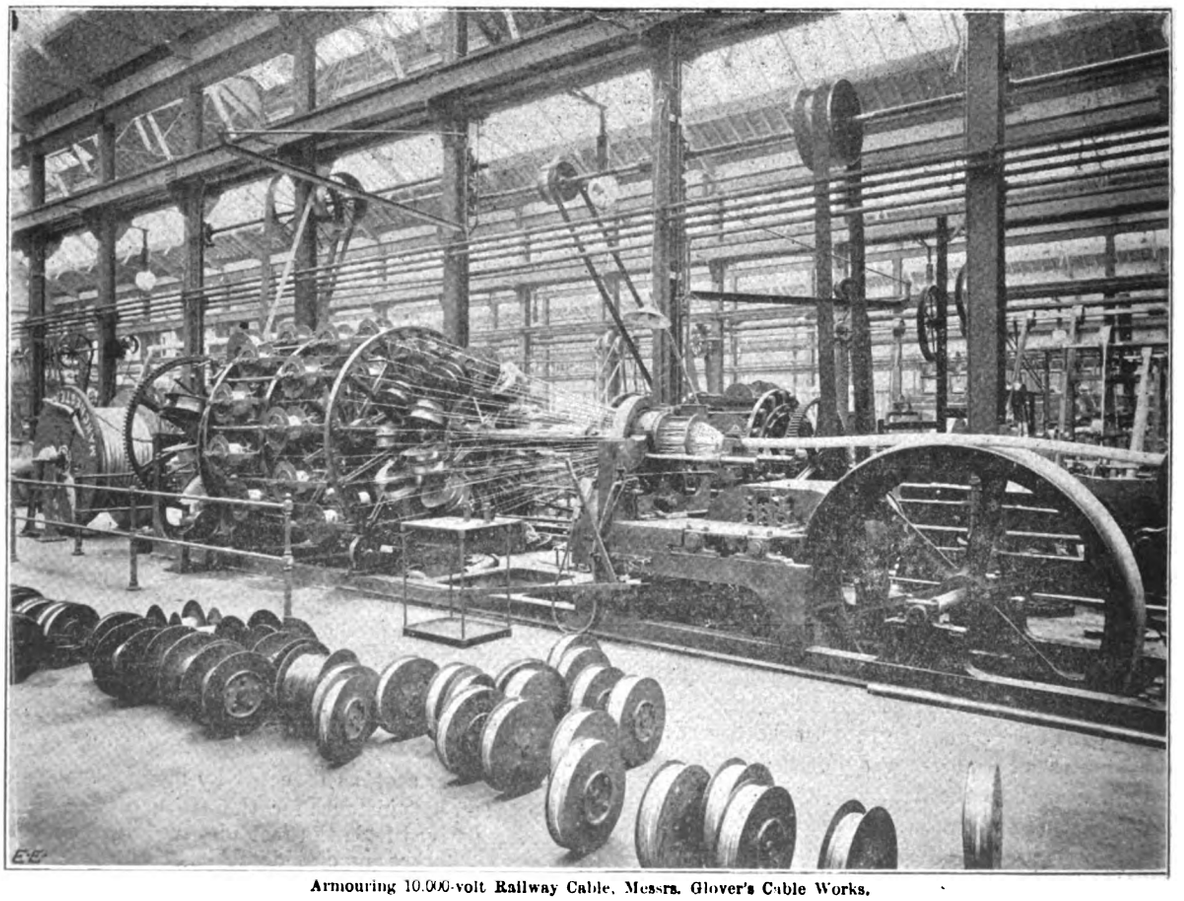
WORKS' VISITS.

III.—Messrs. W. T. Glover and Co, Limited, Trafford Park, Manchester.



Patent Hydraulic Testing Tank, Messrs. Glover's Cable Works.

We have now to deal with works situated immediately opposite those described in the second article of this series. As specialists in the manufacture of electrical cables of all types and sizes, Messrs. Glover and Co. have won a world-wide reputation. Prior to making Trafford Park their headquarters the firm had obtained considerable experience in Salford, where they carried on the manufacture of electrical wire and cables with eminent success for a



Armouring 10,000-volt Railway Cable, Messrs. Glover's Cable Works.

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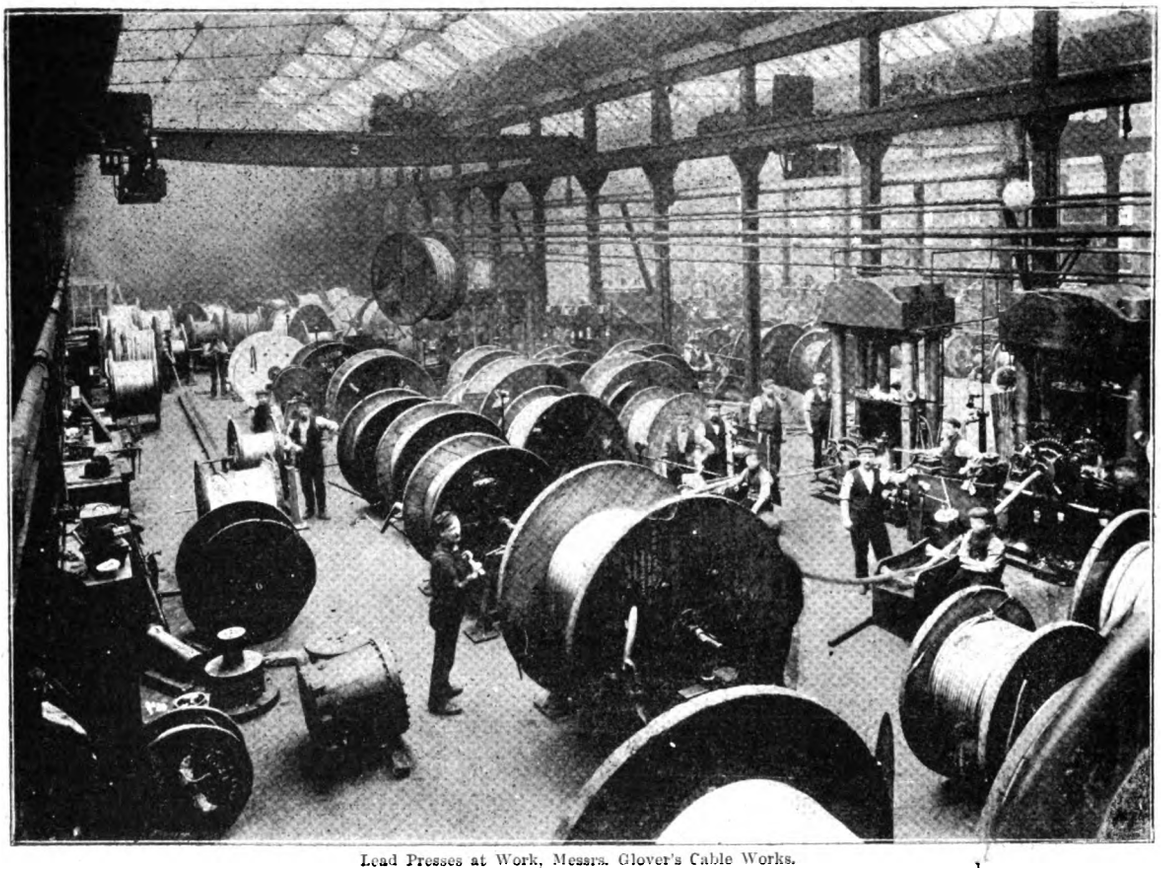
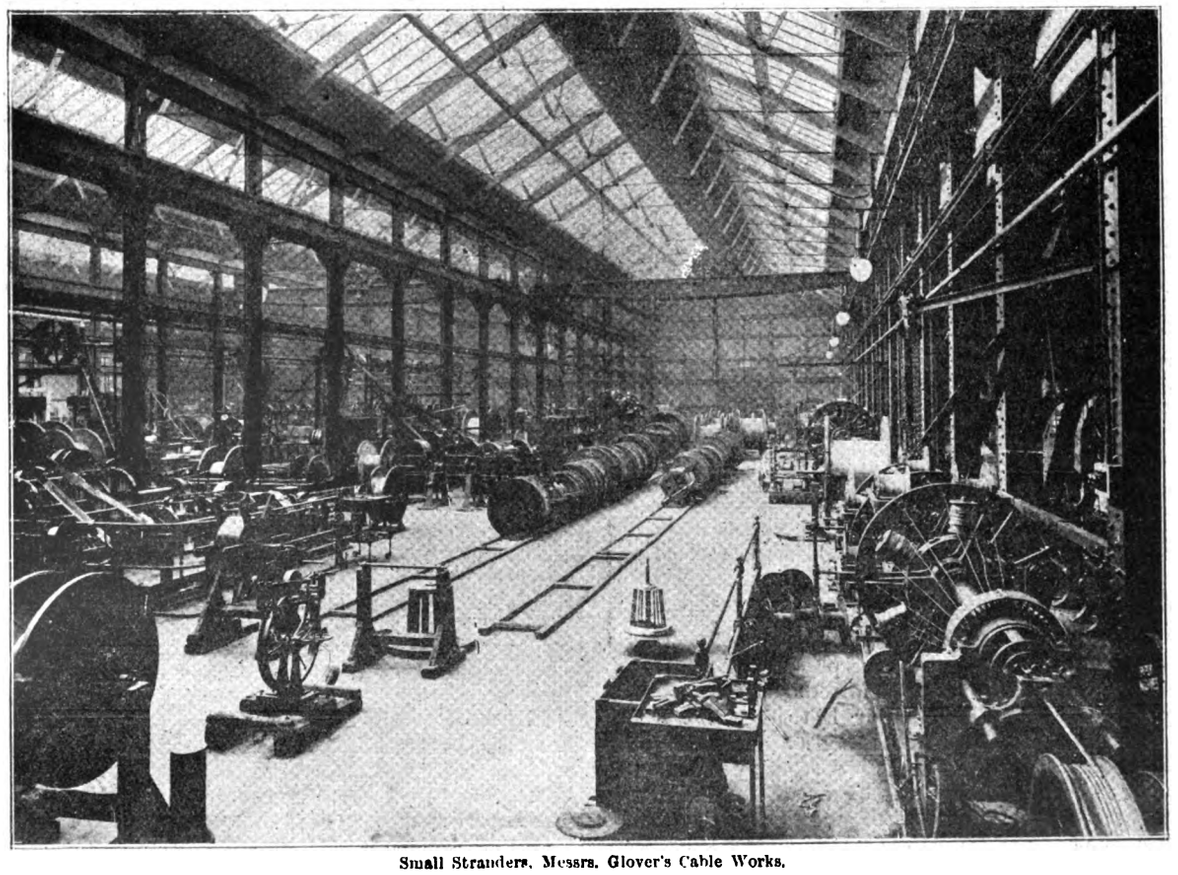
long term of years. This experience is reflected in the arrangement of their present works, than which, it can be said, none are better equipped for turning out the heavy class of electric cables used in connection with modern power and lighting schemes. These works have, however, been several times described, and it is not our intention to repeat well-known details here. It is rather to new additions to the equipment and productions of the works that we shall give our consideration. During a recent visit to the same our special attention was called to a hydraulic testing tank (Claremont's patent), shown in the first of the accompanying illustrations. This tank represents an essentially new departure, and may be destined to revolutionise present methods of testing lead-sheathed cables. There is little to say in regard to its construction beyond what is shown. It is made of boiler plates riveted together, and is designed to



Lead Presses at Work, Messrs. Glover's Cable Works.



Small Stranders, Messrs. Glover's Cable Works.

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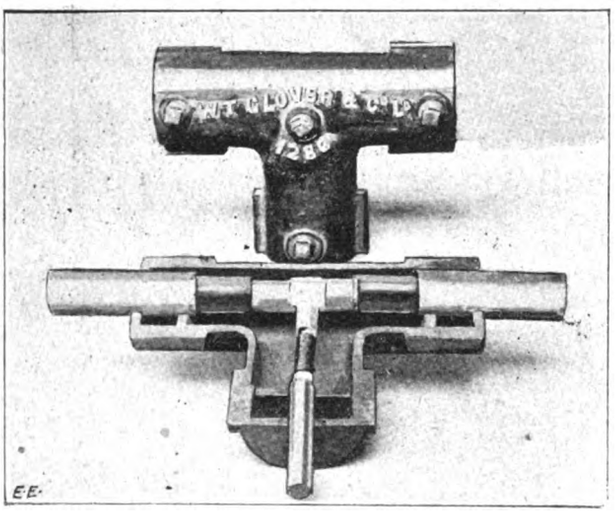
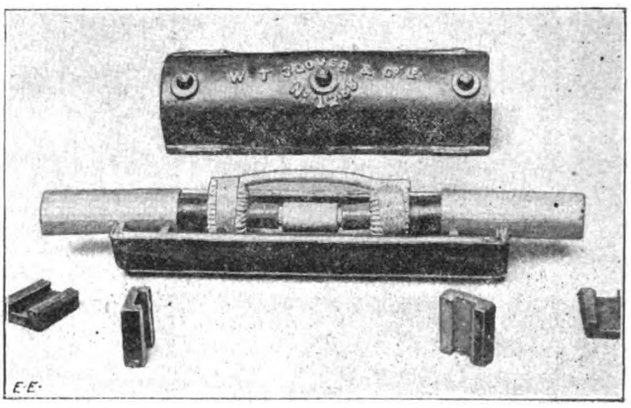
withstand a working pressure of 100lb. per square inch, ample margin being allowed for safety. Watertightness between the two halves of the tank is obtained with the aid of lead, which is pressed into a grooved fillet by the action of the tightening-up process, thus making a close joint. A set of hydraulic pumps furnishes the requisite pressure for testing. About 15 minutes is occupied by each test—that is to say, in enclosing a drum of cable, screwing down the cover of the tank, pumping it full of water and applying full pressure. It is found in practice quite unnecessary to maintain this pressure for more than a few seconds. The output of the tank, then, is largely governed by the speed at which it can be served. It is designed to take any drum up to 9ft. in diameter. When it is a question of testing smaller drums of cable, as many may be put in as the size allows. Roughly speaking, the capacity of this one tank measured over a given time is equivalent to that of about 30 ordinary tanks. In all, four men are required to serve the tank, including nut-pushers. The inception of the idea may be traced to the repeated failure of the usual method of testing to discover pinholes in the lead sheathing of cables, which, after 24 hours' immersion in an open tank, frequently give high insulation resistance, despite the existence of pinholes, this phenomenon being due to the non-hygroscopic quality of the paper insulation employed. In other words, besides being much quicker, careful experiments made by Messrs. Mordey and Dawbarn



Messrs. Glover's Single Cable Tee-Joint.

have shown this method to be more searching than the usual 24 hours' immersion in open tanks. Cables which after 24 hours' immersion withstood 1,000 volts broke down instantly at 500 volts after five minutes' immersion under pressure. And not only does the method instantly show the presence of any holes or cracks in the lead covering, but also breaks down incipient faults and weak places which under ordinary conditions would probably not be revealed until after the cable was laid. Naturally, some conservatism will have to be overcome before the new method is allowed to serve instead of the 24 hours' immersion test for lead-sheathed cables, but meanwhile it is satisfactory to Messrs. Glovers that several engineers have already recognised its efficiency and superiority.

Passing from the above described novelty, we made a rapid inspection of the rest of the works, of which some recent interior views are reproduced herewith. One branch, we noticed, was busily employed in making fireproof cables of a type recently introduced by Messrs. Glovers, and fully described in our last issue, pp. 889 and 890. Leather sheathing was being put on some of these cables, a patent method of protection, by virtue of which they are rendered doubly suitable for use in collieries. In fact, the leather braiding serves to give good mechanical protection to the cable without impairing its flexibility, the durable quality of the material itself making it peculiarly capable of withstanding the rough usage incidental to colliery work. The cost of providing this special protection is about the same as for steel armour, we understand. But when these fireproof cables are required for ordinary purposes, such as switchboard work, arc lamp leads, theatrical displays, railway work, etc., the leather braiding is omitted. We also saw the last instalment of the traction cable destined for use on the Lancashire and Yorkshire Railway—Liverpool and Southport line—in process of manufacture.

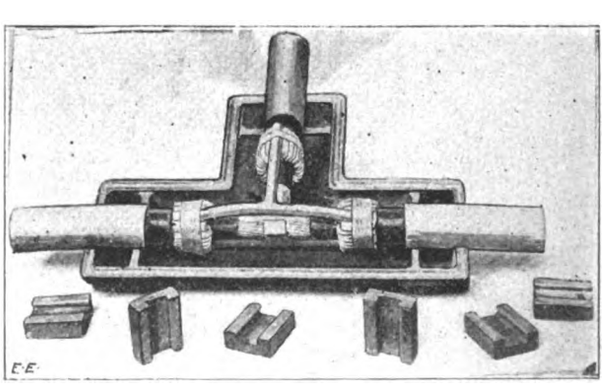


Messrs. Glover's Concentric Cable Straight Joint.

The special features of this important cable have been separately dealt with in a previous issue.

In addition, we noticed traction and lighting cables for about a dozen different municipalities, including Paisley, Sheffield, Blackburn, Bolton, Malvern, Darlington, Shipley, Stalybridge, and Wednesbury in different stages of progress, not to mention Government work, etc. With reference to the Stalybridge contract, it may be mentioned that this also includes cables for the neighbouring districts of Hyde, Dukinfield, and Mossley—thus four separate areas. These areas will be supplied from one central station under the control of a Joint Lighting and Traction Committee. The network of cables will also form one complete whole, the ownership being divided between the district councils representing the four areas in question. This scheme is noteworthy in that it shows what may be effected in small areas by unselfish co-operation.

An interesting feature likewise presents itself in connection with the cables which were being made to the order of the Wednesbury Corporation. This authority has contracted to take a supply of electricity in bulk from the Midland Electric Corporation. The Wednesbury Corporation are laying a twin concentric two-phase low-tension cable to connect their own sub-station with that belonging to the company, a matter of a few hundred yards distant. Why the municipal body should not have connected their distributing network directly with the company's sub-



Messrs. Glover's Concentric Cable Tee-Joint.

station, and thereby saved the cost of building and equipping a second sub-station, does not seem clear. This cable, termed by the makers "twin concentric," contains two inner cores with the common return of the two-phase system arranged concentrically round them. The cable is lead covered and armoured.

The last of the accompanying illustrations show Messrs. Glover's standard single-cable tee, concentric cable straight, and concentric cable tee methods of jointing, which may be

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briefly described as follows: The single cables are connected together by a three-fingered fitting, which is clenched with gas pliers upon the main, the branch cable being sweated into a socket attached, the fitting being also sweated solid. The concentric cable inners are jointed on the straight by a sweating sleeve, and on the tee by the closing joint just described. The outer wires are turned back upon a cast sleeve, which has a groove at the top, into which fits a connecting rod, this and the outer wires being bound down together by No. 18 tinned copper binding wire and then sweated solid. The tee joint outer sleeves are in halves to save cutting the cable. It will be seen that these closing joints and concentric fittings make a very compact job, which is mechanically strong and of lasting conductivity. Also that the joint does not require a man of more than average intelligence and carefulness to make it satisfactorily, as its success depends more upon strength of fingers in clenching and binding than upon excessive accuracy of fit over the conductors. Messrs. Glover stock these joint-boxes and fittings largely to meet the demand that has arisen for them from corporation engineers and contractors all over the country.

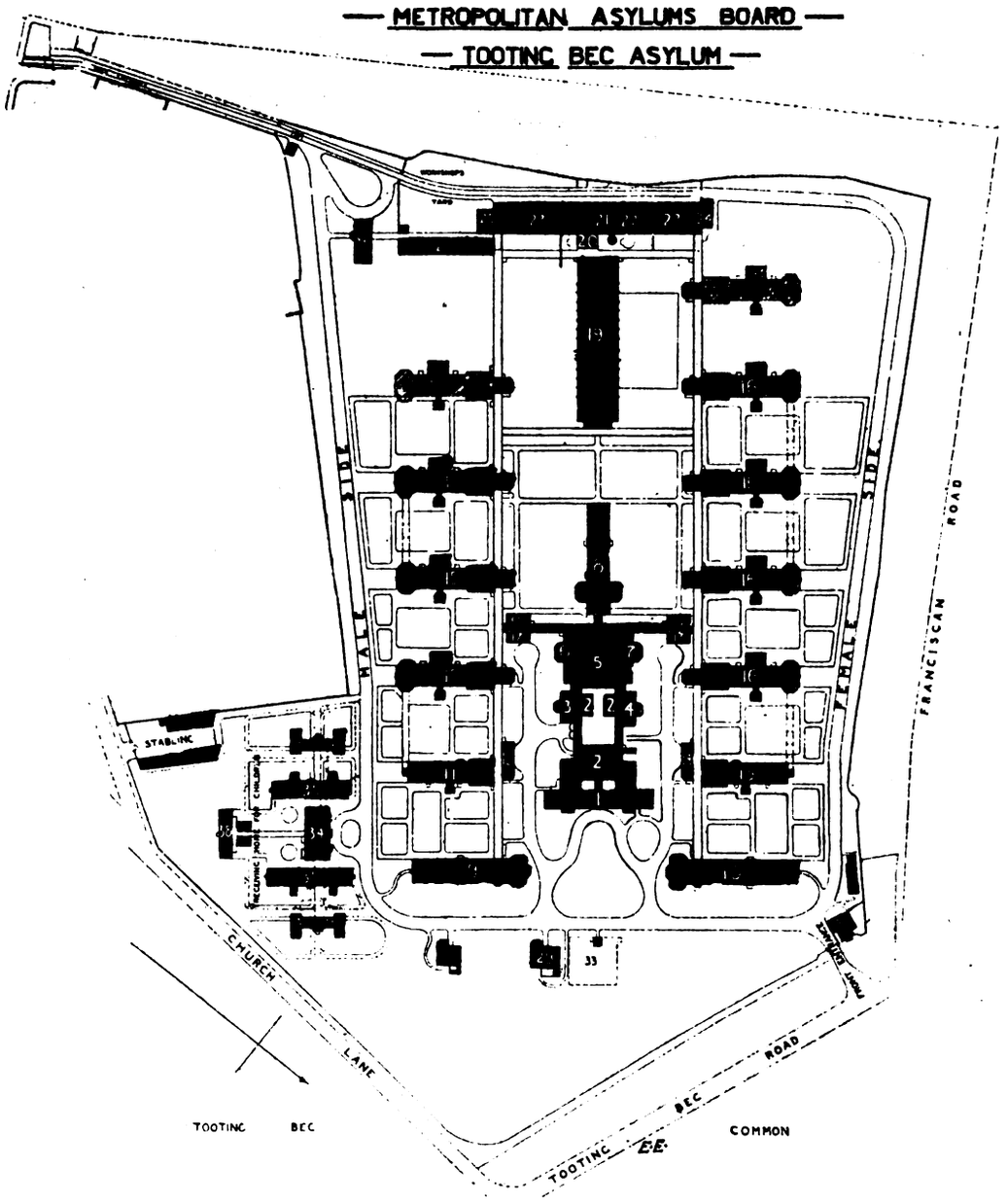

FIG. 1.—Block Plan of the Tooting Bec Asylum.

ELECTRIC LIGHTING AND POWER PLANT AT THE TOOTING BEC ASYLUM.

This latest addition to the undertakings of the Metropolitan Asylums Board was completed early this year, and provides accommodation for 804 patients. The general plan of the buildings is given in Fig. 1, which shows that two additional blocks are allowed for in the arrangements, which will raise the accommodation to nearly 1,000. The interest of our readers will lie in the engineering department, which is located in the buildings numbered 20, 21, and 22 respectively. These are the gas-producer house, the boiler-house, and the dynamo-house, with accumulator-room attached. The plant is novel in many respects for the class of building supplied, and this is particularly so with regard to the heating and lighting. Thus, while steam is used for heating, power gas is produced to drive the engines, which in turn drive the electric lighting dynamos. The wiring, too, is novel. The whole of this work was designed and carried out by Messrs. Handcock and Dykes, consulting engineers, of 1, Victoria-street, E.C.

The heating boiler house (Fig. 2) contains three steel Galloway type boilers, each 20ft. long by 6ft. 6in. diameter, and each capable of evaporating 3,800lb. of water per hour at a pressure of 80lb. These boilers serve to supply steam at 50lb. pressure for heating the various blocks, and at 80lb. pressure for use in the laundry and for the producer of the gasmaking plant. Each boiler is fitted with two mechanical stokers, supplied by the Underfeed Stoker Company, there being a motor-driven fan for supplying the forced draught. The coals used under these boilers are the screenings of the house coals supplied to the asylum. A Green's economiser of 72 pipes is arranged behind the boilers for the purpose of heating the feed water. In the pump-room there are two electrically-driven boiler feed

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pumps, one of which is driven by a constant-speed motor, the pump itself having a link arrangement by means of which the length of the stroke can be varied to suit the output required from it, and the other being an ordinary pattern of three-throw pump direct-coupled to a motor, the speed of which can be varied over wide limits by driving it either across the outers of the three-wire system of mains at 240 volts, or across the neutral and outer at 120. In addition, each boiler is fitted with a Green and Boulding's "Buffalo" injector, and there is one steam-pump in reserve. The contract for the whole of the boiler-house equipment was let to Messrs. H. and T. Danks, Netherton, near Dudley.

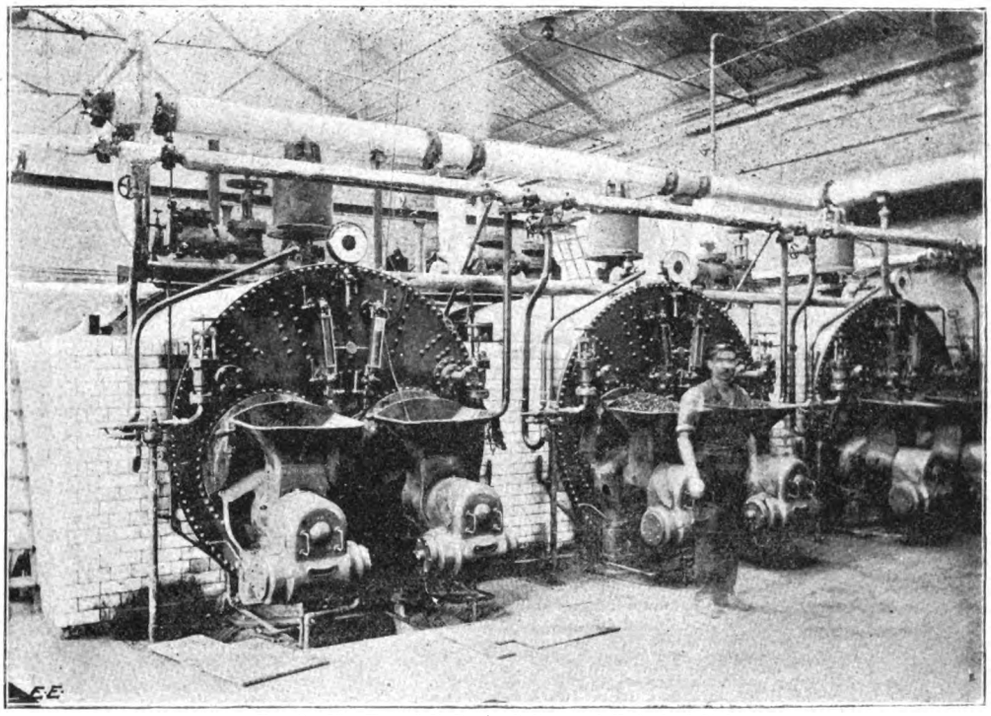

FIG. 2.—The H. and T. Danks Boilers and Underfeed Stokers.

The producer-gas plant was supplied by Messrs. Paisley-Welch, and consists of two of their gas-producers with the necessary scrubbers. After passing through the scrubbers the gas is led into a small regulating gasholder, and thence direct to the engines, the production of gas being controlled automatically by means of the rise and fall of the gasholder. This acts on a valve, which regulates the steam inlet to the producer. The process of making gas consists in blowing a jet of steam through a mass of red-hot anthracite coal contained in the producer, the gas, although of no use for illuminating purposes, being specially well adapted for use in gas-engines. During the trials made by the engineers on completion of the plant, the consumption of anthracite coal per electrical unit measured at the terminals of the dynamo amounted to only 1·4lb., whereas with steam plant this would have been at least 4lb. to 5lb.

The engine-room (Figs. 3 and 4) contains three Crossley gas-engines, each giving a maximum of 70 b.h.p. at about 210 revolutions per minute, and driving by belt a shunt-wound Crompton dynamo giving 140 amperes 250 volts at 550 revolutions. As a general rule, two engines only are in use, one being a stand-by. In addition to the three dynamos, there is a battery of accumulators (Fig. 5), consisting of 132 L B 9 Tudor cells, capable of discharging at 56 amperes for 10 hours at 240 volts, or, in other words, of supplying 1,000 16-c.p. lamps for 10 hours. This battery is used to run the lights during the night-time and during

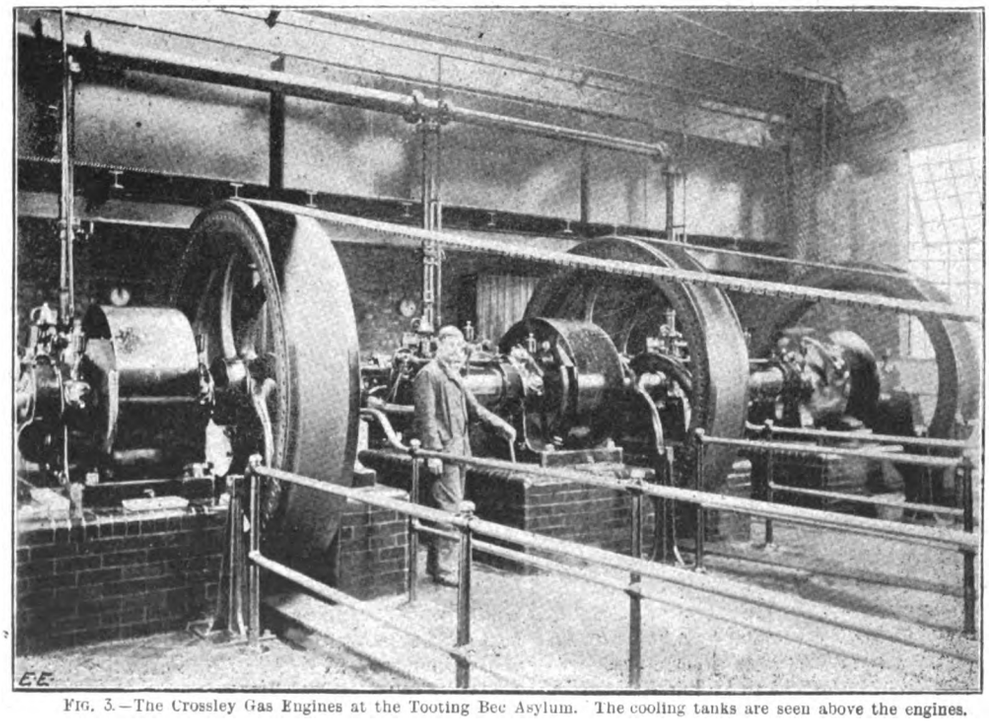

FIG. 3.—The Crossley Gas Engines at the Tooting Bec Asylum. The cooling tanks are seen above the engines.

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parts of the day when there is no great call for current. The battery is charged by means of two boosters which are connected on to the shafts of the two balancing machines used to equalise the load on either side of the three-wire system. The battery connections to the main regulating switches being the switchboard are neatly made with bare copper wire, as shown in Fig. 5. The copper is protected from acid fumes by insulating enamel.

From the main switchboard, which is fitted with the usual instruments for measuring the output of the various dynamos and the current required on the different circuits, a main three-wire ring main is run right round the grounds in the subway connecting the various buildings. The lighting installation consists of about 2,300 incandescent lamps of 8 c.p. or 16 c.p. and 12 arcs for lighting the laundry, and has been carried out on a novel principle

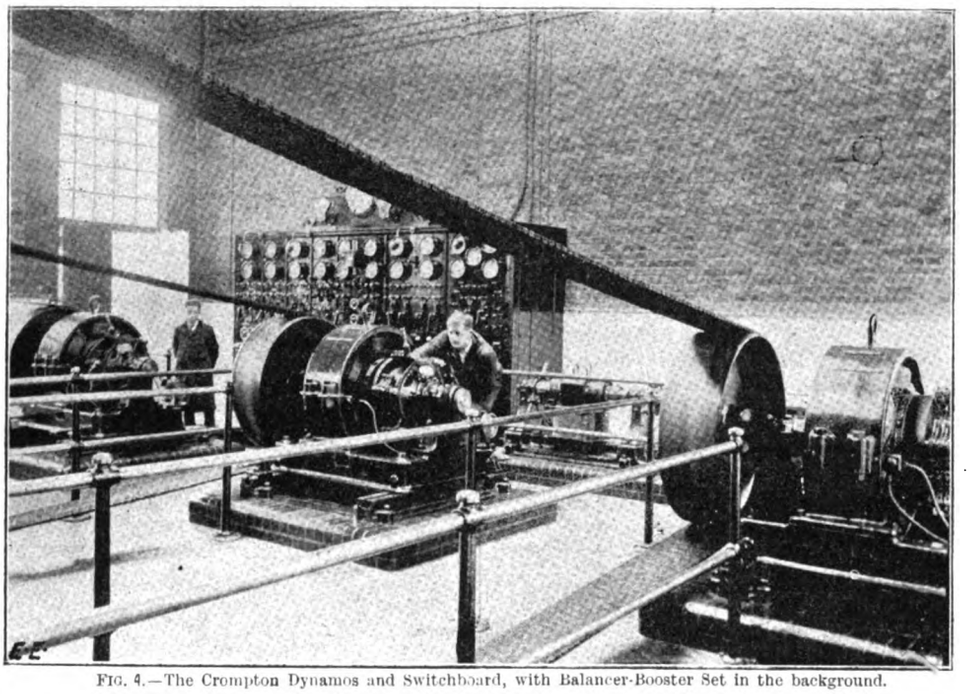

FIG. 4.—The Crompton Dynamos and Switchboard, with Balancer-Booster Set in the background.

In addition to supplying current for lighting, the generating plant also provides for a number of motors in various parts of the institution, there being two motors—one of 15 h.p. and the other of 5 h.p.—for driving the shafting in the laundry, a 10-h.p. driving a fan in the drying-room, a motor-driven pump at the far end of the grounds for pumping water from the rain-water tank

devised by the consulting engineers. This system, which may be called the draw-through concentric system, consists in running on the surface of the walls buried in the plaster small brass pipes varying from $\frac{5}{16}$in. to $\frac{7}{16}$in. internal diameter, and drawing into them a single or, in the case of a three-wire circuit, two insulated conductors. The pipe serves at the same time as a channel for and a

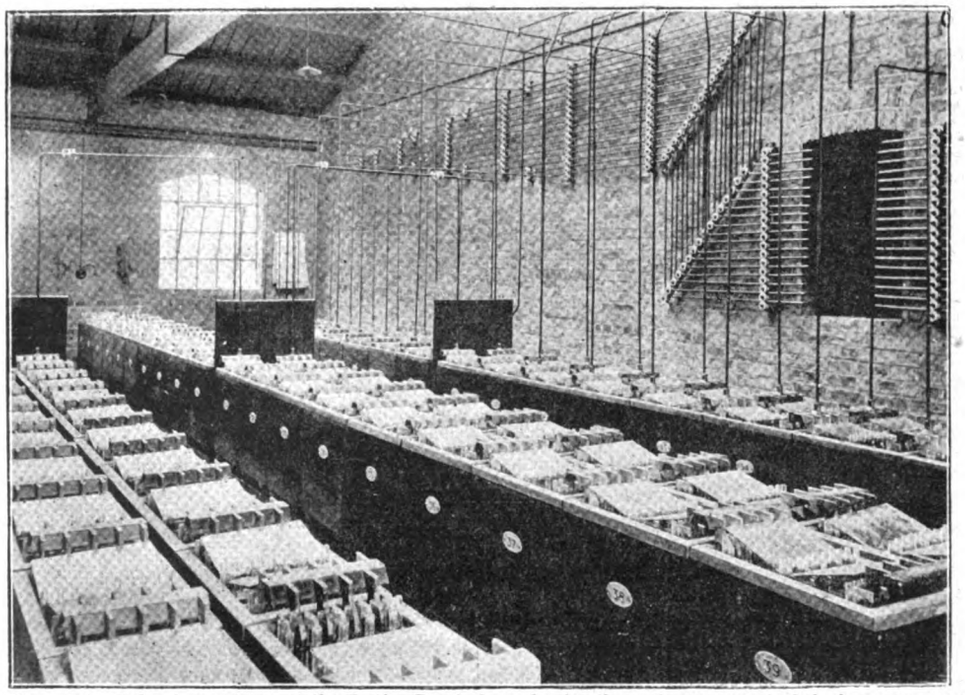

FIG. 5.—View of the Tudor Accumulators at the Tooting Bec Asylum, showing the neat arrangement of the bare copper connections.

for use in the laundry, and the various motors required for feed pumps, forced draught, and for working the scrapers of the economiser. The complete equipment of the electrical generating plant, including the producer-gas plant, gas-engines, dynamos, accumulators, main switchboard, and motors, was supplied by Messrs. Crompton and Co., of Chelmsford.¶

protection to the cable and as the return conductor for the current. One pole being thus connected to, and at the same pressure as, the earth, it is impossible to accidently obtain a shock, and only half the usual amount of wire is required. Owing to the small size of the pipes they can be laid in the thickness of the plaster without requiring to chase the walls, and by means of the system

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of joint and switch boxes provided, any defective wire can be drawn in and out at any time without disturbing the plaster work or decorations; indeed, not a yard of wire was pulled into the pipe until the rest of the building was complete. Another advantage is that, when required for the purposes of cleaning or whitewashing, the whole of the fittings can be unscrewed, taken down, and put up again without breaking any joints or requiring any skilled labour. The lamps are supplied at 120 volts on the three-wire system, and there being, as stated above, a complete ring main, there are thus four circuits available for current, rendering it practically impossible for any breakdown of the main cable to put out more than half the lights at once. Each separate block has its own service box and main switch, by which it can be disconnected at any time from the ring mains, and all the fuses are grouped in distribution fuse-boards in the passages, there being not more than 10 lights on a circuit. The two sides of the three-wire system are practically balanced in each block.

The contract for the whole of the main cables, wiring, and fittings was carried out by Messrs. Robert Dawson and Co., of Stalybridge. The advantages of this system of wiring are many, and not the least is the fact that there is a continuous earthed metal sheath over all the live conductors. The fittings are interchangeable throughout, and screw into the terminal boxes with concentric connections. The architects for the above asylum were Messrs. A. and C. Harston.

INDEPENDENT TELEPHONY IN GREAT BRITAIN.

BY GARDNER AND HOLME.

(Continued from page 881.)

(8) Exchange Construction.

Another and important factor in the installing of the system is the construction and design of the exchange; in fact, as much, if not more, skill and experience is necessary as in the overhead and underground equipment. The exchange is the main spring of the whole undertaking, as upon it will depend the accurate working of the system and the service which can be given. Of late years the practice has been to secure premises quite inadequate for the purpose of giving a good service or of coping with the growth of the traffic. The utility and necessity of the telephone at a reasonable rate is now realised, and the requirements of a suitable building for the occupation of a switchboard and its accessories make it necessary to build specially for the purpose. The building itself should be designed to allow of offices, stores, operating, retiring, battery, test, and distributing rooms being in the same block; ample expansion being provided for future development, and all heating, lighting, fire, and ventilating appliances allowed for. Under the heading of exchange construction the fitting up of the operating, battery, and test room appliances first claims our attention. Owing to the rapid and continuous growth of the telephone industry in other countries, and the great bulk of the apparatus being obtained there, manufacturers in England have, unfortunately, found themselves unable to compete, so much so that at the present day there are few who have the plant and appliances necessary to turn out the apparatus for the equipment of modern test-rooms and large switchboards.

Modern Test-Rooms.—In the arrangement of the many devices and ideas that have from time to time been adopted we will confine ourselves to a general method. The lead-covered cables entering the test-room for distributing

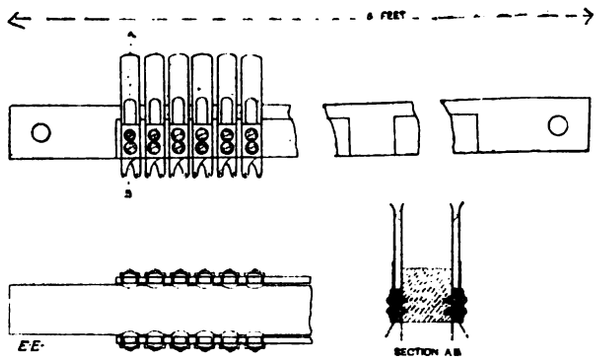

FIG. 45.—Test Jack.

purposes should be available for handling, and in order to effect this the cables terminate in what are termed pot-heads, these pot heads being arranged in order and directly in front of the frame, on the floor level. The paper cables being prepared by waxing, lacing, and taping up ready for soldering on to the test jack strips, which are mounted on the frames. The design of the frame might be after the manner we adopted as shown in Fig. 44, the size being in accordance with the ultimate capacity of the cables proposed to be laid down. To this frame are fitted the strips of test jacks, each numbered from 1 to 100, and mounted on highly insulated wood, as shown in Fig. 45, each individual jack being independently insulated by vulcanite blocks and washers, provided with soldering tags for the reception of the dry-cored paper cable wires. This method of terminating is simple, substantial, and effects a considerable saving over other methods which

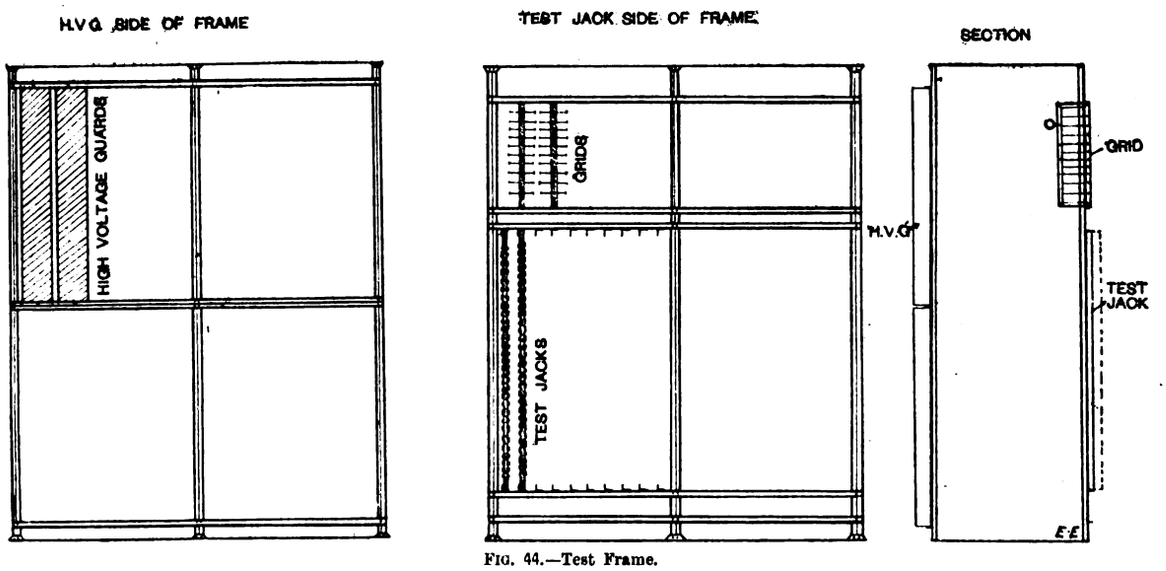

FIG. 44.—Test Frame.

have been tried. Upon the other side of the T iron frame, or what we might term the switchboard side, are erected the arrester strips, again mounted in rows or strips of 100 each (five sets of 20), as will be seen from Fig. 46, being also numbered from 1 upwards. From the arrester, or switch-board, side of the frame paraffined cables can be run to an intermediate distributing frame. From the intermediate distributing frame the paraffined cables are conveyed in ducts to the main switchboard. These cables are generally of 42 wire No. 22 S.W.G., and, if mechanically protected in good strong wood conduits under the floor, need not be lead covered, as it is sometimes the practice. The advantages

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and simplicity of arranging the incoming cables and frames in this manner become apparent, but, on the other hand, arguments might be brought against such a practice, in that no protection is given to the cross-connecting wires on the line side of the distributing frame. That is so where the test and arrester frames are constructed of wood and the cross connecting wires are rubber and paraffined cable, but with frames constructed entirely of iron and fireproof, and the cross-connecting wire asbestos covered, no fear need be anticipated in that direction. It must also be remembered that if the cables are taken directly on to the safety 100. All the combined parts which go to make up a switchboard equipment should be mounted in such a manner that will allow of any one part being removed from the back or front of the board without disturbing the remaining parts and cables in any way either in the taking out or replacing. The design and mounting of the spring jacks and indicators should be done in such a manner as to render them self-contained and readily adjustable at any time. When it is desired to adjust, repair, or clean the various parts, provision should be made to quickly effect this, so as not to disturb the working of the board.

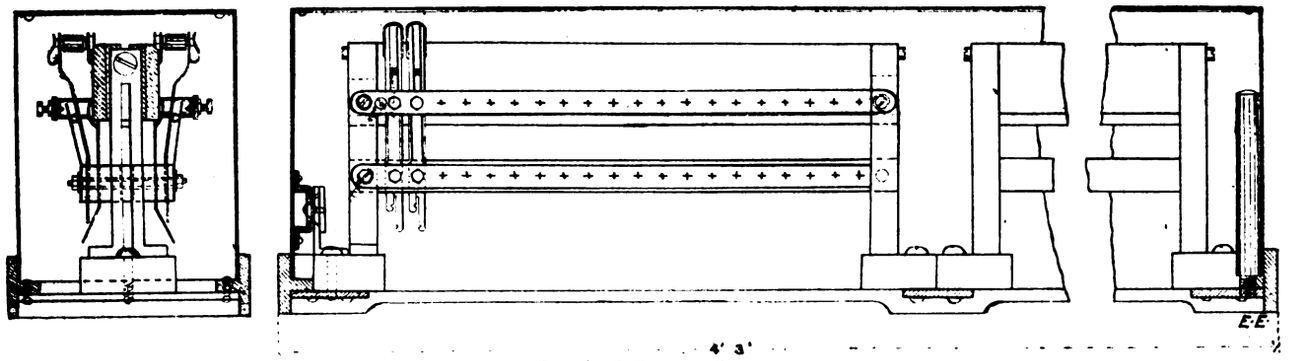

FIG. 46.—Switchroom Guard.

arrester frames a greater number of arresters would be required to accommodate the spare cable wires, which must necessarily and generally are provided for extensions and the growth of the system. This item alone is an expensive one, and ought to be carefully considered when planning out the preliminary arrangements in test-rooms. In designing the frames, provision should be made for the conveyance for the cross-connecting wires in their proper order, and also that access can be given to the removal and transposition of any wires, without interfering with the others. This in a large exchange is a great matter, as numbers are constantly being changed.

Another and important matter, and one which is very often lost sight of, is the amount of spare accommodation to leave in the frame for future development, and by adding combined jacks and indicators in the local field, and multiple jacks in the multiple field as the system expands, due provision being made in the wiring of the local and multiple cables to effect these additions.

Framework.—A rigid angle-iron structure makes the best frame for large multiple switchboards, the objections to wood being the inaccessibility to the various parts through the battens or wood supports being necessarily large, in order to take the weight and strain of the cables and

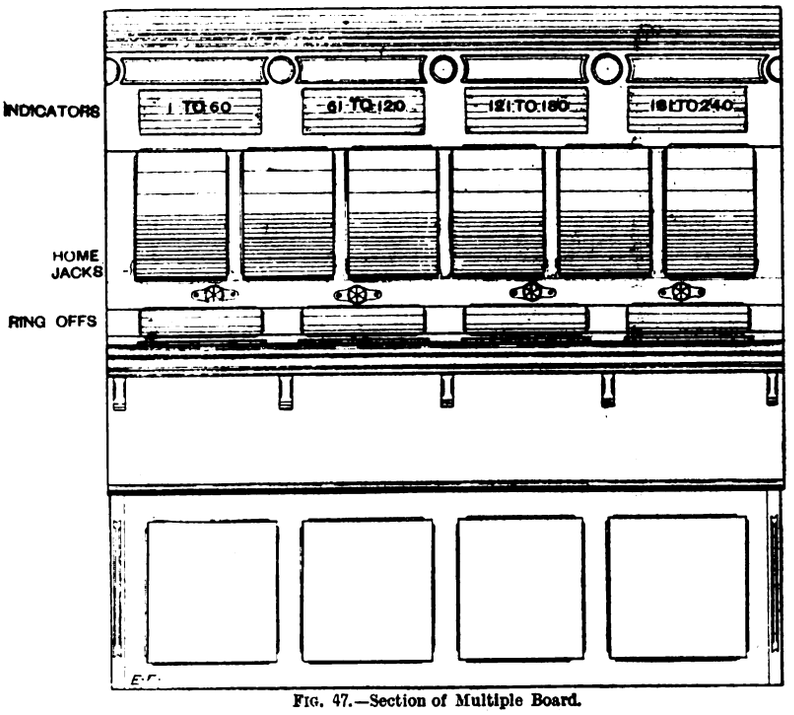

FIG. 47.—Section of Multiple Board.

Switchboard Fitting.—In the designing of switchboards for exchange working many points and circumstances have to be taken into account. These circumstances will vary according to the number of lines to be provided, the system which is intended to be adopted, and also the most suitable for the district, the number of junction lines which will be operated between the various exchanges and Post Office, the number of calls which are likely to be handled, and the number of lines which it is intended to assign to each operator. Assuming that low tariff rates are to be adopted with a toll service, the number of lines to be apportioned to each operator's position could be with

fittings. In the design and setting off of the iron frame great care must be exercised in the drilling and tapping of the various centres. Fig. 47 gives a general idea of one section of a multiple board manufactured by the British Insulated and Helsby Cables Company, Limited.

Self-Contained Indicators and Jacks.—On reference to Fig. 48 it will be seen these are self-restoring, and the jacks and coils are directly placed in the local field in front of the operator, the indicator being restored by actual mechanical contact with the plug. The jacks should be of the very best German-silver springs, rigidly mounted and lightly insulated on strips of vulcanite, and so bolted and

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braced as to prevent warping. The coils being carefully wound to the desired and proper resistance on highly insulating bobbins, and not on the iron cores of the indicator, as is generally the practice, the relay or night-bell circuit being kept independent and absolutely clear of the frame of the indicators or coils.

Ring-Off Indicators are of the differentially-wound tubular type, one drop being provided with each pair of cords, the drops being wound to 1,500 ohms (each winding), and in such a manner as to be absolutely non-inductive no matter what pair of cords are used.

Keys.—Ringing, speaking, and clearing out keys of a thoroughly reliable pattern should be provided, and fitted in the front of the board in a readily accessible manner, one for each pair of plugs. These should be so constructed that a backward movement upon the lever enables the operator to speak on the cord circuit, and a forward movement from the operator throws the calling or power generator on to the calling plug. The lever being arranged to always return to the normal position automatically, when released from either speaking or ringing position, to the ring-off or clearing circuit and cut the plug connection of the through circuit should the operator attempt to break in. All springs should be constructed of the best German silver, platinum pointed to prevent corrosion, and be long, so as to prevent possibilities of weakness setting up after being in use for any length of time.

Plugs and Connecting Cords.—No one has yet been able to place upon the market an ideal switchboard plug and cord, although many ideas have from time to time been tried and adopted. The plug and cord being the hardest worked part of the whole apparatus, it is essential that they be constructed of the very best material which can be obtained. All plugs, whether two or three way, should be substantially made of perfect gauge to fit the jacks, and be provided with

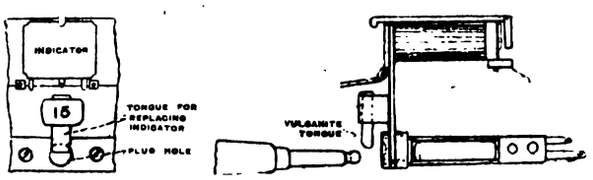

FIG. 48.—Combined Indicator and Jack.

screw connections for the cord strands. Over the connections polished hard fibre sleeves should be slipped to serve as a protection, and a handle for the operator. The conductors of the core strands should be of tinsel, with a stranded core of very fine copper wire thoroughly insulated and protected, all the insulated conductors being closed in a spiral wrapping of spring brass wire to form an armouring for the conductors within. Over this a heavy linen braid should be woven single the entire length and double at each end of the cord for about 6in. This lessens the chance of breakage at the point where the strain is greatest.

Generators.—Hand generators should be provided and fitted to the board ready for use in case of breakdown to the power set. These should be capable of ringing through 50,000 ohms and be provided with noiseless hand driving gear and automatic cut-in worked from the spindle of the driving gear. This prevents any possible chance of the generator being shunted through another.

Operators' Sets.—To each operator's position should be fitted an induction coil of the bridged type, a five-point jack mounted on a vulcanite block, wired ready to receive the stranded flexible cord and plug for the connection to the receiver and transmitter.

Wiring.—The very best of switchboard cable should be used, made up and formed of No. 22 copper wire. To the operators' microphone sets and all power circuits, special highly insulated-rubber twisted twin wires should be used of proper sizes to ensure the carrying capacity on the circuits. The entire switchboard system deriving its current from storage batteries, it is essential to see that these circuits are run in a careful manner and clear of all other wiring on the board. For the reception of these circuits distributing boards should be provided and mounted in each section. These distributing boards, consisting of an enamelled slate base upon which are mounted brass terminals for the various circuits, are as follows: operator's microphone, generator, night-bell relay or pilot circuit, and main calling circuit.

(To be continued.)

THE GILBERT TERCENTENARY CELEBRATION.

As it happened, the usual fortnightly meeting of the Institution of Electrical Engineers in London on Thursday evening, the 10th inst., fell on the three hundredth anniversary of the death of Dr. Wm. Gilbert, of Colchester, and in celebration of the interesting and historic occasion the Council devoted the first part of the meeting to formally presenting to the Mayor and borough of Colchester a picture representing Dr. Gilbert showing his electrical experiments to Queen Elizabeth and her Court. The painting, of which we give the accompanying illustration, is the work of Mr. Acland Hunt, and was subscribed for by the Council and members of the Institution. It bears the inscription: "Presented by the Institution of Electrical Engineers to the Corporation of Colchester in commemoration of the scientific achievements of Dr. Gilbert, on the 10th of December, 1903, the three hundredth anniversary of his death."

The Mayor of Colchester (Mr. E. H. Barritt) attended in state, accompanied by three other members of the Corporation and the Town Clerk; and there were also present in addition to Mr. R. Kaye Gray (the president) and the members of the Council, the Mayor of Westminster (Mr. Walter Emden), the President of the Royal Society (Sir Wm. Huggins), the President of the Société Internationale des Electriciens (Mons. E. Hospitalier), the Treasurer of the Royal College of Physicians (Sir Dyce Duckworth, M.D.), Dr. J. Larmor, F.R.S., of St. John's College, Cambridge (Dr. Gilbert's College), and the Borough Electrical Engineer of Colchester (Mr. A. R. Sillar).

The PRESIDENT, in opening the proceedings, explained that they had met there that night to ask the Mayor of Colchester to be kind enough to accept in the name of the Institution the picture which they saw before them. They all knew something about Dr. Gilbert, but he would leave it to Prof. Silvanus Thompson, who was much more competent to deal with the subject than he, to tell them the particulars of the presentation. Prof Silvanus Thompson and Mr. Conrad Cooke were the two honorary secretaries of the Gilbert Society, and they had both worked very hard in the cause of commemorating the work of Dr. Wm. Gilbert. It would be unbecoming in him, therefore, to say much on this subject, and, therefore, he would simply conclude by asking Prof. Thompson to make a few remarks.

Prof. SILVANUS THOMPSON said he had in the first place to read a portion of a letter received from Lord Kelvin, who regretted very much his inability to be present that evening owing to an engagement in Scotland. Lord Kelvin thought the plan that had been hit upon for the commemoration of Gilbert a good one, and he sent his apologies that he could not take part in the proceedings. Mr. Acland Hunt, the painter of the picture, desired it to be known that he had spent very many years on the painting as a labour of love, but that he was incited to the idea by the late Sir Benjamin Richardson, and had laboured to be faithful even with the best that could be done in the way of portraiture to bring back the episode it commemorated. They, as electricians, owed an enormous debt of gratitude to Dr. Gilbert. There were many great men in the time of Queen Elizabeth, but for electricians Gilbert stood out pre-eminent. It was true that there were statesmen before Cecil, naval heroes before Drake, explorers before Raleigh, dramatists before Shakespere, poets before Spencer, and philosophers before Bacon, but before Gilbert there was no electrician. He was the absolute founder of electricity, and he claimed their admiration not only as the founder of the science of electricity, but as the founder also of another science—that of terrestrial magnetism. They all knew how he devoted the greater part of his activities and no less than £5,000, according to Harvey, or according to Decarte, 5,000 crowns, to this science, and how in 1600 he produced his book, the identical copy of which he (Dr. Thompson) held in his hand, and which the author had presented to

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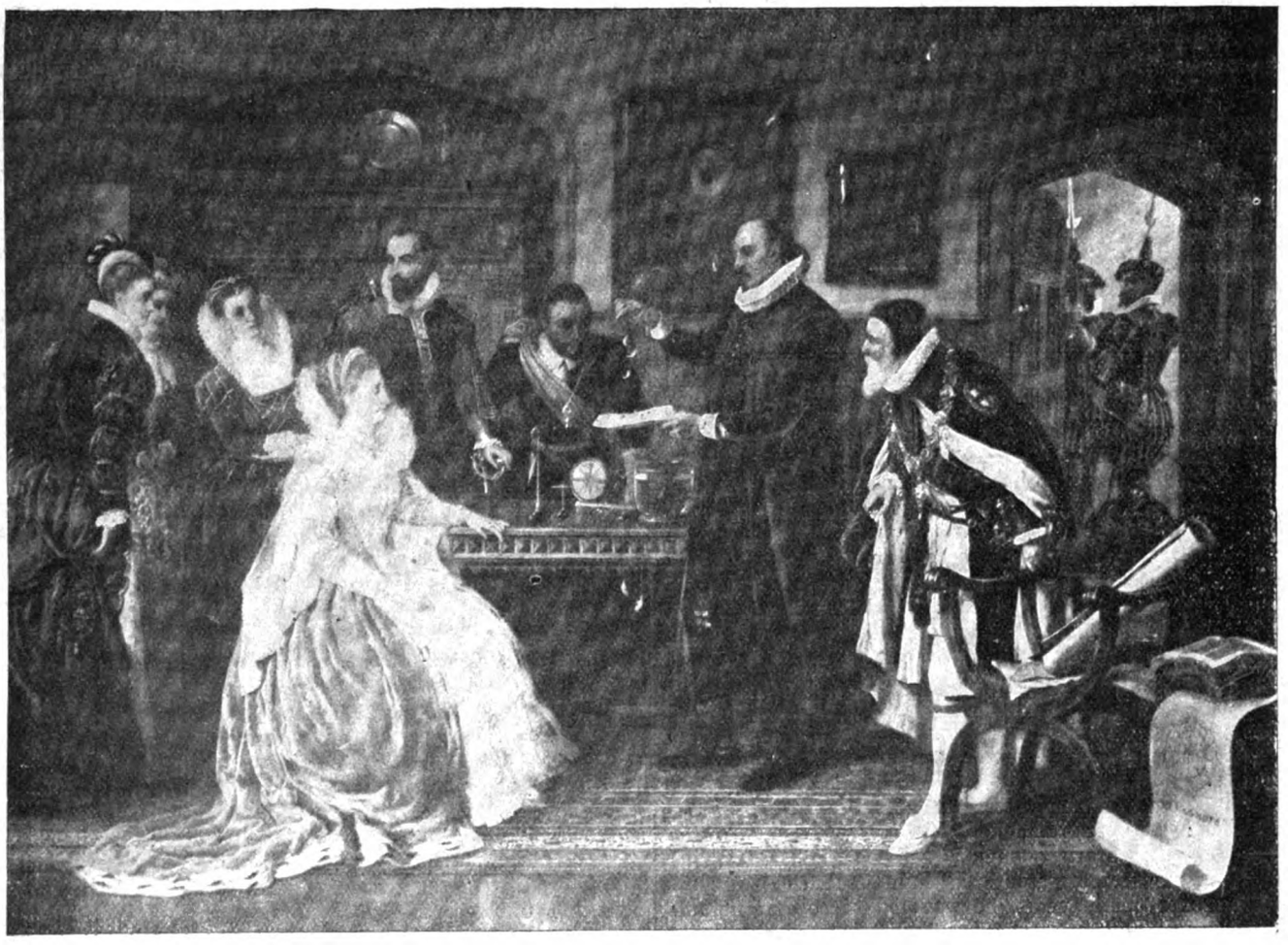
Lancelot Brown, another physician to Queen Elizabeth. In this book Gilbert laid the foundation of terrestrial magnetism, proceeding by the at that time little recognised method of experiment. Gilbert used a little ball of loadstone, and by placing a compass needle over it and seeing how it pointed he was able to show that the variations, the tipping, and the pointing of the needle were identical with those of a needle over the surface of the earth, and he was laid out that new and unheard-of idea that the earth itself a great magnet, That was the text of this book. Not only did Gilbert found the science of terrestrial magnetism, but also contributed to the science of astronomy, and the science of navigation. It was therefore fitting that when they were met together to commemorate the three hundredth anniversary of his death they should have with them representatives of other bodies which represented scientific progress in this country. These representatives they were all delighted to welcome. One fact must not be forgotten. Like Lancelot Brown, Gilbert was a Fellow of St. John's College, Cambridge. He was even mathematical examiner and senior bursar. Also, it must be stated Gilbert was born at Colchester on May 24, 1544, at 2.30 p.m., in a house which was still standing, and to which he returned in his later years, and, for aught they knew, died there. That house was the very Mecca to which all electricians would go to make a pilgrimage, and within a short distance of it, across the street, lay his bones in the churchyard of St. Trinity. In the new church there was a fine heraldic monument to his memory which recorded his virtues and his career. Prof. Thompson, in conclusion, said he had tried to tell the tale of the hero at whose shrine he worshipped, and he hoped many of them would have the opportunity of repairing to Colchester that they might worship at his tomb.

The PRESIDENT then presented the picture, formally asking the Mayor of Colchester, in the name of the Institution, "to be kind enough to accept and keep in your safe keeping for your town and Corporation the picture you see before you."



Dr. Gilbert showing his Electrical Experiments to Queen Elizabeth and her Court.

The MAYOR OF COLCHESTER, returning thanks on behalf of his town, said that the kind words which had been spoken by Dr. Thompson, promoted by the even kinder motive which lay behind those words, were calculated to deeply stir the feelings of a man much older than himself. It was about a month ago that he received a letter from Dr. Thompson asking him in a simple, artless manner whether in the event of any tercentenary celebration being held in London he might possibly be able to attend. He was obliged to own that his thoughts turned to a dinner, but he determined that whatever form that celebration might take, out of respect to the memory of Dr. Gilbert, in honour of the services he rendered to electricity and magnetism, and as the representative of his native town—the borough in which Gilbert lived and worked and died—he should be glad to attend. He rejoiced that the Institution of Electrical Engineers had not stooped to any form of celebration so trenchant, so mundane. He would say a word or two about himself in order to assure them that their gift passed into safe hands, and that it would remain in safe keeping until in his turn he handed it over to his town. About 27 years ago he learnt to reverence the name of Gilbert. It was then, at the age of 13, that he obtained a prize in electricity and magnetism at South Kensington, and, call it a coincidence if they would, that prize was now the favourite book of his only child—a boy of 6½ summers. He remembered when quite a boy going down to the church of Holy Trinity to see the tablet erected to the memory of Dr. Gilbert, and how he was turned out by the gardener without his desire being gratified. He remembered well his first revolving plate electrical machine, and he took even more interest in watching the glass plate revolve than in watching the revolutions of the 550-kw. generator at the Colchester electricity works to-day. He remembered his first Leyden jar—his difficulty in fixing the inner coating of tinfoil, and how he finished the apparatus with a wire and wooden knob covered with foil. He remembered his battery of six Leyden jars; he remembered his first shock

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from them, and then for a time he remembered little more. He never thought how those early struggles were destined to play their part in qualifying him for the position of chairman of the electricity department of the Colchester Corporation to-day; how in the higher office of mayor he should be invited to attend that historic gathering that night, and receive at the hands of the President of the Institution so unique a gift. Colchester had learnt to reverence the name of Gilbert. The Institution of Electrical Engineers had in its wisdom, in its love, and in its devotion to his memory, seen fit to secure this valuable and historic painting, and having secured it to present it a gift to Gilbert's native town. First among the many pleasing recollections associated with the opening days of his mayoralty would rank the knowledge that he was privileged to attend this celebration, to be the recipient at the hands of such donors of so generous a gift. The painting should find a fitting resting place on the walls of Colchester Town Hall, which henceforth would become its home.

The PRESIDENT proposed a vote of thanks to the Mayor of Westminster and the representatives of the various scientific bodies present, which was carried by acclamation, and the MAYOR OF WESTMINSTER and Sir DYCE DUCKWORTH (treasurer of the Royal College of Physicians) having returned thanks, the ceremony ended.

We hardly suppose that there is an electrical engineer to-day who is not familiar with the name of Dr. Wm. Gilbert or with his wonderful achievements as the "Father of Electrical Science." Dr. Silvanus P. Thompson, as our readers know, has taken up the subject as a special study, and it was natural that to him should be allocated the responsibility of preparing some notes on the life and career of Gilbert for publication on the occasion of the tercentenary celebration. Dr. Thompson in these notes traces the foundation of the electrical science to the publication in 1600 of the "De Magnete" of Dr. Gilbert. In a short introduction he says: "Gilbert's renown rests not on his eminence as a physician, but on his achievements in the foundation of the twin sciences of electricity and magnetism. He is beyond question rightfully regarded as the father of electric science. He founded the entire subject of terrestrial magnetism. He also made notable contributions to astronomy, being the earliest English expounder of Copernicus. In an age given over to metaphysical obscurities and dogmatic sophistry, he cultivated the method of experiment and of reasoning from observation, with an insight and success which entitles him to be regarded as the father of the inductive method. That method, so often accredited to Bacon, Gilbert was practising years before him. It seems, therefore, fitting upon the occurrence of the tercentenary of his death to recall Gilbert's achievements as the father of electric science."

Dr. Thompson thus describes Gilbert's magnetic discoveries: "Gilbert's magnetic work has been so often described that a brief summary will here suffice. Trying the properties of loadstones in innumerable experiments lasting over many years, he was led to several notable discoveries, and to one generalisation of immense importance. He discovered the augmentation of the power of a loadstone by arming or capping it with soft iron cheeks. Gilbert called such a cap an *armatura*, the first occurrence of the term. This invention brought him much fame. In the 'Dialogues of Galileo' (p. 369 of Salusbury's 'Mathematical Collections,' Dialogue iii.), Sagredus and Salviatus discuss the arming of the loadstone, and the increased lifting power conferred by adding an iron cap. Salviatus mentions a loadstone in the Florentine Academy, which, unarmed, weighed 6oz. lifting only 2oz, but which when armed took up 160oz Whereupon Galileo makes Salviatus say: 'I extreamly praise, admire, and envy this authour for that a conceit so stupendious should come into his minde. . . . I think him [*i.e*, Gilbert], moreover, worthy of extraordinary applause for the many new and true observations that he made, to the disgrace of so many fabulous authours, that write not only what they do not know, but whatever they hear spoken by the foolish vulgar, never seeking to assure themselves of the same by experience, perhaps, because they are unwilling to diminish the bulk of their books.'

"Gilbert also discovered the screening effect of a sheet of iron; the method of magnetising iron by hammering it while it lies north and south; the destruction of magnetism by heat; and the existence around the magnet of an 'orbe of virtue'—that is to say, a magnetic field. He perfected the dipping needle of the Norman and other instruments of observation. He collected data as to the declination and inclination of the compass in different regions. Using loadstones of many different shapes, he observed their actions on one another and on compass needles. In particular he studied the magnetic properties of a globular loadstone or *terrella*, and found that compass needles were directed toward its poles, and dipped at various angles over its surface, just as compass needles do at various regions of the earth's surface.

"Generalising from small to large, he advanced the entirely novel idea that the globe of the earth is itself a great magnet, thus laying the foundations of the science of terrestrial magnetism. He was particularly keen in disproving the many absurd fables that had grown up about the magnet, such as that the magnet refuses to act in the presence of a diamond, or if touched with garlic. The former he tested by surrounding a loadstone with 70 diamonds. Gilbert denounced the quackery of using loadstone medicinally or in plasters for the cure of wounds. He ridiculed the idea that the variation of the compass was due to imaginary loadstone mountains like those described in the 'Arabian Nights.' He sought to explain it by the local irregularities of the earth's crust, and exemplified his theory by experiments on round loadstones of irregular outline as models. His book, over which he spent 18 years, was published in 1600, and for the next 100 years became the standard work on magnetism. Though denounced by the Church, the theory of terrestrial magnetism was by Gilbert thus firmly established on an enduring basis of fact, and remained a permanent acquisition in science. The publication of the book marked an epoch in scientific development. It was praised by Sarpi, by Galileo, by Kepler. Sir Christopher Wren proposed to erect a statue to its author, while Dryden sang of his enduring fame."

The contribution made by Gilbert to electrical knowledge is contained in the second chapter of the second book of his "De Magnete," and constitutes a digression interpolated into the discussion of magnetic motions. In this chapter Gilbert, after describing the attracting properties of amber, lays down the following maxims: "The difference between magnetics and electrics is that all magnetics run together with natural forces; electrics only allure; that which is allured is not changed by an implanted force, but that which has moved up to them voluntarily rests upon them by the law of matter. Bodies are borne towards electrics; a loadstone draws a loadstone directly at the poles only, in other parts obliquely and transversely, and in this way also they adhere and hang to one another. Electrical motion is a motion of aggregation of matter; magnetical motion is one of disposition and conformation. The globe of the earth is aggregated and coheres by itself electrically. The globe of the earth is directed and turned magnetically; at the same time also it both coheres, and in order that it may be solid, is in its inmost parts cemented together."

Dr. Thompson supplies the following valuable summary of Gilbert's electrical work: "To distinguish his original discoveries from things already known, Gilbert set in the margin of his book asterisks, large or small, in proportion to the importance of the matter. . . . He marked with large asterisks the discovery of the generality of electrifiable bodies, for which he coined the name *electrics*, and the observation that electrified bodies attract not straws and chaff only, but equally attracts metals, woods, earths, and even oil and water. The logical outcome of this discovery was the invention of the versorium or *electroscope*. The method of trying everything instead of accepting statements on authority is characteristic of the man: he must bring all to the touchstone of experiment. The authors who raised Gilbert's wrath by ignorantly copying out all the old tales about amber, jet, and loadstone, instead of investigating the facts, were, as he says at the beginning of the chapter, some theologians and some physicians. He seems to have taken a special dislike to Albertus Magnus, to Puteanus, to Paracelsus, and to Levinus Lemnius.

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Gilbert mentions amber and jet as known to become electrical by friction; but the list was not quite so restricted as would appear from this passage. Five, if not six, other minerals had been mentioned, in addition to amber and jet."

The stones referred to by Dr. Thompson are lyneurium, ruby, garnet, jasper, lychnis, and diamond. Referring to the passage in Gilbert's book, in which he sets forth the differences that exist between magnetic and electric effects, Dr. Thompson says: "Though Gilbert was the first systematically to explore the differences that exist between the magnetic attraction of iron and the electric attraction of all light substances, the point had not passed unheeded, for we find St. Augustine, in the "De Civitate Dei," liber xxi., cap. 6, raising the question why the loadstone which attracts iron should refuse to move straws. The many analogies between electric and magnetic phenomena had led many experimenters to speculate on the possibility of some connection between electricity and magnetism. See, for example, Tiberius Cavallo, "A Treatise on Magnetism," London, 1787, p. 126. Aepinus wrote a treatise on the subject, entitled "De Similitudine vis Electricæ et Magneticæ" (Petropolis, 1758). This was, of course, long prior to the discovery by Oersted in 1820 of the real connection between magnetism and the electric current. It is interesting to note a suggestion of material *rays*, as the operation of electric forces seems to foreshadow the notion of electric lines of force.

"Gilbert had imbibed the schoolmen's ideas as to the relations of matter and form. He had discovered and noted that in the magnetic attractions there was always a verticity, and that in the electrical attractions the rubbed electrical body had no verticity. To account for these differences he drew the inference that since (as he had satisfied himself) the magnetic actions were due to *form*—that is to say, to something immaterial—to an "imponderable," as in the subsequent age it was called—the electrical actions must necessarily be due to *matter*. He therefore put forward his idea that a substance to be an electric must necessarily consist of a concreted humour which is partially resolved into an effluvium by attrition. His discoveries that electric actions would not pass through flame, whilst magnetic actions would, and that electric actions could be screened off by interposing the thinnest layer of fabric, such as sarcenet, whilst magnetic actions would penetrate thick slabs of every material except iron only, doubtless confirmed him in attributing the electric forces to the presence of these effluvia. There arose a fashion, which lasted for over a century, for ascribing to 'humours,' or 'fluids,' or 'effluvia,' physical effects which could not otherwise be accounted for.

"In spite of his care to test everything by experiment, Gilbert fell into several errors. He denied the existence of electric repulsion, and whilst he strenuously affirmed that the magnetic forces were mutual between the magnet and the iron, each being urged toward the other, he also affirmed that, in the case of the action of the electric on the object which moved toward it, the action was not mutual, but was a one-sided force—an impossibility in physics. Gilbert's experimental discoveries in electricity may be summed up as follows: (1) the generalisation of the class of *electrics*; (2) the observation that damp weather hinders electrification; (3) the generalisation that electrified bodies attract everything, including even metals, water, and oil; (4) the invention of the non-magnetic *versorium* or electroscope; (5) the observation that merely warming amber does not electrify it; (6) the recognition of a definite class of *non-electrics*; (7) the observation that certain electrics do not attract if roasted or burnt; (8) that certain electrics when softened by heat lose their power; (9) that the electric effluvia are stopped by the interposition of a sheet of paper or a piece of linen, or by moist air blown from the mouth; (10) that glowing bodies, such as a live coal, brought near excited amber discharge its power; (11) that the heat of the sun, even when concentrated by a burning mirror, confers no vigour on the amber, but dissipates the effluvia; (12) that sulphur and shellac when aflame are not electric; (13) that polish is not essential for an electric; (14) that the electric attracts bodies themselves, not the intervening air; (15) that flame is not attracted; (16) that flame destroys the electrical effluvia; (17) that during south winds and in damp weather, glass and crystal, which collect moisture on their surface, are electrically more interfered with than amber, jet, and sulphur, which do not so easily take up moisture on their surfaces; (18) that pure oil does not hinder production of electrification or exercise of attraction; (19) that smoke is electrically attracted, unless too rare; (20) that the attraction by an electric is in a straight line toward it.

"Gilbert's list of electrics should be compared with those given subsequently by Cabeus (1629), by Sir Thomas Browne (1646), and by Bacon. The last-named copied out Gilbert's list almost without change. Sir Thomas Browne's list is given in the following passage, which is interesting as using for the first time in the English language the noun *electricities*: 'Many stones also both precious and vulgar, although terse and smooth, have not this power attractive; as Emeralds, Pearle, Jaspis, Corneleans, Agathe, Heliotropes, Marble, Alablaster, Touchstone, Flint, and Bezoar. Glasse attracts but weakely though cleere, some slick stones and thick glasses indifferently: Arsenic but weakely, so likewise glasse of Antimony, but Crocus Metallorum not at all. Saltes generally but weakely, as Sal Gemma, Alum, and also Talke; nor very discoverably by any frication: but if gently warmed at the fire, and wiped with a dry cloth, they will better discover their Electricities' ('Pseudodoxia Epidemica,' p. 79).

"If, as shown above, the electric powers of diamond and ruby had already been observed, yet Gilbert was the first beyond question to extend the list of *electrics* beyond the class of precious stones, and his discovery that *glass*, *sulphur*, and *sealing wax* acted, when rubbed, like amber, was of capital importance. So was also his observation that electrical experiments succeed better in dry or frosty weather. Though he did not pursue the discovery into mechanical contrivances, he left the means of that extension to his followers. To Otto von Guericke we owe the application of *sulphur* to make the first electrical machine out of a revolving globe; to Sir Isaac Newton and to Hauksbee the suggestion of *glass* as affording a more mechanical construction. And both materials were discovered by Gilbert to be electrics. 'Such,' said Priestley in 1767, 'were the discoveries of our countryman Gilbert, who may justly be called the father of modern electricity, though it be true that he left his child in its very infancy.' To Priestley's quaint remark we may add that as electricity is no longer in its infancy, we who claim Gilbert as our countrymen are all the more proud to acknowledge his just claims to its paternity."

INSTITUTION OF ELECTRICAL ENGINEERS.

At the ordinary general meeting of the Institution on Dec. 10 the following were the candidates balloted for:

Members.—F. Hird, B.A., 11, Tweedy-road, Bromley; A. G. Ionides, B.A., 116, Chancery-lane, W.C.

Associate Members.—J. Addison, P.O. Box 432, Kimberley, South Africa; C. Manuel, 116, Chancery-lane, W.C.; W. J. Mitchell, Union S.S. Company, Port Chalmers, New Zealand.

Associates.—E. Butler, 171, Coatsworth-road, Gateshead; F. Dickinson, Clifton-terrace, Prescot-road, St. Helens, Lancs.; J. Z. George, Tulane-Newcomb-building, New Orleans, U.S.A.; F. C. Harding, Highstead, Brownshill-road, Torquay; W. de M. Landon, Wychwood, Poplar-grove, Sale; G. Newby, Imperial-chambers, James-street, Harrogate; C. Newton, Engine-Room Department, General Post Office, Cape Town; A. M. Niven, 74, Stradbroke-road, Southwold, Suffolk; R. Watson, Postal Telegraphs, Beaufort West, Cape Colony; E. H. W. Westwood, Knox, Schlapps, and Co., 163-169, William-street, Melbourne.

Student.—A. C. Blyth, Apartado 151, Barcelona, Spain.

PERSONAL.

The Gloucester Tramways Committee have selected Mr. E. Edwards, A.M.I.E.E., of Bradford, out of 116 applicants as general manager of the electric tramways now in course of construction. The salary will commence at £300 a year, rising by annual increments of £25 to £450.

The Sheffield Tramways Sub-Committee have selected Mr. Arthur Fearnley, of Birkenhead, to succeed Mr. A. L. C. Fell, who has been appointed manager of the London County Council tramways as general manager of the Sheffield system. The commencing salary is £700 a year.

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TO CORRESPONDENTS.

All Rights Reserved. Secretaries and Managers of Companies are invited to furnish Notices of Meetings, Issues of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration.

All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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MARYLEBONE.

Unfortunately at the time of writing we cannot record the decision of the Marylebone Council as regards the imbroglio into which it has landed itself. The history of the whole case is exceedingly simple, and in its various phases have been recorded in our columns. The fundamental point is in the oft-told tale of private enterprise showing a thing to be practical and commercially successful, then municipal traders wanting to take the cream of the success to the detriment of the original pioneers. In this case the Metropolitan Electric Supply Company were the pioneers. They proved the commercial practicality of electric lighting, and the Marylebone Council determined to force the hands of the company and take over the concern. It was too good a thing to wait till the end of the period indicated by law and then take it over without paying for goodwill, but merely for the then assets. Negotiations were commenced. The company offered terms which were rejected, and, at the instigation of the Council, the matter was forced into the hands of an arbitrator. His decision was not favourable to the Council. Justice had been asked for, they got it, but they really wanted spoliation. We have no sympathy for the Marylebone Council, which went out to shear and came back shorn. Had they taken their reverse like men one could, perhaps, have spared a little sympathy, but they have not done so. Every possible suggestion has been made to repudiate what they themselves angled for and caught. It is perfectly evident that there was no counting of chickens in the earlier stages. The game was one huge matter of bluff without a single good card to play. The result will be serious enough to the ratepayers The latest development is that, owing to the financial difficulties of the Council, application was made to Mr. Justice Buckley for postponement of completion of purchase. This was granted with some demur on terms, the most important of which is that the Council pay sixty thousand pounds to the company on or before Jan. 31, 1904. Then the purchase has to be completed by Feb. 29, 1904 (Leap Year). It was pointed out that the company was in a very invidious position. It was carrying on a concern which belonged to someone else, had to expend large sums on capital account, and had an overdraft at its bankers.

The present position is this. The Council has to pay sixty thousand pounds by the end of January next, and by the end of February has to provide for an expenditure of something like two million pounds. The London County Council has refused to advance the money. The Council's bankers will advance the sixty thousand pounds, and it is proposed to promote a Bill to obtain sanction to borrow the amount required. But—and here comes the crux of the matter at this moment—such a Bill must be sanctioned at a meeting of ratepayers. Suppose such sanction is withheld—what then? The ratepayers are in revolt, and would retrace the steps taken by the Council. If the boot had been on the other foot, would they have been so anxious to repudiate? We trow not. They would have cared not one whit for the losses of unknown shareholders. In our opinion, Marylebone cannot get out of its bargain, and must do the best it can under the circumstances. The time to object was when the Council first commenced to move, or, rather, when the supply company first wanted leave to work within the borders of the borough. Why should the Metropolitan Company again negotiate? It did that long ago, and it is the fault of Marylebone, and Marylebone only, that the negotiations were not successful.

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Surely we have had recently a few object lessons in the fatuousness of certain phases of municipal trading, not the least important of which is the case of Marylebone. The desire to let someone take the chestnuts out of the fire is too palpable, combined with the equal eagerness to take the chestnuts and the benefits accruing therefrom. Undoubtedly the matter is one of extreme difficulty. Lighting must savour of the nature of a monopoly, and, therefore, cannot quite be regulated as an ordinary factory production. Thus there is need for greater forethought, for greater care in acquiring information relating to every phase of the subject, and if it is a matter coming within or likely to come within the region of municipal action, casual dealing with it after the manner of Marylebone should be absolutely impossible. We have always held, and we still maintain, that pioneer workers of the class referred to should be generously dealt with in the way of money remuneration if their work is compulsorily acquired either by municipalities or governments.

THE MANCHESTER CITY ELECTRICAL ENGINEER.

The new borough electrical engineer of Manchester, appointed in succession to Mr. Metzger, who resigned, is Mr. Standen Leonard Pearce, A.M.I.C.E., M.I.Mech.E., A.M.I.E.E., whose portrait we are able to give herewith.

MR. S. LEONARD PEARCE,
The newly elected City Electrical Engineer of Manchester.

We take this opportunity of cordially endorsing the action of the Manchester City Council in placing at the head of its electrical department an engineer who is already familiar with the inner working of the undertaking, Mr. Pearce having acted as deputy chief electrical engineer to the Corporation since March, 1901. The new chief has had a varied experience, having been connected successively with Messrs. Thomas Richardson and Sons' engineering works, the British Steam Navigation Company, the Metropolitan Electric Supply Company, the British Thomson-Houston Company, and the Central London Railway. Further details of Mr. Pearce's career were given in our last issue. We wish him all success in his new and more responsible appointment.

Society of Engineers.—This society, which has just appointed Mr. David Butler Butler as president for the coming year, has awarded premiums for papers read during the past session as follows: The president's gold medal to Mr. Douglas Mackenzie for his paper on "Motor Transport for Goods," the Bessemer premium of books to Mr. Robert J. Thomas for his paper on "Road Maintenance and Administration," and a society's premium of books to Mr. Albert Gay for his paper on "Mechanical Stokers for Electricity Generating Stations."

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

STEAM TURBO GENERATING PLANTS.

SIR,—I have read with interest the correspondence following on Mr. Wilkinson's paper. As I hope to shortly have an opportunity of dealing with this question at greater length than is possible in a letter, I will not discuss in detail the accuracy of the figures quoted by your correspondents; but as more than one reference has been made to the Wallsend plant of our clients, the Newcastle-upon-Tyne Electric Supply Company, I think it well to point out that the results quoted depend upon such a variety of factors that, in the absence of fuller information, any deductions therefrom are liable to be quite misleading. As Mr. Lea points out, an attempt is being made, based upon entirely inadequate information, to compare plant working under conditions which differ almost as widely as the machines themselves.

The first of the two 2,000-kw. turbines now working at Wallsend was ordered more than three years ago, and it is sufficient indication of our opinion to say that as a result of our experience we have recently placed orders for six Parsons turbines with an aggregate output of over 11,000 kw. for our clients, the Newcastle-upon-Tyne Electric Supply Company and the Priestman Power Company.

We have also on order for another client a 500-kw. Curtis turbine, which will, we believe, be the first turbine of this type to operate in a central supply station in this country.—Yours, etc., CHARLES H. MERZ.

28, Victoria-street, S.W., Dec. 15.

SIR,—Supplementing my communication of last week, in which I referred to the fact of blades having been stripped off a large turbine in the States, I am just now in receipt of further information which shows that the difficulty is a very real one, and has not been got over. The turbine has again broken down recently from the same cause—in fact, twice. The blades were stripped, the turbine was laid off for a considerable period for the replacement of them, and then, again, after running only an hour or so the blades again stripped. When it is remembered that stripping the blades usually means the destruction of the fixed as well as the moving blades, it will be understood how serious the difficulty is.—Yours, etc.,

RECIPROCATING ENGINE.

THE DIESEL ENGINE.

SIR,—In reply to your correspondent, "E. F.," in your issue of the 11th inst., may I say that he does not appear to have understood me quite in my answer to Question 634. It is there distinctly stated that the diagram accompanying the article is only for the purpose of explaining the successive operations of the ideal Diesel engine, and is not meant to include practical modifications which experience has shown to be necessary. Whether the present external form of the engine is like that of an ordinary gas or oil engine is beside the point. The important thing is the thermodynamic cycle on which it works, the method of producing the combustion temperature, and the other points enumerated in my answer. To these points is due the high thermal efficiency not previously attained or attainable by any Otto cycle engine, and hence it is on these that stress has been laid.—Yours, etc., A. C. G. I.

CAR AXLES BREAKING.

SIR,—With respect to the article in your last issue concerning trams and tramcar wheels, the present cars at Brighton are not, in my opinion, a good type of what might have been expected from a transference of horse power to electrical traction. There is a considerable jar at the track crossings, causing heavy strains on axles, which might be lessened by raising the bed of the channel in the rails so that the wheels rested on the flanges when passing over crossings. The doorway and stairs would be more conveniently situated if at the centre instead of at both ends

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of car, accommodating about eight more passengers. They would also find seats, and alight quicker. With one stairway instead of two, the driver being on top like a 'bus driver, there would be a double advantage where the trolley system is employed.—Yours, etc., S. EDWARDS.

FLATS IN COMMUTATOR.

SIR,—In reply to Mr. F. J. Hopley, the flat on the commutator may be due to three things: (1) faulty connection on commutator lug causing undue sparking; (2) defective or gritty mica between sections; and last and most likely, minute blowholes in commutator bar. Where cast bars are used, either in replacing a damaged section or throughout the whole commutator, trouble of this kind may be looked for. The only real cure is to replace faulty section by a drop forged one. If Mr. Hopley likes to try the following, however, he might cure the fault if the blowholes are only local. Take out the faulty bar, make a hole in a piece of clay twice the depth of the bar and as long as the flat, press down the bar in this till surface is level. Fill up hole (in which a few drops of oil have been poured) with lead, wrapping wet string round the lug if soldered. With a light hammer tap all over the bad piece, melt off the lead, and file up true; replace and turn true, taking off very little. This sometimes closes a blowhole.—Yours, etc.,

POLYPHASE.

QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any questions should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

645. Describe one modern type of governor used in conjunction with steam-turbines. Give a detailed account of its method of operation and construction.—A. D.

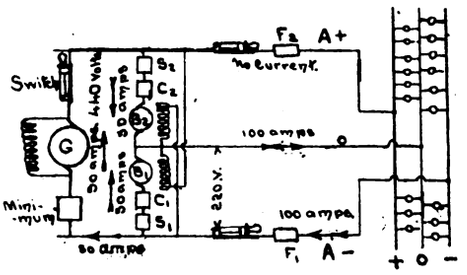
646. Give an explanation of reactance voltage in a dynamo, and a reliable method of how to calculate same. How does it affect the sparking conditions of a machine?—E. B.

[N.B.—In the answers sent in to this question there is shown a doubt as to the meaning of the same. By "doing 50 amperes out of balance" we understand the questioner to mean that the balancer can equalise the load when there is 50 amperes more on one side of the three-wire system than the other.—ED., *E. E.*]

Question No. 638. Explain and give best and safest methods of dealing with accidents which might happen as under. Supposing in a three-wire station, with voltage 440 and 220, you have a machine on the 440-volt bars, you have only one set of feeders connected +, 0, −. There is also a balancer capable of doing 50 amperes out of balance with maximum circuit breakers and starter on each outer and shunts cross-connected. If at some time you have 100 amperes each side on, and one of the outer main fuses happens to burn out, explain and give sketch as to what would happen, and the best and quickest way of righting things without the use of a battery and without damage to lamps. Also with circumstances as regards load same as above, and your machine minimum circuit breaker accidentally falls out, explain how to bring load on again with safety, your shunt resistance not being large enough to bring voltage lower than 300. —ELECTRO.

ANSWERS.

Best Answer to No. 638 (*awarded* 10*s.*).—The diagram below shows the arrangement of connections described in this question. A + and A − represent the only feeder running, and F_1 and F_2 are its fuses. If, then, as stated, F_2 burns out, all current to the positive side of mains will be cut off, and the remaining load will be 100 amperes on the negative side only. One-half of this load will, therefore, fall upon balancer B_1 to generate, and 50 amperes will be supplied to machine B_2, the positive balancer, in order to drive B_1 at the above load. This will, of course, be automatically brought about, within limits, by the crossing of the balancer shunts. What would happen then is shown on the diagram, the amount and direction of the current flowing through each machine being indicated.



For simplicity the efficiency of the balancer is taken as 100 per cent., and the amount of current necessary to run it light neglected. Thus it will be seen that the load on the main generator is 50 amperes at 440 volts, which is in effect transformed down to 100 amperes at 220 volts on the negative side. All this is assuming that the maximum circuit breakers, C_1 and C_2, of the balancers have not yet operated, which is very unlikely, as from the data given the balancer is only able to deal with 50 amperes out of balance, and therefore each machine is only capable of carrying one-half of this current, or 25 amperes. It is thus practically certain that the circuit breakers could not stand the 100 per cent. overload thrown upon them, and either one or both would operate and cut off current to the negative side of mains as well. Then, of course, the "minimum" of the main machine would fall out. The best method of proceeding in order to resume supply would be as follows: Open starting switches, S_1 and S_2, of balancers and switch off the feeder; replace the burnt-out fuse with a stronger one. Now prepare to burn out the fault on the mains which caused the original interruption. As there is no battery available for this purpose, run up and excite two or more generators, if available, and parallel them together on the unloaded 'bus bars, keeping their voltage as low as possible. Now run up the balancer, and finally switch on the feeder. It should thus be possible to burn out the fault with strengthened feeder fuses and, say, three engines running, without dangerous shock to the engines and with much smaller risk of the machines losing their field and reversing than if only one machine were used. This method is somewhat brutal, but saves time. Having in this way got rid of the fault, one machine could be left running on the normal load.

Another method of dealing with the situation would be to give up trying to resume the supply on the positive side until the fault has been removed by the mains department, and to give all attention to getting the current on to the negative side. In order to do this the balancer would have to be reinforced, and this might be done by utilising what is generally available at any central station, and that is a water resistance test tank or tub, which could be connected across the positive side in order to make an artificial load of, say, 50 amperes. One lead should be fastened to one of the studs on the positive 'bus bar, and the other on to the middle wire. It should not take more than about 20 minutes to rig up this arrangement, as even an ordinary bucket would, in the absence of a test tank, serve to dissipate the extra 50 amperes (at 220 volts) that the balancer could not deal with. The writer has had to balance a station in this way for a few days on account of the breakdown of the balancer at a time when the battery was not available.

In the second case should the main machine "minimum" accidentally fall out the load could be put on again as follows: switch off balancer and feeder, now, as described above, parallel two or three engines together on the unloaded bars, next run up balancer, and last switch on the feeder; the load would now, as before, be divided amongst the machines. In this case again the water resistance

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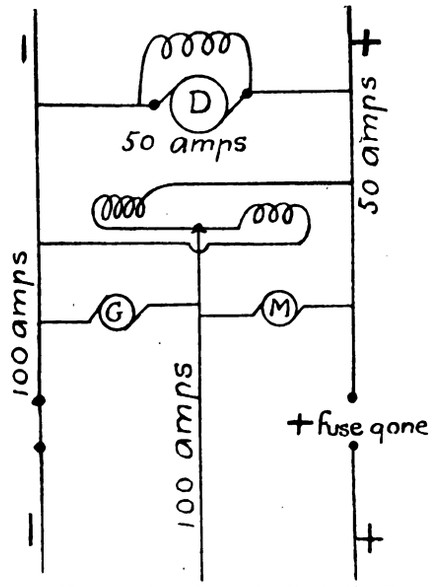
could be utilised if the spare plant were not available, as it could be connected across the bolts of the machine main switch, and the load thus brought on gradually through the resistance; when the full load was approached the switch could be put in, thus cutting out the resistance, which could then be disconnected.—D. J.

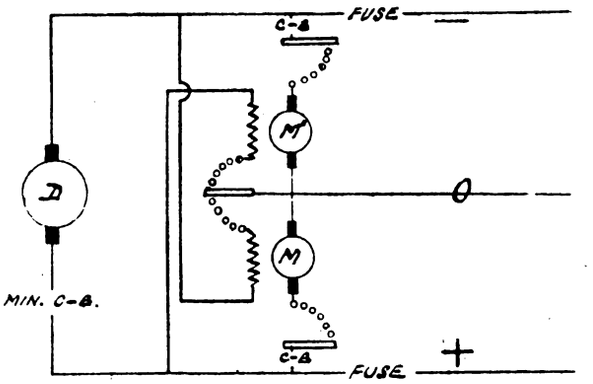
Answer to No. 638 (*awarded* 7*s.* 6*d.*).—With regard to the first part of this question, in the event of the main fuse on the outer of the set of feeders burning out we have the following results: Half the load on the generator is suddenly thrown off, causing a sudden rise of pressure across its terminals, all the lights on the side on which the fuse blows being put out. The generator is now doing 50 amperes, and we have 100 amperes going through the middle wire to supply the other side. The balancer is doing its full duty, dealing with the 50 amperes out of balance. As shown in rough sketch, it is taking 50 amperes from the + side "for motoring," and on the − side is "generating" 50 amperes, which with the 50 amperes from the main circuit makes up the total load on the − side of 100 amperes. The occurrence would be dealt with in the following way: Resistance put into the shunt of generator to bring rise of voltage down, then if there is a regulating resistance between the middle-wire connections of balancer shunts this would be adjusted so that the field of the − balancer was fully excited, leaving all the resistance in that of the + balancer, now "motoring." The fuse on the + outer of feeders can now be replaced (provided, of course, that it has simply burnt out, and that is not case of a "short" still on), and the generator and balancer resistances again adjusted. In this way the normal conditions would again be reached, and with a good balancer the lamps should not be badly over-run.



D, Generator giving 50 amperes to main circuit; M, Positive Balancer motoring 50 amperes; G, Negative Balancer generating 50 amperes.

With regard to the second part of the question—*i.e.*, in the event of the minimum circuit breaker falling out and throwing the load off the generator, etc.—the speed of the engine would have to be reduced as much as possible, the balancer being, of course, left on, and slowing down with the engine. In this way, with the shunt resistance all in, the voltage can be steadily reduced below the 300 mentioned. The minimum circuit breaker should then be put in, and the engine gradually run up to full speed, the balancer speed increasing also with the voltage, and the load being safely brought on again.—DOUGLAS KELLEWAY.

Answer to No. 638 (*awarded* 5*s.*).—Premising that the connections are as shown as in sketch, suppose first that with 100 amperes on each side one of the main fuses, say the one on the positive side, burns out. M will then, owing to its weakened field and the greater potential across its brush, tend to run as a motor, and M^1 become a generator. There will not be 100 amperes to be delivered by the middle wire, as the current will be lowered in proportion to the voltage drop between the middle and negative conductors. With everything in order, therefore, M^1 should give an approximate 50 amperes, and the other approximate 50 amperes pass through M from the positive terminal of main dynamo, D. To replace burnt-out fuse, cut down volts on D to 300; the current flowing in its armature will then be about 40 amperes.



Open the main circuit, open starting resistances of M and M^1, and replace fuse. D should now have its circuit closed, M and M^1 be put to line, and voltage brought up to normal. If minimum circuit breaker of D fall off, starting switches of M and M^1 should be opened, voltage of D lowered, and the circuit breaker replaced. M and M^1 are then started and volts readjusted. There will probably be no occasion to alter resistance between the shunt windings, as presumably both sides would be in balance at time of accident.—M. M.

THE SLOW REGISTRATION OF RAPID PHENOMENA BY STROBOGRAPHIC METHODS.*

The "Ondographe" and the "Puissancegraphe" (Wave Recorder and Power Recorder).

BY E. HOSPITALIER, FOREIGN MEMBER.

As one of the oldest of the French members of the Institution of Electrical Engineers, and as one who has always followed its proceedings with the greatest interest, the author regards it as a great honour to be permitted to place before the Institution an apparatus for which he begs the indulgence and consideration of his audience, if, by reason of its industrial and practical character, it should appear to them at all out of keeping with the scientific character of the subjects which are commonly dealt with at their meetings. The object of the "ondographe," and of other instruments derived from it, is to register within a reasonably long period of time (of the order of from 15 to 60 seconds) a periodic phenomenon of so rapid a nature that the period may be as short as one-thousandth of a second, or even less. Before entering, however, upon the description of the apparatus, it will be necessary to refer to certain general considerations. The observation of a rapidly variable phenomenon may be effected with the aid of apparatus based upon two very different principles—viz., direct observation and indirect observation.

Direct Observation.—The apparatus to be used for observation or registration should be capable of following the phenomenon instantaneously and without affecting it in any way. This result may be attained by either of two methods. That most commonly employed consists in designing the instrument so that it has a small moment of inertia, a very short natural period of oscillation, compared with that of the phenomenon to be recorded, and a degree of damping as nearly as possible critical—that is to say, it is so damped that the apparatus, when disturbed from its position of equilibrium, tends to return to that position in the shortest possible time and without over-shooting. The second method, which is at present represented only by Mr. Abraham's rheograph used in studying the characteristics of variable currents, involves the use of an observing instrument in which the moment of inertia is high and the natural period of oscillation is much greater than that of the phenomenon to be observed. Under these conditions the instrument would indicate something different from the phenomenon which it is wished to observe. However, it is not submitted to the action of the phenomenon itself, but to that of one more complex, which has been previously regulated in such a way that the disturbing effects due to inertia and to damping of the oscillat-

* Paper read before the Institution of Electrical Engineers, Dec. 10

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ing system are compensated. In this way the same result is obtained as with an instrument without inertia; but these compensations at present only appear to be possible for the observation and measurement of electric currents.

Indirect Observation.—Indirect observation, based upon stroboscopic principles, is effected by reproducing the phenomenon with a much longer period, obtaining the record of the whole of its phases by taking them successively from a large number of periods. The period of oscillation peculiar to the apparatus may in this case be very long as compared with that of the phenomenon observed, provided that the duration of the total number of periods from which the different phases are collected is itself very great relatively to that of the oscillation peculiar to the recording instrument.

1. Direct Methods.

In order that a recording apparatus may follow a given phenomenon with precision, it must satisfy the following conditions: (1) the period of of oscillation must be very short as compared with that of the phenomenon to be studied; (2) the damping must be approximately aperiodic; (3) disturbing causes due to the apparatus must be as small as possible; and (4) it must be sufficiently sensitive. The first condition is realised in practice when the period of oscillation peculiar to the system of the measuring instrument is about 50 times as short as that of the phenomenon to be observed. This condition is readily satisfied when the frequency of the phenomenon under examination does not exceed from six to eight per second. Beyond 500 periods per minute, the disturbance caused by the inertia of the moving parts, and the excessive or insufficient damping, render the indications illusory, unless special arrangements are made. The theoretical study of the conditions to be fulfilled has led to the development of instruments such as the oscillograph of M. Blondel and that of Mr. Duddell, which the members of the Institution have had the opportunity of seeing in this room.

2. Stroboscopic or Indirect Methods.

Notwithstanding the elegance of the direct methods, and the results which have already been attained with instruments based upon them, the author is of opinion that the industrial future is reserved to the indirect methods, which have a wider field of application, and which permit of the direct recording of the phenomenon to be studied upon a strip of paper, in a way that is not possible with the direct methods, in which recourse is always had to photography. In order to understand the principles of the stroboscope as applied to the observation and recording of periodic and rapidly varying phenomena, the most simple of all the periodic movements may be considered—namely, that of uniform rotation. At the end of every revolution the rotating system attains the same relative position that is occupied one complete turn earlier. Suppose now that the system is illuminated for a very brief instant once in each revolution at the moment at which it passes a certain position, which is regarded as the initial position. The rotating system will then appear at rest. If, now, the periodic illumination be slightly retarded, so that the successive flashes follow one another at an interval of time a little longer than the period of the revolution itself, the system will be illuminated in its various phases in turn, and will appear to revolve slowly in the sense of its actual rotation. If, on the contrary, the flashes follow at shorter intervals, the system will appear to be turning in a sense inverse to that of its real rotation, since at every revolution it will be illuminated an instant before it attains the same position as on the preceding revolution. In this way the apparent velocity of rotation will have been reduced in a proportion which depends only on the acceleration or the retardation of the successive illuminations of the system. The simplest means of obtaining these successive flashes consists in using a disc pierced with a slit as a shutter in front of a projector. The same result may be obtained by means of the sparks caused by interrupting the current through an inductance, or with alternate-current arcs, etc., but the sharpest effects are obtained with the revolving stroboscopic disc.

In order to obtain a variable difference in the periods or slip, it is possible to use an electric motor, of which the speed is capable of variation—or a synchronous motor if the system is driven by a synchronous machine—which determines the measure of the slip, or a train of wheels, as in the ondograph, or (the most rational of all) a differential gearing, of which one of the axes is controlled by the system to be studied, whilst the other actuates the stroboscopic disc, and the crown containing the intermediate wheels between them receives from an outside source a more or less rapid movement of rotation which defines the slip. This disposition offers the great advantage of allowing the phenomenon to be apparently stopped in any specially interesting position. The stroboscopic method is the basis of a large number of instruments, which may be classed in two groups: (A) stroboscopes, or apparatus used for observations; (B) strobographs, or recording apparatus. It is proposed to limit this paper to the study of instruments of which the applications are directly or indirectly connected with electricity.

A. Stroboscopes.

Stroboscopes, of which the number is infinite, do not, properly speaking, constitute apparatus, but rather experimental arrangements which are susceptible of modification depending upon the material at the disposal of the observer, and upon the research that he has in view. By way of example, reference will be made to those which the author has used for the examination of alternate-current arcs and of machinery in motion.

The Arcoscope.—A very simple experimental arrangement has been designated by this name (which is at once French and Greek), an arrangement intended to facilitate the examination of the variation in the luminosity of an alternate-current arc during a single period—variations which it is impossible to observe directly because of their great frequency. It consists, in principle, of a small asynchronous single-phase alternate-current motor, having on its axis an opaque disc provided with narrow slits placed at regular intervals, the number of the slits being equal to the number of pairs of poles of the motor. Thus, for a motor with four poles, the disc would have two slits, placed one at end of the same diameter. The motor is driven by alternate current taken from the same source as that traversing the arc under examination. The disc, which is rotated by the motor at quasi-asynchronism, is placed in the path of the luminous rays emitted by the arc, which latter is projected by a lens upon a screen. The image of the arc is thus allowed to fall on the screen for one instant during each period, and in consequence of the slight slip of the motor when running light, the phenomena of the arc may be observed during a complete period, and this period may thus be prolonged to as much as from 10 to 15 seconds. By applying a braking action to the motor the slip is increased, and the apparent duration of the oscillation of the light of the arc is reduced. It is possible to observe the arc directly through the slits in the disc, but the result is less clear than when a projection is used and the image of the arc is magnified. If the same disc be made to carry a series of sectors, alternately white and black, the number of each kind being equal to that of the poles of the motor, and if it be illuminated by an arc or incandescent lamp served by the same current as is the motor, the slip of the motor may be observed and directly measured by observing and measuring the apparent inverse rotation of the disc mounted on its shaft. In this way it is in some degree possible to analyse the light of the arc, and to judge the influence of the form of the current curves, of the nature and quality of the carbons, of the frequency, the conditions of regulation, etc. It is also practicable to cinematograph the phenomenon in order to be able to study it at leisure. This can be done by controlling the cinematograph by means of an asynchronous motor and photographing the arc, either directly or after projecting it upon a screen.

Stroboscopic Transmission Dynamometer.—If a driving shaft, A, actuates a working shaft, B, through the medium of a spring coupling between the two shafts, the product of the torsional couple or torque transmitted by this spring, multiplied by the angular velocity, is equal to the power transmitted by the shaft A to the shaft B. A large number of arrangements have been devised to determine this torque, which generally shows itself in practice by a relative angular displacement of the two shafts proportional to the torque. A simple means of reading this consists in mounting a disc on each of the shafts, and in placing the rims of the two discs close together and marking on them graduations proportional to the couple exerted in each or the relative positions of the discs. When the system is in motion, the relative displacement of the two shafts can be read off on the graduations, just as if the discs were stationary, by illuminating the system once in each revolution at the same instant in each period. For this purpose the stroboscopic eyeglass can be used with advantage.

Stroboscopic Eyeglass.—A small electric motor, driven by two accumulators, actuates a disc pierced with radial slits. The system in rotation is viewed through these slits with one eye, the other remaining closed. With the aid of a rheostat the disc may be caused to revolve at various speeds, so regulated that the system, illuminated permanently from an external source of light, appears to be either stationary or revolving very slowly. The stroboscopic eyeglass, so arranged, when brought to synchronous speed, permits the graduation of the above-described dynamometer to be observed and read with ease. If it revolves with a certain amount of retardation, it allows of the observation of rapid phenomena as readily as if they were produced at a slow speed which can be regulated at will. All the phases of an explosion engine may, for example, be thus observed: the lifting of the valves, the contact and the ensuing vibration of the ignition cam, the formation of the stitch in a sewing machine, the starting of a part having an independent movement, etc.

Differential Stroboscope.—For the study of thermal engines, MM. Malicet and Blin have constructed for the author a special differential stroboscope in which the motor is illuminated only once in every two revolutions. This result is obtained by providing the stroboscopic disc with only one slit and mounting the

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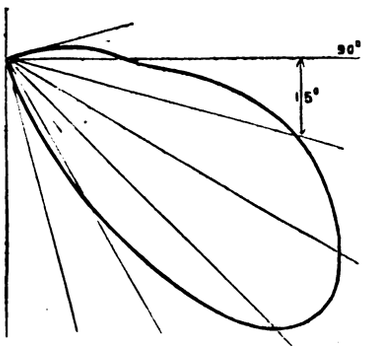
disc on the crown of the differential gearing. One of the shafts of the gearing is connected by a flexible shaft to the motor engine under examination, and the other shaft, in order to produce the stroboscopic effect, may be rotated slowly by means of an endless screw controlled by a small handle turned by hand. The apparent velocity of rotation of the engine is varied by turning the handle more or less rapidly. On stopping the handle the apparent movement is also arrested. Examples could easily be multiplied, but those which have been given suffice to show the important part that can be played by stroboscopic methods—confined, so far, to the laboratory of the physicist—in taking their places in the test-rooms of the great mechanical and electrical industries.

(To be continued.)

TRADE NOTICES AND NOVELTIES.

General Electric Company's British-Made Carbons.

It is only within the last two years or so that the manufacture of arc lamp carbons in this country has been brought to a successful commercial stage. True, many attempts have been made to arrest the large imports of carbons from the Continent, by producing a home-made article of equal merit, but until the General Electric Company entered the field no really effective opposition had been offered to these imports. The company deserve every encouragement, therefore, in the plucky attempt which they are making to reclaim an industry which, though first introduced in this country many years ago, has been allowed to slip into the hands of Continental manufacturers. The difficulty has been to produce an article in England capable of competing successfully with the carbons turned out by foreign firms. This the General Electric Company have succeed d in doing, and they are to-day producing arc lamp carbons at their Witton Works which, both in point of quality and general efficiency, are claimed to be at least the equal of any of the leading Continental makers.



PHOTOMETRIC TEST OF
THE BIRMINGHAM CARBON WORKS.
ENGLISH MADE CARBONS.
18 m/m Cored Positive
12 m/m Solid Negative.
Current 10 Amp.
Arc E.M.F. 42 Volts.
SCALE
0 100 300 candles.

Tests have been carried out quite recently, and we are indebted to the General Electric Company for a report of the same, which contains some striking figures in proof of the high state of efficiency and economy to which the English-made carbon has been brought. The tests in question were carried out on five 10-ampere "Angold" arc lamps in series, fitted with the firm's "Apostle" carbons, of which the following were the dimensions: 18mm. by 12in. long cored, 18mm. by 12in. long solid, the weight of a pair being 162 grm. The average line pressure was 238 volts, and allowing a drop of 23 volts in the steadying resistance, the average pressure across the lamps was 215 volts, or 43 volts per lamp. An average current of 10 amperes was used. The tests lasted 20½ hours, and the average rate of consumption of the carbons per hour was ·506in., or 1·282cm., for the cored and ·451in., or 1·145cm., for the solid. The first lamp gave an ash residue of 3·7 grm., the second the same, the third was open, the fourth gave 3·2 grm., and the fifth 4 grm. Thus the average ash of the four lamps with globes was only 3·65 grm., or 2·25 per cent. The total volume of ash from the four lamps was 22·6 cubic centimetres, and the rate of the volume of the ash to the weight of the ash equally $\frac{1·54}{1}$. The carbons started up without flaring, with full pressure across the five lamps, and normal resistance in circuit. They continued to burn absolutely steady during the whole time of testing, while the formation of the arc was normal. The above satisfactory results, it will be observed, were obtained under ordinary working conditions, and are in no way exceptional for "Apostle" carbons.

We may also give the results of a highly successful photometric test of the company's carbons carried out by the Electric Standardising and Training Institute. The sizes of the carbons used were the same as in the tests above described. The voltage across the arc was maintained at 42 volts to a current consumption of 10 amperes. The test showed that the maximum light ray occurred at an angle of about 38deg. from the horizontal, when it was of the value of 1,820 c.p. At 50deg. the candle-power was still 1,500, and the same at 20deg.; thus over an angle of 30deg. there was only a fall of 320 candles, or 16 per cent. of the maximum candle-power obtained. If we take the results of this test and apply them to the figures obtained in the previous tests, we find that the consumption of current expressed in watts per maximum candle-power is only 0·24—a remarkably low record.

Fuses, etc.

From Messrs. Ernest F. Moy, Limited, Greenland-place, Camden Town, London, N.W., we have a sheet dealing with their supply companies' fuses, type No. 76, for pressures up to 250 volts. An illustration is given of a single-pole fuse box. In this box the terminals are fitted with sweating sockets, which can be readily removed for the purpose of connecting up. The base is of highly vitrified porcelain with stout raised sides, which project well above the fuse strip. The box is stove enamelled, and fitted with the usual inspection window in the cover, which latter is hinged to the box and fastened by a sealing bolt. Three sizes are made—namely, for 25, 50, and 100 amperes. The firm's stage plug, type No. 283, is described on another sheet.

Cables.

From Messrs. Johnson and Phillips, Old Charlton, Kent, we have received a price-list dealing with their L.T. "Mauilla" paper-insulated lead-covered, lead-covered and armoured, and twin house-wire cables. On the back of this list is an illustration of a large shipment of the firm's cables for Kimberley.

An Artistic Production.

We have pleasure in acknowledging the receipt of a handsome calendar from the United States Metallic Packing Company, Limited, Soho Works, Bradford. The feature of this gift is a charming art bas-relief representing "Ceres," Goddess of Harvest. So unique a combination of utility with artistic beauty will, no doubt, be in great demand.

Flexible Tubing.

Messrs. John Lawman and Co., 143, New Kent-road, London, S.E., have sent us some particulars and a sample of the flexible tubing of special manufacture which they supply for the protection of electric cables. This tubing is largely used for covering portable cables exposed to the liability of external damage, serving as a mechanical protection without impairing the flexibility of the cables. The various sizes and weights of this tubing can be supplied either zinc, brass, copper, or nickel plated as required.

Cranes.

We have received a copy of a new catalogue illustrating some of the cranes constructed and erected by Messrs. Thomas Broadbent and Sons, Limited, Central Ironworks, Huddersfield. The firm have standardised two types of electrically-driven overhead cranes—namely, the multimotor and the monomotor types. Extended descriptions are not included in the catalogue, the illustrations being largely left to speak for themselves, but special features are, of course, mentioned. One of these consists of an automatic mechanical brake fitted to the hoisting motion of the firm's three-motor type of crane. The arrangement is such that the brake pressure is applied by the load, the friction on the pulley being always in direct proportion to the load on the hook. The brake pulley itself is on the free wheel principle, and only revolves when the load is being lowered, so that in hoisting there is a total absence of brake friction. In addition to the above an electric brake is fitted to the armature of the hoisting motor, operated by a solenoid connected in such a manner that, should the supply of current be interrupted through any cause, the brake will immediately apply itself and prevent the running down of the load. The longitudinal and cross-travelling motions are also fitted with electric brakes when the speeds are abnormally high. Evidently both the mechanical and electrical details of these cranes have received very careful attention.

BARKING ELECTRICITY ACCOUNTS.

Below we give an abstract of the accounts of the Barking Urban District Council's electric light undertaking for the

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year ended March 31 last, at which date the total capital expenditure amounted to £40,796.

Dr. Revenue Account.	£	s.	d.
Generation—Coal or other fuel	1,098	0	10
Oil, engine-room stores, etc.	165	5	2
Wages at generating station	628	12	6
Repairs and maintenance, etc.	210	4	6
Distribution—Wages to linesmen, etc.	13	7	2
Repairs, etc., of mains	33	1	6
Repairs, etc., of meters, switches, fuses	87	10	1
Public lamps—Attending and repairs	478	19	2
Renewals	102	0	10
Rents, rates, and taxes	203	2	9
Management—salaries and collector	380	13	7
Stationery and printing	49	12	6
General establishment charges	23	12	9
Special charges	33	11	0
Total expenditure	3,507	14	4
Amount carried to net revenue account	2,203	0	8
	£5,710	15	0

Cr.	£	s.	d.
Sale of current per meter	2,969	8	8
Public lighting and outside lamps at hospital	2,269	6	4
Heating water for public baths, etc.	105	5	0
Rentals of meters and other apparatus, etc.	175	10	5
Re-erecting lamp-posts, repairs, fittings, etc.	128	15	0
Stores on hand	62	9	7
	£5,710	15	0

General Balance-Sheet.

Liabilities.	£	s.	d.
Capital account—amount received	40,796	1	1
Sundry creditors	245	16	10
Cash due to treasurer	3,085	3	5
Cash due to engineer	8	0	11
	£44,135	2	3

Assets.	£	s.	d.
Capital account—amount expended for works	40,447	17	10
Stores on hand	184	16	10
Sundry debtors for current	949	19	5
Cash	348	3	9
General district rate account (deficit)	2,204	4	5
	£44,135	2	3

Statement of Electricity Generated, Sold, etc.

Quantity generated in B.T. units			443,634
Quantity sold	Public lighting (estimated)	182,478	349,624
	Private lighting by meter	167,146	
Quantity used on works			71,078
Quantity used in distribution			22,082
Maximum demand (kilowatts)			250

FORTHCOMING EVENTS

Friday, Dec. 18.

North-East Coast Institution.—At 7.30 p.m., general meeting at Newcastle. Discussion on Mr. Max Wurl's paper on "Technical Education in Germany." Paper: "Notes on the Construction of Stability Cross Curves from Balanced Paper Sections," by Mr. John H. Heck.

Institution of Mechanical Engineers.—At 8 p.m., ordinary meeting. Papers: "An Enquiry into the Working of Various Water Softeners," by Messrs. C. E. Stormeyer and W. B. Baron.

Electro-Harmonic Society.—At 8 p.m., in the King's Hall, Holborn Restaurant, smoking concert.

Institution of Civil Engineers (Students' Section).—At 8 p.m., ordinary meeting. Papers: "The Action of the Sea upon the Foreshore," by Mr. C. B. Case; "The Causes of the Loss of Beaches," by Mr. F. W. Cable.

Saturday, Dec. 19.

Junior Institution of Engineers.—At 3 p.m., visit to the electricity works of the Walthamstow Urban District Council. Train leaves Liverpool-street at 2.23 p.m.

Tuesday, Dec. 22.

Institution of Civil Engineers.—At 8 p.m., ordinary meeting. Paper: "On the Resistance of Plane Surfaces in a Uniform Current of Air," by Mr. T. E. Stanton, D.Sc.

NEW COMMITTEES.

Aston.—*Electricity*—Alderman Gittings; Councillors A. E. Godrich, C. Barnard, T. P. Bird, J. E. Berry, F. S. Tomey; and the Mayor (*ex officio*).

Hereford.—*Electricity*—Mr. W. Hewitt, chairman; Aldermen H. C. Beddoe (mayor), T. Llanwarne, and T. W. Clarke; Councillors S. Bye-son, W. C. Gethen, E. W. Langford, and S. H. Prosser.

LONDON TRAFFIC ENQUIRY.

The Royal Commission on London Locomotion sat at the Westminster Palace Hotel on Thursday and Friday last week, the chairman, Sir David Barbour, presiding.

Mr. R. F. Whur, vice-chairman of the Works Committee of the Paddington Borough Council gave evidence as to the statutory powers possessed by certain public companies to break up streets on serving notice on the borough council, and the disastrous effects on the surface of the roadways, and suggested that they should be prohibited excepting in cases of great urgency from making openings during December, January, and February, and compelled to lay new mains and execute necessary repairs, save only those of great urgency, within a period of three months before a carriageway was to be repaired, and only subsequently to notices given by the borough council, or at such periods as might be fixed. He considered that the introduction of a central authority having powers in reference to the breaking up of roads would cause friction between it and the local authorities, involve a multiplication of officers, and generally be to the public disadvantage. The extension of underground railways or shallow tramways in accordance only with a scheme embracing and providing for the needs of the whole of London would considerably mitigate the existing difficulties of locomotion in London, and in illustration of that he pointed to the relief of the traffic in Uxbridge-road since the opening of the Central London Railway. He objected to the removal of the existing right of a borough council under the Tramways Act and the Standing Orders of Parliament to veto a tramway scheme passing through their district which would be inimical to the best interests of the ratepayers. Where it was essential for the proper construction of a tramway that street widenings should be carried out, the whole costs attached to the construction of the tramways and the execution of the street widenings should be borne by the tramway authority, and not shared between that authority and the local or road authority. The fixing of point stations or stopping places for omnibuses would greatly relieve traffic, as it would enable the police to prevent the stopping of all omnibuses at other than the authorised points, as was the case with electric trams.

Mr. W. N. Blair, borough engineer and surveyor for St. Pancras, stated that it was of the greatest urgency that the widening of Hampstead-road, authorised by the Act of last year, should be carried out; but the County Council had repeatedly sought to make it a condition that, before they proceeded with the widening, the St. Pancras Council should give consent to the continuation of the tramways down Tottenham Court-road, although Parliament had expressly declined to recognise any such compact. The Borough Council had expressed their willingness to reconsider the proposal to lay tramways in Tottenham Court-road if proper widening was undertaken, and also that the tramway should not terminate at Oxford-street but continue to Charing Cross; but having regard to the fact that the Charing Cross, Euston, and Hampstead Tube Railway was now in course of construction on this particular line of road, it was doubtful, in the opinion of the Council, whether any necessity to extend the tramway was likely to exist on the completion of the tube railway.

Mr. W. C. Leete, town clerk of Kensington, having given evidence,

Mr. Henry C. Jones, town clerk of Holborn, stated that the Council attached the greatest possible importance to the tube railways already sanctioned by Parliament, and had supported the proposals of the Charing Cross, Euston, and Hampstead Railway Company to make a connection at the junction of New Oxford-street with Tottenham Court-road and Charing Cross-road with the Central London Railway. They were now carrying out, at the expense of the railway, very considerable works with a view of enabling that connection to be made. A scheme for an interchange station between the Great Northern, Piccadilly, and Brompton Railway Company and the Central London at High Holborn was also supported by the Council. His Council cordially supported shallow underground tramways, but surface tramways should not exist in the central parts of London. Continuing, the witness said that in Gray's-inn road and Theobalds-road the omnibuses carried on a recent day 39,843 passengers, as against 28,278 by the trams, and did not cause nearly so much congestion, by reason of their mobility. As to the right of veto at present enjoyed by road authorities with regard to the introduction of Tramway Bills, his Council were strongly of opinion that no case had been made out for interfering with the rights given them by the Tramways Act and by the Standing Orders of both Houses of Parliament. With regard to the establishment of some authority or tribunal to which all schemes of railway or tramway construction should be referred, his Borough Council suggested that the functions of such a tribunal should be judicial, that they should be absolutely independent, and that they should be appointed for a period. He suggested a tribunal somewhat on the lines of the tribunal of appeal constituted by the London Building Act, 1894, or the Court of Arbitration under the London Water Act, 1902. He did not think that either county councils or borough councils ought to be represented upon that body.

Mr. H. Edwards, borough engineer of Lambeth, said his Council saw no reason why the London County Council, in their tramway operations, should be dealt with in any other manner than a private promoter. With reference to the use of the carriageway generally, the electrification of the tramways had had a marked effect upon vehicular traffic. The old rate of progress had quite changed, and all other traffic had been thrown completely on to the sides of the carriageway, for the upkeep and maintenance of which the local authority was responsible, and with the prospect of express trams this monopoly of the greater portion of the road would be much increased.

Mr. T. W. E. Higgens, borough surveyor of Chelsea, said that his Council, in common with some other borough councils, had grievances against the London County Council. They had been asking for a long time for contributions towards widening King's-road. The Improvements

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Committee of the London County Council recommended that the London County Council should bear two-thirds of the cost of widening the street, but when the matter came before the London County Council last year an amendment was moved recommending that only half the cost be borne by the London County Council unless the Chelsea Council would agree to tramways being laid down the centre of King's-road, and the matter was still delayed. His Council considered that the London County Council would not give adequate contributions towards street widening unless tramways were laid in the streets; they also felt that the London County Council had no settled policy for carrying out street widenings. If a generous offer was made by a local authority to bear the cost of an improvement, the London County Council would try and squeeze a larger contribution out of them, whereas in cases where the local authority would give nothing the London County Council often stepped in and carried out improvements almost entirely at their own cost. Their vexatious rule that they would not contribute to any improvement unless they had been first consulted led to injustice and delay.

The Commission adjourned.

LEGAL INTELLIGENCE.

FERRANTI LIMITED.

In the High Court of Justice on Tuesday Mr. Justice Buckley, sitting for the disposal of companies' business, had before him an application on behalf of a creditor of this company asking for the production of certain documents referred to in an affidavit filed on a petition for liquidation.

Mr. Buckmaster, K.C., for the petitioner, said he was a creditor for dishonoured bills, and he had presented a petition for the winding up of the company. The answer put in to that petition consisted chiefly of an affidavit by certain receivers who had been appointed in a debenture-holders' action. They had been appointed on Sept. 9, 1903, and the main ground of their objection as disclosed in their affidavit was the allegation that certain contracts, of which the company had the benefit, contained clauses which would cause the contracts to be forfeited in the event of a winding-up order being made. On that affidavit being served it was suggested that the creditors should call a meeting to consider what should be done. The petition accordingly stood over for a fortnight till the creditors' meeting was held. At that meeting a committee was appointed, one of the members of that committee being the petitioning creditor. On Dec. 1 his Lordship allowed a further adjournment until the first petition day of next sitting, in order to see if this committee would recommend any course. Several applications had been made to the solicitors for the defendants, who had sworn the affidavit, asking for liberty to inspect the documents, but the petitioning creditor had been unable to obtain inspection of them.

Mr. Vernon, for the receivers and managers, said they were really no parties to these proceedings at all. He submitted that what they had done was perfectly right in the circumstances. They were willing to give any reasonable information, but they considered it undesirable and detrimental to the interests of the company that such contracts should be produced. They were further instructed that the company could not conduct its business if these contracts were taken from the works at Manchester. If copies were made it would lead to very considerable expense, and would be an oppressive proceeding.

Mr. Buckmaster said he wished to see the forfeiture clauses.

Mr. Vernon said he was perfectly willing to give verified copies of these as well as the dates of the contracts. The reason the receivers and managers were so cautious was because Mr. Ferranti and Mr. Anderson had specially warned them that it would be detrimental to the company to produce any contracts relating to the works. There was danger of these becoming known to competitors in the trade.

Mr. Buckmaster said that the petitioner was Mr. Estler, and the petition was in respect of goods supplied. He did not carry on business in competition with the company, nor was he in a position to undertake the work.

His Lordship said it was perfectly reasonable that the contracts should not be produced. The receivers and managers must, however, give copies of the forfeiture clauses, and so far as possible dates fixed for the completion of these contracts. The costs would be costs in the petition.

TRAMWAY COMPETITION IN VIENNA.

In the Chancery Division on Friday Mr. Justice Farwell had the matter of Richmond *v.* the Vienna General Omnibus Company, Limited, before him on a motion by the plaintiff, a debenture holder to the amount of £2,000 out of £50,000, for the appointment of a receiver and manager of the company's property on the ground that there was default in payment of interest, and the notice of motion asked that Mr. Neville, who had acted as auditor of the company since its formation, should be appointed. The company had made losses, it was said, for each of the three last half-years of £1,616, £2,500, and some £3,000.

Mr. Wilkinson, on behalf of the company and bearer debenture holders to the amount of £27,800, opposed the motion. He said that if the order were made it would have the effect of sinking the ship. The company was struggling against the electric tramway system now being introduced into Vienna, but by a deviation of route where the electric system did not prevail the company hoped to improve its position.

After hearing **Mr. Austen Cartmell** for the trustees, **His Lordship** made the order asked for, the managers of the company not to act beyond six months without the leave of the Judge in Chamber.

In another motion by **Mr. Upjohn, K.C.**, against the company, it was agreed that no order should be made save that the costs should be reserved.

ST. MARYLEBONE ELECTRIC LIGHT.

On Friday last the action of the Metropolitan Electric Supply Company, Limited, *v.* the Mayor, Aldermen, and Councillors of St. Marylebone came before Mr. Justice Buckley in the High Court.

Mr. Buckmaster, K.C., moved on behalf of the defendants that the time which the Court fixed for the completion of the purchase by the defendants of the plaintiffs' undertaking might be extended. The Corporation became bound to buy the undertaking of the plaintiffs in their district. The purchase price had been fixed by arbitration at £1,212,000. An action was brought, and the Court ordered the specific performance of the contract. It was impossible to raise the money by loan, and a rate would mean, apart from other rates, one of 20*s.* in the pound. In order to get out of the difficulty the Council had decided to appeal to Parliament, but under the Act they must first obtain the opinion of the ratepayers. The earliest date at which that could be done was Jan. 28, 1904, and the latest Feb. 18, while on Dec. 31, 1903, they were bound by his Lordship's order to complete the purchase and pay money which they had not got, and could not by any possibility obtain. They, therefore, asked for an extension of time for them to see if they could secure relief from Parliament to enable them to carry out the bargain.

Mr. Cripps, K.C., for the company, pointed out that they had nothing to do with the means of raising the money, but they dissented from what was said about the difficulty of raising it. If the proposed Bill were accepted by the ratepayers, the company were prepared on that basis to give all proper indulgence to the Borough Council, but on terms. In the other alternative, which was not an improbable one, of the ratepayers rejecting the idea, the method of procedure would be for the company to enforce their rights by applying for a mandamus to have the rate enforced.

Mr. Justice Buckley: The crux of the case is that the Borough Council have unfortunately involved themselves in enormous liability which they do not find themselves in a position to discharge. They ought to have thought of that before coming under the statute.

Mr. Cripps said they could not play fast and loose with the company. He did not think any other municipality in the country had ever taken up such an attitude to escape from a liability, which it had undertaken on its own motion, because the arbitrator had not decided just as it wished.

Mr. Justice Buckley: It is for them to find the money, but it is for me to see that they have a reasonable opportunity of complying with an obligation which, in my view, they have been very foolish to place themselves under. It is a complete satire on municipal trading. The unfortunate ratepayer finds himself in this position through no fault of his own, but by that of his representatives.

Mr. Buckmaster repudiated any desire or wish on the part of the Council to escape from the bargain.

Mr. Justice Buckley, in giving judgment, said that the Council seemed to have gone with a light heart and obtained powers which compelled them to buy and the company to sell. To comply with that they wanted a million and a quarter, and, of course, they had not got it. They endeavoured to get sanction to borrow and failed. To obtain the whole capital sum by a rate would mean such a very heavy burden on the ratepayers that his Lordship was not surprised that the Council were afraid. Now they were in it, it was for the Council to resolve their own difficulties. The position was complicated by the fact that the undertaking required perpetual addition and extension, and capital expenditure had to be increased. As matters stood at present the company were the custodians of somebody else's undertaking, for which somebody else would not pay. If the ratepayers did not approve the proposed Bill, the situation would become more acute. His Lordship was of opinion that there should be an extension of the time of completion of the purchase till Feb. 29, but only on certain terms. The company said it was not reasonable to expect them to raise more capital, and they had borrowed from their bankers at 4½ per cent., and they said that that interest and the money expended for further capital expenditure should be paid by the Council. There was great justification in that argument, and the borough must pay £60,000 and 4½ per cent. on £7,250. The evidence was that that would require a rate of something like 9d. in the £. There would be the further term that there should be added to the purchase money such other expenditure as the plaintiffs should make in respect of reasonable and proper expenditure on capital account.

Order accordingly.

GEO. F. MILNES AND CO.

In the Chancery Division on Tuesday before Mr. Justice Farwell, Mr. R. J. Parker, in a debenture holders' action of the Bank of Liverpool, Limited, *v.* George F. Milnes and Co., moved for judgment in default of defence. The bank holds a third debenture and the whole series of the second debentures, while the Law Guarantee and Trust Society was trustee for first and second debentures. An interim order has been made for the appointment of a receiver and manager, and counsel asked that this appointment should be continued in chambers. It was one of those cases in which, no doubt, everybody would be paid, and the bank was meanwhile advancing the money.

His Lordship gave judgment on the minutes submitted, which were in the usual form, with a declaration as to the bank's charge, and the customary enquiries.

WEST WALES TELEPHONES.

At Haverfordwest County Court on Tuesday, Judge Bishop heard a number of cases in which the National Telephone Company were the

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plaintiffs and several inhabitants of Haverfordwest were the defendants, arising out of claims for rental of telephones alleged to be due. The amounts sued for were from £17 to £24 for three years at £8 a year

The case for defendants was that when they signed the contracts they did so on the understanding that a Pembrokeshire exchange area was to be established, which would include the most important towns in the county. Such an exchange area had not been provided, and they contended that the telephones had not served the purposes for which they required them. Each defendant had paid a small amount into court.

The plaintiffs contended there was no promise, but it was stated by the company's representative that they were about to open out in the county if subscribers could be obtained. The company could not guarantee that there would be subscribers.

His Honour held that the evidence showed that defendants were given to understand there would be communication with other towns in the county, but the promise had not been fulfilled. Therefore, when defendants got their telephones they found they were no use. He, however, reserved judgment.

ALLEGED THEFT OF ELECTRICITY.

Walter Lawrence, stated to be an electrical engineer, was charged on remand, at Bow-street Police Court on Thursday last week, with stealing 10s. worth of electricity at his rooms in the Strand. The facts of the case were given in our last issue.

The **Magistrate** said that, as a warning to others, there would be a fine of £5.

COMPANIES' MEETINGS AND REPORTS.

NERNST ELECTRIC LIGHT.

The ordinary general meeting of the shareholders in this Company was held on Tuesday at the Westminster Palace Hotel, S.W., Mr. Bernard M. Drake presiding.

The **Chairman** said the balance-sheet showed that they had made a net profit during the past year. He regretted that Mr. Hugo Hirst had found that his other engagements prevented his continuing to occupy a seat on the Board. Mr. Hirst had, however, kindly offered the benefit of his advice on all questions arising out of the policy which had been adopted during his term of office. Turning to the balance-sheet, they had made a net profit of £3,926. 1s. 11d. for the year, as against a debit of £3.157. 9s. 7d. for the previous year. The value of patents had been left as before, the charges in connection with the maintenance of the patents having this year been paid out of the revenue, as they only amounted to about £70. It had not been necessary to augment the suspense account as a result of this year's working, but an item which previously appeared under another heading was considered by the auditors to fall under the suspense account owing to the alterations introduced under the new working agreement with the Allgemeine Elektricitäts-Gesellschaft, and was accordingly so transferred. He was pleased to say that the working arrangement made with the Allgemeine Elektricitäts-Gesellschaft had resulted in the continuance of friendly relations, and he was satisfied that they were doing their very best to improve the quality of the lamps sent out. With regard to the progress of the lamp, the following extract from the last report of the Allgemeine Electricitäts Gesellschaft would be of interest: "The Nernst lamp, as regards its durability and the life of the burners, has been further improved, and is showing good results, particularly on the higher volt circuits so general now on modern installations. A new type of lamp for 250 candles, also a candle lamp, and lamps suitable for searchlights have been placed on the market. Up to now approximately 2,000,000 of lamps and burners have been sent out, and the demand is increasing." Continuing, the Chairman said there was no doubt that the lamp did consume about half the current required by carbon lamps for the production of an equivalent amount of light. On the other hand, it was a more delicate piece of apparatus than the ordinary lamp, and hence required very skilful handling. For these reasons he thought they ought to appreciate the fact that the original hopes formed at the time the invention was made—namely, that it would create a complete revolution in the industry—would not be realised by the lamp in its present form. It, however, fulfilled a most useful purpose, and he had little doubt that the sale would increase, especially in quarters where the generating stations had been well designed and the staff were possessed of good electrical knowledge. In view of the above, they were again brought face to face with the difficult problem of the value at which the patents stood in the books. A provisional suggestion had been made that the capital be reduced to £100,000; and although a circular was sent out on the basis of a reduction to £50,000 to meet the views of an important section, it remained for the shareholders, with the knowledge now before them, to decide which alternative they preferred. The result of the circular sent out showed that only the holders of some 10,000 shares out of 320,000 were opposed to the scheme. On the other hand, a considerable number, as might have been expected, did not reply, and it was, therefore, impossible to say whether they could go to the courts as a united body with a request that they would grant the reduction they desired. Another course open to them was liquidation and reconstruction, which could be carried by a three-fourths majority; but if they could only agree, they should hope by the first process to effect their purpose by the expenditure of a few hundred pounds, whereas the second course would involve more than this sum in stamp duties and registration fees alone. On one point, however, there seemed to be no doubt — namely, that the directors would not, under existing circumstances, be justified in dividing any profits made until the losses of the past had been met. These losses, with the depreciation which would have to be faced, would mean that the shareholders would all have to wait some years before they could hope to receive any return on their money, if they decided to leave things as they were. Although, therefore, the directors did not feel that they should do more than advise the shareholders in this matter to the best of their ability, and subsequently to spare no efforts to carry their wishes into effect, he must say that, personally, he should like to see the Company put on a proper commercial footing without further delay.

Mr. J. G Dalzell seconded the motion, which was adopted.

Mr. Langham Reed then moved: "That the shareholders of this Company desire that the capital of the Company should be reduced to £100,000, in ordinary shares of £1 each, all one class; that the preference shareholders shall receive, as nearly as may be, £75,000 and the ordinary shareholders £25,000, and that the directors be requested to take such steps as they may be advised are necessary for the reduction of the capital of the Company on the basis of this resolution."

Sir Henry Mance seconded the motion, which was ultimately agreed to, with two dissentients.

INDIARUBBER, GUTTA PERCHA, AND TELEGRAPH WORKS.

Presiding at the ordinary general meeting of this Company on Tuesday, **Major Leonard Darwin** said they were not at the present moment engaged in any work of great importance, and he could not prophesy what might be in store for them during the coming year. Since the ordinary general meeting, held about a year ago, legal sanction had been received to the amendment of the Company's memorandum of association, and the Board had under preparation a new set of articles of association, which would be more in accordance with existing wants and practice. The present articles of the Company were about 40 years old, and they had been altered from time to time in such a way that reference to them in their present state was very troublesome, and misunderstandings and mistakes were liable to occur. Their solicitors had prepared the drafts. The directors thought that the shareholders were to be congratulated on the results of the past year's working, as, while paying the usual dividend of 10 per cent. for the year, the Board had written off buildings, machinery, and ships £46,150, or about £26,000 in excess of the usual annual depreciation. The general business had fallen off in bulk when compared with that of the previous year, and competition had been keen. In one "line," which was not an inconsiderable one, they had been beaten by German manufacturers, who, the Board believed, were selling, under the cartel system in vogue among them, about 18 per cent. cheaper to English consumers than they sold to the German trade. The directors hoped to recover this "line" by new methods of manufacture, while maintaining a good quality of production, as they did in this particular article on a previous occasion. The laying of the San Francisco-Honolulu cable was successfully accomplished shortly after the Board met the shareholders a year ago, and it had since continued to give every satisfaction to the Commercial Pacific Cable Company. The works at Silvertown and Persan were in an efficient state, but it would be necessary to make some further additions to the plant if, as the directors anticipated, the new motor tyre referred to in their report met with the approval of the motoring public. The chairman of the Company, Mr. Henry Marsham, was absent on a tour in Japan, and would doubtless make their name and the nature of their manufactures known to many in the districts he would visit. He concluded by moving the adoption of the report and accounts and the payment of a dividend of 15s. a share, tax free.

Mr. George Henderson seconded the motion, which was adopted.

ARON ELECTRICITY METER.

The ordinary general meeting of the shareholders in this Company was held at Winchester House on the 10th inst., Mr. H. Hirst presiding.

In moving the adoption of the report, the **Chairman** reminded the shareholders that there was a loss last year of £6,032, while £2,500 had to be paid out of capital towards sinking fund. This year, after a liberal writing off, they had made no loss, and had been able to provide practically the whole of the sinking fund out of the profits. The balance-sheet for the past year was a healthy one, comparing it with that of 1902, in so far as there had been ample depreciation, and the decrease in stock and sundry debtors of £9,370 was represented by about £10,000 additional hard cash. The results would have have been better but for three particular causes, which showed themselves in the shape of expenses against the year's trading. First, the stagnation in business last year led the directors to make serious efforts to endeavour to apply some of the unused capital at their disposal for new enterprises, none of which, however, were sufficiently encouraging to warrant them in investing any of the Company's capital in them. The second cause was the continuance of experiments with a new meter and the taking out of patents for it. He explained to them last year that the larger quantity of very small meters required owing to the change of voltage in stations all the world over, had been a reason why the Company were kept out of a great many stations, as their meter could not compete in price satisfactorily for the smallest sizes. Dr. Aron had succeeded in finishing what appeared to be an excellent little meter for alternating currents, and it would very shortly be on the market. He was satisfied with the technical success of the meter, while so far as he (the speaker) could judge as a manufacturer, he believed that the Company would be able to produce it sufficiently cheaply to compete. The third item which had worked against this year's profit was the expenditure of several thousand pounds for the purpose of making good the meters in

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this country which they supplied two or three years ago, and which developed faults in practical use. The Company had liquid assets amounting to £75,455, against which there were the debenture issue, £56,900, and creditors, £5,444, leaving a net balance of £13,111, without any valuation of land, freehold buildings, machinery, tools, fixtures, patents, or goodwill and stock, the stock alone amounting to £37,560. On a recent visit with Mr. Blumlein to Germany, he convinced himself that the Company had an excellent property in Schweidnitz, and that it had considerably improved in value. They sanctioned an expenditure of £2,500 for an extension of works in which to manufacture the new small meter. As regarded the commercial outlook in Germany they had been eminently successful, especially during the latter half of last year. They supplied 150 stations in that country, and had increased their business with nearly all of them. The Physikalisch Technisch Reichanstalt had, on behalf of the German authorities, passed the Company's meter for both alternating and continuous currents. In Austria and France they had held their own. In this country they were in rather a peculiar position. A few stations which had used their meters largely had again returned to them A great number of engineers, however, were so discouraged about 15 or 18 months ago that they had not returned to them, although the meters were now giving most satisfactory results. The Company would have more chance of regaining their support if they could supply both large and small meters, and the Board would make every effort to do this as soon as the small meter was on the market. An effort was now being made to bring more "life" into the American business.

Sir James Pender seconded the motion, which was adopted.

DOUGLAS SOUTHERN ELECTRIC TRAMWAYS.

The annual meeting of the shareholders in this Company was held in Manchester, Mr. T. J. Hutchinson presiding.

The **Chairman** said the directors were satisfied with the state of the undertaking. Notwithstanding the bad weather of last season the tramways had done exceedingly well. It was hoped that next year they would be able to pay a dividend upon the ordinary shares. In reply to a shareholder, the Chairman explained why nothing was set aside for depreciation of plant and permanent way. The undertaking had only finished its eighth year. But the line was not worked 365 days in the year; its season only lasted 120 or 130 days. In the whole eight years the trams had only run 960 days, or less than three years. Each of these days had not been above six hours in length on an average, and so it might be said that the permanent way and plant had only had two years' real hard wear and tear. In mileage they got from each car only a sixth of a year's work. Then considerable expense had been incurred from year to year in repairs and renewals, and the Company kept a small staff at work all through the year improving and repairing the plant. Moreover, at the end of 10 years from the start—or in two years from now—the Company could demand to have the whole undertaking purchased by the Marine Drive Company at cost price, or in the alternative further running powers over the Marine Drive for 21 years. The proper time for considering the depreciation question would be when the present lease from the Marine Drive Company had expired, and the Marine Drive Company had decided to give another lease rather than purchase the undertaking. A dividend of 7 per cent. on the preference shares was declared.

BRITISH ELECTRIC TRACTION.

The interim report of the directors states that, having regard to the very unfavourable weather which has prevailed throughout the year, the traffic receipts of the various associated undertakings on the whole show satisfactory increases. During the present year over 50 route miles of new or reconstructed tramways or light railways have been opened for traffic by electric traction on the overhead system. The policy of the directors for some time past has been to restrict as much as possible the further capital commitments of the Company on new schemes or extensions, and the attention of the management is now mainly concentrated upon increasing the revenue from the Company's present investments. No portion of the additional debenture capital authorised at the last general meeting has yet been issued. The Auckland Electric Tramways Company, Limited (New Zealand), in which the Company has an interest of nearly £300,000, has been successfully established. Some of the lines were opened for traffic at the end of last year, and others during the present year. The traffic receipts are satisfactory, and in excess of the estimates, and it is expected that a dividend will be paid on the ordinary shares of the Auckland Company for this, the first year of working by electric traction. The business of the Metropolitan Electric Tramways, Limited, in which the Company holds shares to the amount of about £219,000, and has guaranteed to raise further capital to the extent of about £300,000, is also developing satisfactorily. That company will eventually operate in the important area north of London about 48 miles of light railways, under leases from the County Councils of Middlesex and Hertford, in conjunction with its own 8¼ miles of tramways. It also holds about 70 per cent. of the capital of the North Metropolitan Tramways Company and all the issued share capital of the North Metropolitan Electric Power Supply Company, which latter company owns Acts of Parliament authorising the supply in perpetuity of electricity in bulk in an area of about 325 square miles in Middlesex, Hertford, and Essex. Considerable progress is being made by the County Council of Middlesex and by the Metropolitan Company in the construction of lines and works, and it is hoped that about 20 miles of lines will be opened for traffic by electricity on the overhead system early next summer. Arrangements are in progress for the consolidation of the Company's interests in the various associated companies in Birmingham and adjacent districts, now operating about 90 route miles of tramways and light railways. During the past session the Company has obtained an Act of Parliament authorising the reconstruction for working by electric traction of the existing Brighton and Shoreham tramways and extensions of the lines to Worthing. The tenure of the greater part of the lines is for 42 years, and the Company has obtained a favourable purchase clause. The Company has also obtained an Act of Parliament authorising the construction of further tramways in the neighbourhood of Croydon, forming extensions of the existing Croydon electric tramways, thus completing an important network of tramways of about 30 route miles.

ISLE OF THANET ELECTRIC TRAMWAYS AND LIGHTING.

The ordinary meeting of the shareholders in this Company was held on Wednesday at Salisbury House, London-wall, Lord Arthur Butler presiding

The **Chairman**, in moving the adoption of the report, said that the past summer had been most disastrous as regards receipts for an undertaking such as theirs, which mainly depended for its revenue on the influx of visitors to the Isle of Thanet during the summer and autumn months. Considering that the difference between the receipts in a fine and in a wet week during the season would run into from £300 to £400, it was impossible to show the returns they would like to unless there was favourable weather. The lighting receipts were, of course, only in their infancy Mains were now being put down in the Margate area, where there was a considerable demand for electric lighting, which should improve the Company's receipts materially next year. The accrued interest due on Sept. 30 to debenture holders and preference shareholders had been met. From the sum of £10,804 brought forward from last year's revenue account, £1,853 had been deducted, the bulk of which consisted of compensation for injuries and legal charges resulting from the unfortunate accident in August, 1901. An amount of £3,403 had been carried to appropriation account to meet various charges, leaving £5,047 to be carried forward. The traffic receipts for the period under review were £33,465, against £35,088, being a decrease of £1,623 on the year. The number of passengers carried, 4,406,821, showed a falling off of 165,575. It would be interesting to the shareholders to know that the highest single day's takings since the opening of the line was on August Bank Holiday of this year, when the amount was £452, and the lowest on record, £14. 6s. 1d., was on Dec. 5, 1902, when the line was practically snowed up.

Mr. A. Wright seconded the motion, which was agreed to.

An extraordinary general meeting was afterwards held to consider a Bill which is being promoted in the next session of Parliament in the name of the Company. It was explained that the Bill, though in the Company's name, was being promoted at the risk and expense of the contractor, the object being to overcome a technical difficulty with regard to the acquisition of certain land. The Bill was approved.

BLACKPOOL, ST. ANNES, AND LYTHAM TRAMWAY

The directors have issued their annual report, which states that the work of doubling the line and equipping it for the overhead traction system has been proceeded with. In the latter part of June the line was opened so far as it was then available, but with a supply of cars totally insufficient for the business offered. Still, the directors report that the receipts have more than come up to their expectations, and the traffic done, they add, augurs well for the future returns. The completion of the contract with the Blackpool Electric Tramways (South), Limited, had not taken place when the books of the Company were closed, so that the items of capital and capital expenditure present a somewhat different aspect on the balance-sheet from what they will in the future. The cost of property is set down at £109,745. The purchase of the undertaking and additions come to £122,679; and various additions, including £3,742 for the cost of obtaining the Parliamentary Bill in 1900, and £2,578 for plant and machinery, make a total of £133,134. But against this are other items, including £21,971 put to the suspense account, which total £23,388. The suspense account mainly consists of £14,319 loss on the sale of gas cars, £2,778 loss in realising on the plant and machinery, £1,700 loss on the damage to the depôt by the storm, and £2,013 for preliminary expenses. Stock is valued at £836, and £2,365 stands for the parliamentary deposit on the new Bill. Money owing to the Company amounts to £1,390, and there is £7,110 with the bank and in hand. The traffic receipts show the good return of £13,386, whilst advertisements and other receipts brought in £144. The working expenses took £7,314, and salaries, etc., £1,020. A balance of £5,196 is left, and with other items it is raised to £5,936. Interest on debentures claims £3,559, and law costs £359, so that £2,017 is actually left for balance, and this, the directors recommend, should be carried forward. There is £4,800 due for arrears on dividend, and other claims against the Company amount to £241.

ARC LAMPS.

The report of the directors for the year ended July 31 last, presented at the meeting on the 17th inst., stated that the gross profit for the period was £5,835, as compared with £3,989 for the year to July 31, 1902. After payment of all expenses of management, and after substantially depreciating machinery and plant, the surplus was £2,639. Mr. Davy had, as the result of extensive experiments, made important discoveries, and again added to the patents held by the company, but mention need only be made of the 1904 type of lamp, which was now being placed on the market. For the third time in the history of the company it had become necessary to extend the works, and negotiations were proceeding for the acquisition of the additional premises. In March last the Jandus Arc Lamp and Electric Light Company, Limited

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issued a writ against this Company, alleging infringement of certain letters patent owned by them, and a statement of claim was duly delivered in June. After deferring the trial of their action as long as they possibly could, the plaintiffs applied for leave to still further postpone for the purpose of amending their patents, and permission was granted on Nov. 18 by the judge on certain terms, one being to the effect that all amendments to the specifications (which can only be made by way of disclaimer) be made within four months. The directors declared an interim dividend at the rate of 5 per cent. per annum for the first half of the year to July 31, 1903, and the shareholders were asked to sanction a distribution at the rate of 7 per cent. per annum for the second half of the year.

NEW COMPANIES REGISTERED.

Etheridge Railway Company, Limited.—Capital, £30,003. Object: to acquire concessions, rights, and privileges for the construction of railways and tramways in Queensland, or in any other part of the world, etc.

Paine, Mainwaring, and Lephard, Limited.—Capital, £15,000. Object: to carry on the business of machinists, mechanical and electrical engineers, motor and cycle manufacturers, etc. Registered office: Broadwater-street, Broadwater, Worthing.

Britannia Engineering Co., Limited. — Capital, £40,000. Object: to acquire and carry on the business of general engineers, engineers' and machine tool manufacturers, etc., heretofore carried on by T. M. Bear and J. Blomfield, as the Britannia Company, at the Britannia Works, Colchester, etc. Registered office: Britannia Works, Magdalen-street, Colchester.

Goodfellow Engineering Co, Limited. — Capital, £20,000. Object: to carry on the business of iron, steel, and metal manufacturers, merchants, and agents, machine and tool makers, ironfounders, engineers, machinists, millwrights, boiler makers, contractors for refrigerating plant and mill gearing and for fitting up mills, collieries, pumping and electrical stations, tramways, etc. Registered office: 12, Exchange-street, Manchester.

Durham and District Electric Traction Co., Limited.—Capital, £30,000. Object: to carry on the business of carriers of passengers and goods, electrical and general engineers, electricians, contractors, wharfingers, agents, manufacturers of and dealers in railway, tramway, electric, and other apparatus, etc. Registered office: Donington House, Norfolk-street, W.C.

Synchronised Electric Clock Company. — Capital, £2,500. Object: to acquire the following provisional specifications for patents—namely: No. 18,309, dated Aug. 25, 1903, of W. W. G. Webb, J. Hall, and J. F. A. Chandler relating to improvements in clocks; No. 22,858, dated Oct. 22, 1903, of F. A. Chandler and B. Bonnisken for improvements in electrically-synchronised clocks and the like; and No. 24,684, dated Nov. 16, 1903.

Kroeger Light Cure and Electric Therapeutic Institutes, Limited.—Capital, £15,000. Object: to acquire and carry on the businesses heretofore carried on by M. Kroeger at 67, Elizabeth-street, Eaton-square, S.W., and 11, Grand-parade, Eastbourne, by the said M. Kroeger and Mrs. I. Maxwell at 12, Cheniston-gardens, W., and by the said M. Kroeger, A. L. Smith, and Miss E. W. Smith at Mansion House-chambers, 11, Queen Victoria-street, E.C., under the style of Kroeger's Light Cure Institutes.

APPOINTMENTS VACANT.

Surveyor and Electrical Engineer, Boston. Salary, £300. Dec. 18.

Wiremen, and Armature Winders. Apply, Harland and Wolff, Belfast. See advertisement.

Head Draughtsman. Apply to J. H. Holmes and Co., Newcastle-on-Tyne. See advertisement.

Wireman, at the Goldsmiths' Institute, New Cross, to conduct classes in electric wiring. See advertisement in last issue.

Resident Electrical Engineer, Leicester Tramways. Salary, £250, rising by £25 a year to £350. Applications by Jan. 1, 1904. See advertisement.

CONTRACTS FOR ELECTRICAL SUPPLIES.

Paris.—The Post and Telegraph Department, 103, Rue de Grenelle, require tenders for 24 lots of accessories by Dec. 29.

Rome.—The Admiralty require tenders for electric lamps, estimated at £6,000, by Jan. 23. Foreign competitors are invited.

Madrid.—The Public Works Department require tenders for installation and working of electric tramways from Mondariz to Porrino by Feb. 12, 1904.

Barcelona.—The Harbour Works Commissioners require tenders for installation of electric light and power by Feb. 15. Particulars may be obtained from the Commissioners.

Pontypridd.—The Urban District Council invite tenders for free wiring, and for Section O, the supply of tramcars. Tenders by 24th inst. See advertisement in former issue.

Whitby.—Tenders are invited for fitting-up the Whitby Temperance Hall with electric light. Specifications from Mr. A. Palframan, Leesholme, Bagdale, Whitby. Tenders by 19th inst.

Govan.—The Corporation invite tenders for the supply, delivery, and erection of coal bunkers, conveyor, and electric capstan. Tenders by 28th inst. See advertisement in former issue.

North Shields.—Tenders are invited for installation of electric light at the Tynemouth Victoria Jubilee Infirmary. Particulars from Mr. John W. Meadows, 43, Howard-street, North Shields.

Peteringa (Croatia).—The Municipality require tenders for installation and working of electric lighting; 6 to 8 arc and 160 to 180 incandescent lamps are required for the street-lighting.

Blackpool.—The Tramways Committee invite tenders for laying about 1,650 yards of double-line tramway. Specifications, etc., from Mr. John S. Brodie, Town Hall, Blackpool. Tenders by 29th inst.

Greenwich.—The London County Council invite tenders for six electrically-driven three-throw boiler feed pumps. Specifications, etc., at the County Hall, Spring-gardens, S.W. Tenders by Jan. 19.

Plasencia.—The Municipality require tenders for electric lighting of the town for 12 years by 26th inst. Particulars from the above authority, Casas Consistoriales, Plasencia, Province of Carceres, Spain.

London, E.C.—The East Indian Railway Company invite tenders for the supply and delivery of electric plant for a lighting installation. Specifications from Company's Offices. Tenders by 12 noon on 23rd inst.

Irvine (Scotland).—The Corporation invite tenders for providing, erecting, and laying down the whole plant and apparatus necessary for electric light installation. Particulars from Mr. Jas. Dickie, town clerk.

Canterbury.—Tenders are invited for wiring the Kent and Canterbury Hospital for electric lighting, and other works in connection therewith. Specifications from Mr. W. J. Jennings, 4, St. Margaret's-street, Canterbury.

Hackney.—The Council invite tenders for feeding and distributing mains. Specifications from Mr. Robert Hammond, M.I.C.E., 64, Victoria-street, Westminster, S.W. Tenders by Jan. 4, 1904. See advertisement in last issue.

Paris.—The Post and Telegraph Department require tenders for 80,000 km. bronze wire, 1,081,000 km. copper wire, 105,000 porcelain insulators, 250,000 km. galvanised iron wire, by Dec. 28. Particulars, 103, Rue de Grenelle, Paris.

Camberwell.—The Borough Council invite tenders for the maintenance of electric bells and private telephones. Forms of tender from Mr. W. Oxtoby, borough engineer, Town Hall, Camberwell, S.E. Tenders by 5.30 p.m. on Jan. 18.

Sydney (N.S.W.).—Tenders are asked for the supply of continuous and alternating current meters. Specifications, conditions, and forms of tender are obtainable from Messrs. Preece and Cardew, 8, Queen Anne's-gate, S.W. Tenders by Jan. 12.

Christchurch (New Zealand).—Tenders are invited for the complete installation of electrical tramways, other than buildings. Specifications, etc., may be obtained from the Agent-General for New Zealand, Victoria-street, S.W. Tenders by March 17. See advertisement.

Wallasey.—The Urban District Council invite tenders for the supply and delivery of about 7,100 yards concentric armoured cables, together with joint boxes and section boxes. Specifications from Mr. J. A. Crowther, Electric Supply Works, Sea View-road, Liscard. Tenders by Jan. 16.

Culiacan (Mexico).—Tenders are invited for lighting the town by electricity: 60 arc lamps of 1,200 c.p. and 110 incandescents of 50, 30, and 16 c.p. will be required. Propositions will be received by letter until Dec. 31 in the Secretaria del Ayuntamiento, Culiacan, where further information may be obtained.

Long Eaton.—The Urban District Council invite tenders for engine, dynamo (250-kw. set), and accessories, one Lancashire boiler, overhead hand travelling crane, economiser, for the electricity works. Specifications from Mr. Frank Worrall, A.M.I.C.E., Electricity Supply Works, Long Eaton. Tenders by Jan. 1.

Enniscorthy (Ireland).—The District Lunatic Asylum Committee invite tenders for the following works: generator and motor-generator converter; motor and motor pumps; accumulators; main switchboards; overhead conductors and telephone; gearing and shafting; wiring asylum. Specifications, etc., at the Asylum Office. Tenders by Jan. 20.

Sydney (New South Wales).—Tenders will be received at the office of the Deputy Postmaster-General, Sydney, New South Wales, up to 2.30 p.m. on Dec. 30, for the supply and delivery at the departmental stores, Sydney, of telegraph, telephone, and electric light material. Specifications, etc., may be seen and tender forms obtained at the General Post Offices, Sydney, Melbourne, Brisbane, Adelaide, Hobart, and Perth.

Harrismith (South Africa).—The Town Council invite tenders for high-tension concentric feeder cable, low-tension triple-concentric distributor cable, low-tension service and street-lighting cables, joint-boxes, service boxes, and other accessories, and the supply of five 30-kw. transformers, four transformer pillars, high and low tension switchgear, etc. Specifications from Messrs. Mordey and Dawbarn, 82, Victoria-street, Westminster. Tenders by Jan. 18.

Erith.—The Urban District Council invite tenders for the supply and erection of two Lancashire boilers, with fittings, brickwork settings, and steam feed pump; steam, exhaust, feed, air and circulating, blow-off, and drain pipes; surface condenser, with steam-driven air and circulating pumps; three-phase alternator and direct-coupled high-speed enclosed-type steam-engine of 500 kw. capacity; extensions to main switchboard and cable connections. Tenders by Jan 18. See advertisement.

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RESULTS OF TENDERS.

Gravesend.—The Town Council have accepted Messrs. Balfour and Sons' tender for tanks, at £178.

Cardiff.—The Tramways Committee have accepted the tender of the British Westinghouse Company for supplying 15 combination cars at a cost of £601. 10s. per car.

Radcliffe (Lancs.).—The Urban District Council have accepted the tender of W. Metcalf, Limited, Church, Lancashire, for the supply of the pitch and oil required in the construction of the tramways.

Yarmouth.—The tender of the British Electric Transformer Company for additional transformers, at £240, has been accepted, and that of Mr. McNaughton, for carbons, at £3. 18s. 9d. per 1,000 pairs.

Portsmouth.—The Telephone Committee have received three tenders for the switchboard extension at the central exchange, and recommend the acceptance of that of the International Electric Company, London, the amount being £645.

Johannesburg (S.A.).—The tender of Bolckow, Vaughan, and Co., Limited, Middlesbrough, has been accepted for tramway rails, fish-plates, and flange rails required by the Corporation. The total quantity required is about 7,000 tons, and the value of the order is over £40,000. The order for the points and crossings has been secured by Hadfield's Steelfoundry Company, Limited, Sheffield.

Maidstone.—The Corporation have received the following tenders for the construction and equipment of light railways:

British Westinghouse Company, Limited, Manchester...	£23,052	5	10
Brush Electrical Engineering Company, Limited, Belvedere-road	21,759	11	5
W. Griffiths and Co., Bishopgate-street Without	21,634	11	11
British Electric Equipment Company, Queen Victoria-street	21,532	8	9
Blackwell and Co., Limited, 59, City-road, E.C.	20,079	3	3
J. G. White and Co., Limited, College-hill, Cannon-street	19,016	1	4
Dick, Kerr, and Co., Limited, Abchurch-yard, Cannon-street*	18,871	3	11

* Accepted subject to confirmation by Council and Board of Trade.

BUSINESS NOTES.

TRACTION.

Walsall.—Dec. 31 has been fixed for the opening of the Walsall tramways.

Leith.—The Town Council have approved the petition for a tramway provisional order.

Portsmouth.—The Town Council have decided to try the use of covers on the cars.

Cheltenham.—The Tramways Committee have agreed to the proposed double line in High-street.

Newcastle.—The Corporation are going to proceed with the tramway extension from Scotswood to Blaydon.

Ardsley.—The proposed extension of the tramways to East Ardsley has been approved by the District Council.

Maidstone.—An extension of time is being applied for by the Maidstone and Faversham Light Railway Company.

Hull.—The Works Committee have given an order for 15 patent Kennington collapsible car covers for the electric tramcars at £80 each.

Mandalay.—*Indian Engineering* states that the Mandalay tramway will be running by April. The manager is expected to arrive this month.

Exeter.—An arbitration has been held to determine the price to be paid by the Corporation for the compulsory purchase of the tramway undertaking.

Warwick.—The Town Council have approved the plans of the proposed tramways. Wood paving is to be laid along the whole line, except at certain specified places.

Hove.—The Town Council have decided to have the existing tramway within the borough valued in the event of their deciding to purchase within the next seven years.

The Lake District.—Two companies are being formed to run a service of motorcars between Windermere Station, on the London and North-Western system, and Keswick and other places in the Lake District.

Electro-Pneumatic Signalling.—The North-Eastern Railway Company have introduced a large installation of electro-pneumatic signalling on their Sunderland and North Shields line at Harton Colliery.

South Bank.—A special meeting of the Urban District Council is to be held to consider the intended application of the Imperial Tramways Company for powers for a tramway extension to South Bank and Eston.

Pemberton.—The new engines which have been installed at the tramway power house will be formally started early next month. The committee are considering the mode of reconstructing the Ormskirk-road route.

Blaydon.—A deputation from the Newcastle Corporation attended the last meeting of the District Council and explained the tramway proposals of the former in that district. The local Council are supporting the scheme.

Beckenham.—The British Electric Traction Company have informed the District Council that "under no circumstances" would they be prepared to entertain the proposal for the conduit system in connection with the projected tramways.

Paisley.—Mr. H. F. Parshall, engineer for the Paisley District Tramways Company, has forwarded to the District Committee of the County Council plans showing the general arrangement of the proposed tramways and overhead construction.

Ipswich.—A trial trip over the Spring-road and Derby-road section of the tramways took place on Tuesday. The Board of Trade inspection of the whole of the lines not previously examined by the inspectors will probably take place on the 23rd inst.

Poplar.—The General Purposes Committee of the Borough Council have approved the plans for the London County Council electric tramways to be constructed along East India Dock-road, and the proposed extension to the Iron Bridge. The conduit system is to be adopted.

Lambeth.—The Borough Council have declined to agree to contribute more than £20,000 towards the cost of the street widenings in connection with the tramway reconstruction. This is only one-sixth of the total amount, whereas the County Council require a one-third contribution.

South Shields.—The scheme for electric tramways has so far advanced that the Tramways Committee will recommend to the next meeting of the Town Council that tenders be invited, to include offers for the leasing, as well as for the construction and electrical equipment of the tramways.

Llanelly.—At a meeting of the Urban District Council on Monday the proposal to promote a Bill in Parliament for the specific performance of the agreement between the Council and the British Insulated Wire Company failed to get the required support, and the application will have to be dropped.

Glasgow.—The Glasgow Chamber of Commerce have passed a resolution deciding to petition the Corporation in favour of withdrawing the present proposed provisional order in so far as the extension of the present tramway system is concerned until the ratepayers have had reasonable time to consider the Bill.

Everton.—The Tramways Committee of the Liverpool Corporation have postponed for a month the consideration of the general manager's report on the Everton tramways. They have had under discussion the report of the general manager as to the results of working the Everton experimental routes. The routes are to be discontinued.

Wolverhampton.—A long discussion took place at the last meeting of the Town Council on Monday with regard to the recent suspension of the service on a section of the new Hampton-road route. It was explained that the committee decided on this course from anxiety for the ratepayers' interest, and their action was ultimately approved.

Southwark.—The County Council have informed the Borough Council that all that is possible will be done to relieve the inconvenience caused to the public by the electrification of the tramways in the district. Some of the traffic will be diverted to secondary streets, whilst the whole work will be completed as rapidly as possible.

Tube Breakdown.—On Wednesday morning, at five minutes to nine, a train on the Central London Railway, bound Citywards, broke down near the Marble Arch, owing, it is stated, to some slight defect in the motor equipment. As quickly as possible the train was shunted to a siding, and the passengers transferred to another train. There was very little delay.

Chester.—The Tramways Committee have resolved: "That it be recommended to the Council that the committee be authorised to advertise for tenders and enter into a contract for the privilege of advertising on the tramcars for three, five, and seven years respectively, the advertisements to be placed on outside boards and the ventilator windows only."

Hammersmith.—At the last meeting of the Borough Council, Mr. Collins, L.C.C., said the London County Council were short of money, and it rested with that Council to find the money for the proposed tramway from Hammersmith to Harrow-road, or he was afraid it would be deferred for a considerable time. It was decided to leave the matter in the hands of the Special Purposes Committee.

Cape Electric Tramways.—The directors of the Cape Electric Tramways, Limited, have declared an interim dividend of 5 per cent., payable to shareholders registered on the 24th inst., and to holders of coupon No. 16 attached to share warrants to bearer. The transfer register will be closed from Dec. 24 to 31 inclusive. The dividend will be payable after the receipt of transfer returns from South Africa.

Barrow.—Good progress has been made in electrifying the tramways, and it is expected the first run by the new electric cars will be made before the end of the present month. The suggestion that the Dalton Council should approach the British Electric Traction Company with a view to obtaining an extension of the tram service as far as Dalton has met with great favour among the residents of Barrow and Dalton.

Argentine.—The City of Buenos Ayres Tramways Company, Limited, states that negotiations have been opened with a view to the transfer of the company's undertaking to the Anglo-Argentine Tramways Company, Limited. The Board favourably regards these proposals, and as soon as a provisional agreement has been concluded an extraordinary general meeting of the shareholders will be called for its consideration.

Sheffield.—Satisfactory progress is being made with the extensions of the tramcar sheds at Queen's-road, Sheffield. The cost will amount to about £20,000, and the work is being carried out by Messrs. T. Roper and Sons, under the supervision of the city surveyor. The new sheds

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will be ready for occupation in the spring of next year. The tramways department have now 215 cars running, but this number will probably soon be increased.

Bradford.—Major Pringle has inspected the new tramway laid by the Corporation in Church-bank, which is the steepest gradient in the city—namely, 1 in 9—and serves two termini. Major Pringle expressed himself satisfied with both sections, and sanctioned a speed of four miles per hour on the Church-bank portion. The public cars will start running to Undercliffe, *via* Church-bank, as soon as the Board of Trade certificate is received.

Derbyshire Light Railways.—The Light Railway Commissioners have granted the draft order relating to the proposed electric railway in Derbyshire from Hope to Bradwell and Castleton. The line is to be connected with the Dore and Chinley Railway, a short distance from Hope Station, and the terminal station will be at Castleton. The power station will be near Greyditch. The total estimated cost of the new line is a little under £40,000.

Islington.—A communication received from the Board of Trade with reference to the London County Council's application to lay a tramway in Rosebery-avenue, St. John-street, and St. John-street-road, was referred to the Works Committee, with power to act. At the last meeting of the Borough Council the Council decided any other than the conduit system for the tramways proposed to be laid down in Islington would be "detrimental to the best interests of the borough."

Ayr.—Colonel Yorke has inspected the Corporation electric tramway system with a view to increasing the speed over the whole route. Colonel Yorke was satisfied that an increase of speed was justifiable. The total length of the system is over 5½ miles, and with the exception of half a mile from the north end of the new bridge along High-street and Alloway-street to the Burns Station, the speed is to be increased from 10 to 12 miles, which will greatly facilitate the efficiency of the service.

Yarmouth.—Acting on a hint from the Board of Trade, the Tramways Committee have passed a resolution the effect of which is that on occasions of exceptional traffic or inclement weather conductors may admit seven persons into the interior of a car when the maximum seating accommodation is already occupied. A hitch has occurred in the negotiations for the purchase of the Gorleston and Southtown Tramways, and the Corporation have decided to take no further action in the matter.

Plymouth.—The Borough Council at their last meeting decided that an application be made to the Board of Trade for a provisional order to authorise the Council to construct four additional tramlines in the borough. Three of the proposed new tramways are short lengths in connection with the Old Town-street and Tavistock-road improvements already approved by the Council. The net increase of receipts for the past five weeks over the corresponding five weeks in 1902 was £283.

Manchester.—The Watch Committee have decided to rescind their resolution of December last year in favour of allowing an excess number of passengers in the electric cars during "rush" hours in wet weather, and in future the practice will be discontinued. The Tramways Committee have under consideration the purchase of 100 large cars. Designs have already been submitted to the committee, and it is hoped that when they are put in service the present congestion on several of the routes will be much relieved.

Cardiff.—The Tramways Committee's proposals for revised fares to come into force on Jan 1, have been referred back for further consideration. It was decided at a meeting of the Tramways Committee on Tuesday to extend the tramways from Castle-road to Crwys-road, over the Rhymney Railway bridge, and from the latter place to Talygarn-street, at a cost, including car and electrical equipment, of £12,218, and further, from the present Cowbridge-road terminus to west of Victoria Park, Canton, at an expenditure of £5,455.

Spen Valley.—A sub-committee of the Cleckheaton District Council have had an interview with Mr. E. A. Paris, local manager of the British Electric Traction Company, with reference to the reported intention of the company to postpone indefinitely the construction of the Hartshead Moor section of their scheme. It is stated that Mr. Paris holds out no hope of the whole undertaking being proceeded with yet, but that the present intention is to construct a line along Westgate, Cleckheaton, as far as the Punch Bowl Hotel, in the coming spring.

Reading.—Last week the tramway employés of the Corporation had a social gathering and entertainment in the clubroom of the tramway depôt in Mill-lane. A social and athletic club has been started for the men, thanks to the consideration of the manager (Mr. W. Binns) and the help of many members of the Town Council and others, and it was under the auspices of this club that the entertainment was held. Both the tramways manager and the assistant electrical engineer (Mr. A. Shearer) were present, and great interest was shown in the proceedings.

Aston.—The reconstruction of the tramway route is, so far as the portion in the city of Birmingham is concerned, expected to be completed by the last day of the present year, when the lease expires, and the line will be worked by the Corporation. In Aston Manor, however, the work of transformation is not so well advanced, and probably an additional month will elapse before the British Electric Traction Company, to whom the Aston authorities have leased their interests, will be able to join with the Corporation of Birmingham in a through service to the Lower Grounds and Whitton.

Darwen.—At the monthly meeting of the Town Council the Chairman of the Tramways Committee said that in September last year the net loss on the main section of the tramways was £214. 0s. 10½d., and this year at the end of September the net loss was £120. 15s. 4½d., showing a net loss this year of £93. 5s. 6d. less than last year. On the Hoddlesden section at the end of the same month last year the net loss was £118. 1s. 11d., and this year at the end of September it was £108. 1s. 1d., a sum which included £75 for depreciation, showing that the section was £85 better than at the end of September last year.

Dunedin (N.Z.).—Rapid progress is being made with Dunedin electric tramways. There is about 5¼ miles of single track of permanent way constructed, and the work of construction in the North-East Valley is being pushed ahead, a start having been made at Normanby. The overhead construction is well in hand. In the power station the first unit is erected, and the second unit will shortly be on its foundations. The "Rangatira" also brings the balance of the motor equipments for the cars. It is expected to have steam on the first unit in about a fortnight or three weeks' time.—*New Zealand Mining Journal, Oct. 24.*

Lowestoft.—The general manager of the tramways reports that the total receipts from July 22 to Nov. 24 amounted to £4,841. 0s. 4d.; passengers carried, 1,058,842; total mileage run, 88,672 miles; average receipts per day, £38. 8s. 4d.; average receipts per car mile, 13·10d. The surveyor and general manager have been instructed to confer and prepare a plan for widening London-road and St. Peter's-street, opposite the Triangle, and to submit the plan and estimates of the expense to the next meeting of the Tramways Committee. The new Willans engine is now running at the power station. The British Westinghouse Company have agreed to deliver the new cars in February.

Camberwell.—With respect to the proposed acquisition and electrification of the London southern tramways by the London County Council, the Borough Council have agreed to give their consent to the working of the lines by the overhead system, subject to the point of transfer from the underground conduit to the overhead system being at a point in Coldharbour-lane about midway between Valmar-road and Crawford-street, and to the doubling of the existing lines where proposed by the London County Council. The Council have also agreed to contribute one-third of the cost of the street widenings in the borough in connection with the proposed tramway from Lordship-lane to Forest Hill.

South Lancs.—The South Lancashire Tramways Company are proceeding with the construction of several extensions of their existing tramways. It is intended in the first instance to begin the extension from Tyldesley to Worsley boundary at Boothstown, from Hindley, *via* Westhoughton, to the Bolton Corporation boundary at Deane, and from the Leigh boundary to St. Mary's railway station, Lowton. These will be constructed immediately and will be followed by the equipment of the routes from Four Lane Ends, Hulton, *via* Little Hulton and Walkden to Swinton, from Boothstown to Irlams-o'-th'-Height, and from Lowton to Newton-le-Willows. The extensions comprise about 40 miles of tramways.

Additional Traffic Returns.—Anglo-Argentine, £1,875 increase; Barcelona Ensanche y Gracia, £88 increase; Barcelona, £48 increase; Brisbane, £73 decrease (month of November, £10,544, increase £253), British Columbia Electric (month of March), gross earnings £10,352, net income £2,659; Buenos Ayres and Belgrano Electric, £166 decrease (month of November, £14,142, increase £444); Calcutta, £261 increase; Cape Town (month of November), receipts £16,785, expenditure £8 673; Isle of Thanet Electric, £10 increase; Lisbon Electric (month of October), receipts 93,725 milreis, expenses 50,350 milreis; Mexico Electric (month of November), receipts £47,350, expenses £27,600; Perth Electric, £249 increase; Port Elizabeth (month of November), receipts £4,073, expenditure £2,989.

Huddersfield.—At Wednesday's meeting of the Town Council a long discussion ensued upon a proposal of the Tramways Committee to rearrange the distances and fares for workmen. The facilities are to be increased by allowing workmen to return at any hour between 5.30 p.m. and 7.30 p.m. at the top of any car. On those routes where the ordinary fares are in excess of those authorised by Parliament for workmen, special cars will be run. The chairman of the committee said that their chief point had been to increase the revenue if possible, whilst giving every facility they could to workmen, and also to prevent those who were not workmen from taking advantage of the cheaper rates. The tramway receipts were nearly double what they were three years ago, when the fares were double what they were now, and they were carrying 12,000,000 passengers a year, against 4,500,000. An amendment of Mr. Oxley, which was to be submitted, was, he said, based upon the Glasgow system of fares, which could not be made to apply to Huddersfield, with a much smaller population, but a proportionately larger area.

Birmingham.—It is officially announced that the Birmingham and Midland Tramways Company have entered into a provisional agreement with the British Electric Traction Company to acquire certain of that company in the following tramway companies in Birmingham and adjacent districts: the Dudley, Stourbridge, and District Electric Traction Company, the South Staffs Tramways (Lessee) Company, Wolverhampton District Electric Tramways Company, the City of Birmingham Tramways Company. The effect of the proposals will be to give the Birmingham and Midland Company controlling interests in the various tramway and light railway companies in Birmingham and adjacent districts. These companies are at present operating an aggregate of 90 route miles of tramways and light railways, and have obtained powers for constructing 31 route miles of new tramways and light railways. The majority of these tramways and light railways are already working by electric traction on the overhead system. The directors firmly believe that this consolidation of interests will lead to increased efficiency and economy, while enabling greater facilities to be offered to the travelling public by interchange of cars and otherwise.

Westinghouse Single-Phase System of Traction.—The Westinghouse Company have furnished us with details regarding their new single-phase system of traction, which is said to be specially suitable for the electrification of main steam railways. The company, who have an experimental line at Pittsburg, claim to have successfully over-

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come all difficulties; and their system is now ripe for application on the most extensive scale. The primary advantages claimed for the single-phase over the direct-current system at present in vogue are that it costs less to instal and less to work, the amount of electrical energy required for a given service being considerably reduced. A high acceleration and retardation are possible, this being a *sine qua non* for short railways with many stations close together, and these are secured without the unpleasant jolting and jerking. The heaviest trains can be dealt with, and high speeds developed, so that the system is admirably fitted for the operation of main as well as of local lines. The public safety is enhanced by the simplification of the controlling gear, and the absence of electrolytic troubles removes many difficulties which beset the laying-out of direct-current lines. The special type of single-phase motor which has been devised is said to have many advantages over the direct-current series motor. Thus the efficiency is higher at low speeds, the speed being regulated by varying the terminal voltage. The frequency employed is 25 cycles. The abolition of the rotary converter effects a great saving of power, and the complications and losses of the series-parallel system of control are entirely eliminated, the motors being connected permanently in series or in parallel, according to the working voltage used. In either case the voltage at the motors is lower than in direct-current work, so that insulation difficulties are minimised, and the liability to burn out is almost negligible. Furthermore, as the motors are in a secondary circuit, of which the line is the primary, the chances of damage thereto from lightning are greatly reduced. These motors and their controlling gear are specially adaptable to the multiple-unit system of control.

London County Council.—At the usual weekly meeting of the London County Council on Tuesday the Highways Committee presented another report with reference to the proposed acquisition of the London Southern Tramways Company's undertaking. The Lambeth Borough Council have not yet agreed to make the one-third contribution towards the estimated cost of the necessary street wideuings as required by the County Council, and the committee stated that they cannot recommend the Council to purchase the undertaking unless the Borough Council will do this and also agree to the use of the overhead trolley system except on the lines in South Lambeth-road. On Dec 22 a special meeting of the County Council will be held to decide the question of purchase one way or the other, and the Borough Council have been given till that date to make up their minds. The Camberwell Borough Council have already given their consent to the use of the overhead system, and no street widenings will be required in that borough. The Council, on the recommendation of the committee, decided to pay a sum of £300 to Mr. Alfred Baker as an honorarium in respect of the services rendered by him subsequent to his relinquishment of the position of tramways manager on Oct. 1 last A new by-law has been adopted by the Council, on the suggestion of the Board of Trade, to the effect "that the rate of speed to be observed for tramway traffic worked by animal or cable power shall in no case exceed nine miles an hour." The Council approved the Tramways and Improvement Bill for the construction of 16 new tramways and the extension and doubling of existing lines, including the Hampstead to Oxford-street, Westminster Bridge-road to the Strand *vid* the Embankment, and the Marble Arch to Cricklewood lines. Mr. Napier, the chairman of the committee, dealing with the matter, reported that some slight friction had occurred with the St. Marylebone authorities in connection with the last-named line, but it was expected that it could be overcome. The full list of the proposed tramways was given in a recent issue of this journal. The following report relative to the reconstruction for electrical traction of the cable tramways from Kennington to Streatham was brought up by the Highways Committee, and adjourned till next meeting: "In the report presented by us on Nov. 24, 1903, with regard to the rebuilding, for the accommodation of electrical cars for use on the tramways between Kennington and Streatham, of the existing car-sheds at Streatham, we stated that we proposed to submit at an early date proposals for the reconstruction of these tramways (about seven miles of single line) for electrical traction. It is of great importance that this work should be completed with as little delay as possible, owing to the inconvenience which results from dealing with the traffic on these lines, which are now worked by cable traction, in conjunction with the lines which are worked by electrical traction. An arrangement is now in force by which passengers on the Streatham lines who desire to travel to the various London termini have to change into the electrical cars at Kennington-gate, a course entailing grave inconvenience and discomfort, and, moreover, the receipts from the tramways are diminished owing to the absence of through car services. We therefore suggest that the Council should at once approve the necessary expenditure for the reconstruction of the lines referred to, for the conduit system of electrical traction, and that the work should be put in hand early in 1904. The Board of Trade has approved of the system to be adopted for the reconstruction of the lines. We propose that the work, when once commenced, should be carried through with as much expedition as is practicable, both in order to minimise the inconvenience caused to the residents along the route by the disturbance of the carriageway, and also to ensure, if possible, that the lines shall be ready for electrical working before the heavy summer traffic commences. We have had before us a suggestion that the present conduit, along which the cable runs, might be utilised in connection with the reconstruction of the tramways; but, after very careful consideration, we have come to the conclusion that this could not be done, the conduit being too small for the underground system of electrical traction. The approximate cost of the road work portion of the reconstruction of the lines, including platelaying, paving works, etc., is £90,000, and we have to ask the Council to pass a vote for that amount. This sum does not include the cost of the rails, estimated at £17,300, which is provided for in the estimate of £90,000, approved on Nov. 17, 1903, for the purchase of rails for these and other lines. Pending the completion of the Greenwich electricity generating station, we propose to make temporary arrangements for the supply of power for working the lines. The cost which will be incurred for this purpose will probably not exceed £500, and will be charged to maintenance account. The electrical cars required for the working of the Streatham lines have been obtained under a contract entered into in pursuance of the resolution of the Council of July 29, 1902, at a cost of £47,686, and these will be ready for use by the time the lines are reconstructed. We have forwarded to the Finance Committee an estimate for £90,000, the approximate cost, as stated above, of the excavation, platelaying, etc., in connection with the reconstruction of the seven miles of single line above referred to; and we recommend that the estimate of £90,000 submitted by the Finance Committee be approved, and that expenditure on capital account of sums not exceeding that amount in all be authorised in connection with the reconstruction for the conduit system of electrical traction of the cable tramways between Kennington and Streatham."

LIGHTING AND GENERAL.

Kirkcaldy.—A day rate of 1½d. per unit is to be charged for power consumers.

Sale of Plant.—Particulars of the sale of a complete electrical plant appear in another column.

Banbury.—The proposed electric lighting of the municipal buildings is before the Town Hall Committee.

Leigh.—The Town Council have resolved to apply for sanction to borrow £8,280 for electricity works extensions.

Barnstaple.—The Electric Lighting Committee are seeking to raise £5,400 for the extension of mains in the outside area.

Hampton.—The electric light company have promised to supply electricity for the new isolation hospital next February.

Middlesbrough.—Application is to be made for sanction to borrow £16,000 to cover the cost of the extension of plant and buildings.

Epsom.—An enquiry has been held into the Urban District Council's application for sanction to borrow £5,930 for electric supply purposes.

Walton.—The Urban District Council have finally decided to apply for a provisional order for electric lighting powers for their area.

Whitehaven.—The engineer is preparing a report for the next meeting upon the cost of laying public and private lighting mains to Kells.

Blaydon.—Arrangements have been made with the owners of Priestman Collieries for the provision and lighting of electric street lamps.

Penrith.—The Urban District Council have adopted an electricity supply scheme, as suggested by the engineers, at the estimated cost of £7,507.

Metropolitan Asylums Board.—The estimated cost of the generating plant and electric wiring for the Grove and Fountain Hospitals is £4,300.

Elland.—The Water and Lighting Committee have decided to light Huddersfield-road from the Weel-yan chapel to the town hall with electricity.

Eastern Telegraph Co.—The directors announce an interim dividend of 1½ per cent. on the ordinary stock in respect of the quarter ended Sept. 30 last.

Nantwich.—The Urban District Council are communicating with the Board of Trade with reference to the extension of the period for the electric lighting order.

Concert.—The employés of the "Robertson" Electric Lamp Works are holding a concert on Saturday, Dec. 19, at 7.30 p.m., in the dining hall at the works at Brook Green.

Insulating Compound.—Messrs. Rowland Carr and Co. have again secured the annual contract for the supply of insulating compound for the National Telephone Company.

Trowbridge.—The Council have appointed Mr. George Pearson, solicitor, chairman of the Bristol Corporation Electricity Committee, to report on the proposed electricity supply agreement.

Devonport.—The output from the electricity works for private lighting for the quarter ended September last shows an increase of 16,788 units over the corresponding quarter of last year.

Bristol.—It has been decided by the Electrical Committee to extend the alternating-current main to New Brislington. Short extensions of the main at Phippen-street, Malago Vale, and Queen-street have also been agreed to.

Tiverton.—The Town Council on Tuesday agreed to enter into a contract with Messrs. Suter and Co. for the construction of the electric light works, and to apply for sanction to borrow £12,200 for the undertaking.

Portsmouth.—A petition from inhabitants of Buckland and Kingston Ward, asking that arc lights should be substituted for what they called apologies of lamps in that district, has been referred to the Roads and Works Committee.

Lowestoft.—The electrical engineer's last report states that nine new consumers, representing 743 8-c.p. lamps, were connected up during last month, making a total of 442 consumers, representing 21,718 8-c.p. lamps now connected to the mains.

Coventry.—The Corporation propose spending £5,000 in purchasing additional motors to be let out on hire. They also contemplate the expenditure of over £31,000 in carrying out extensions in the electricity works to enable them to cope with the increased business.

Wandsworth.—The County of London and Brush Provincial Electric Lighting Company have informed the Borough Council that they would be in a position to deal with the question of a reduced charge for electric light when the figures for the current year were available.

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Beverley.—The Corporation have instructed the town clerk to take the necessary steps for protecting the interests of the borough, after having received an intimation that the Lincolnshire and Yorkshire Electric Power Company intend to apply for powers to supply electricity in the borough.

Hamilton.—The Gilbert Arc Lamp Company, Limited of Chingford. have been asked to replace the existing street-lighting arc lamps in that town, as anticipated in our note on this subject on Nov. 27. The work has to be carried out very urgently, and is be completed in about four weeks.

Jarrow.—The Town Council have asked the County of Durham Electric Power Distribution Company if they will supply the electricity for the lighting of the town hall on a flat rate. We understand that this has been refused, and that the matter will be fully discussed at the next Council meeting.

Cheshire Electricity and Power Gas Bill.—At a meeting of the Cheshire Non-County Boroughs Association on Monday, the following resolution was unanimously passed: "That the various boroughs, members of this association, be advised to combine to offer the strongest opposition to the Bill at every stage."

Bangor.—The electrical engineer (Mr. Price White) in his report for the five weeks ended Nov. 28 states that, in comparison with the corresponding period last year, there had been an increase equivalent to 17·9 per cent. in the number of units of electricity sold. Up to Nov. 28 the works supplied current for 8,563 lamps of 8 c.p. each.

Erith.—The specification for the additional generating plant to be installed at the electricity works is divided up into five contracts—namely: (1) 7,500lb. Lancashire boilers, mechanical stokers for the boilers, pumps, and all accessories; (2) pipe work; (3) condenser; (4) steam alternator, with exciter; (5) extensions of main switchboard.

Swansea Telephones.—The Telephone Committee have decided to notify the National Telephone Company that it is the intention of the Council to demand intercommunication as from Jan. 1 next. It is further proposed to ask the company to appoint representatives to confer with the Council with reference to the methods of intercommunication.

King's Lynn.—The engineer's last report states that applications had been received for 114 additional lamps of 8 c.p., or equivalent, making a total of 17,067 from private consumers, and that five additional consumers had been entered, making a total of 440; 21,518 units had been sold during the month to private consumers, as compared with 14,938 for the same period last year.

East London and Lower Thames Power Bill.—The object of this Bill is to incorporate a company which shall establish generating stations and supply electric energy or power in the whole of the eastern and south-eastern districts, including Hackney, Bethnal Green, Stepney, Poplar, Deptford, Greenwich, Bermondsey, West Ham, and all the urban districts of South-East Essex.

Bridlington.—The Corporation's Bill was approved last week, and it was decided, on the recommendation of the Local Government Board, to alter the site of the proposed electric lighting generating station from the depôt in the hands of the Council to a site on the recently acquired Elms Estate, adjoining the main thoroughfare, between the old town and the new.

Bath.—On Nov. 25 it was reported to the Electric Lighting Committee that applications for new connections had been received equal to 481 8-c.p. lamps, and at a subsequent meeting on Dec. 4 this number was augmented by applications for connections amounting to 72 8-c.p. lamps. The maximum load occurred on Friday, Nov. 20, being 793·4 kw. as against 727 kw. for the corresponding week last year.

Dover.—At the last Council meeting attention was called to the inconvenience to business men caused by the breaking down of the telephone between Dover and Folkestone. For the last three days two miles of wire had been blown down. Considering the exposed nature of the coast, it was considered the wires should be underground, and the Council will make a representation to that effect to the National Telephone Company.

Camberwell.—It appears that the Borough Council have no objection to the proposed transference of the undertaking of the Crystal Palace District Electric Lighting Company to the Blackheath and Greenwich Electric Light Company, Limited, or the alteration of the system of supply, subject to the existing rights of the Borough Council to purchase the undertaking under the Crystal Palace District Lighting Orders not being prejudiced in any way by such transference or alteration of system of supply.

Gosport.—The Electricity Committee have informed the Board of Trade that the Provincial Tramway Company have entered into an agreement with the Council to put into operation the provisions of the lighting order. Steps are being taken to establish a power station and to lay the necessary mains for the purpose of supplying electric current for lighting purposes. Hope was expressed that the work would be finished in the winter of 1904.

Glasgow.—The Electricity Committee of the Town Council in their last report recommend that the extension of the generating station at Port Dundas be proceeded with, and that a deputation be sent to Sunderland and other English towns to see turbine machinery in connection with the proposed extension of the plant. Mr. Chamen, the engineer, reports that the contemplated extensions will cost £135,000, which would be distributed over a period of three years. Application is to be made to the Secretary for Scotland for sanction to borrow for capital purposes in conection with the department a sum of £250,000, being the balance of the half million authorised by the provisional order, 1901.

Wolverhampton.—At the last Town Council meeting, Councillor Allen referred to the comparative cost between lighting the streets with electricity and gas. He said the question was rather difficult to answer, because they had no record of the exact number of gas lamps that were replaced by arc lamps. Approximately there were 150 gas lamps replaced by 51 arc lamps. Now 150 gas lamps at £2. 18s. 1d. per lamp came to £435 per annum; 51 arc lamps at £22. 10s. per annum cost £1,150. As to candle-power, 150 gas lamps at 15 c.p. per lamp made a total cost of 2,250 c.p.; 51 arc lamps at 1,000 c.p. per lamp totalled 51,000 c.p. Cost per candle-power per annum: gas, 46·4d.; arc, 5·4d.

New Issue.—The Harwich Electric Lighting and Tramways Company, Limited, propose to acquire from the Harwich Corporation the right to supply electrical energy for public and private purposes. The Corporation are willing to make such a transfer of their privileges immediately the sanction of the Board of Trade can be obtained, and a suitable site has been already purchased for the erection of a generating station. The vendors to the company are the Electric Generating Stations, Limited, who have obtained the provisional order. The total share capital consists of £50,000, in shares of £1 each, and an issue of 25,000 shares, of which 3,000 are taken by the vendors, is just being offered for public subscription.

Islington.—At the last Borough Council meeting a letter was read from the London County Council Finance Committee drawing attention to the desirability of a sinking fund for the renewal and replacing of machinery being provided by those bodies who had taken up loans on electrical undertakings for a period of 42 years. The sum of £388,081 had been borrowed for that period, and up to March 31 last only £20,646 had been paid off those loans. Under those circumstances the Finance Committee regarded the creation of a reserve fund as desirable in the interests of finance, and invited the opinion of the Borough Council on the subject. The Council propose to borrow £849 for electric lighting purposes under those conditions.

Annual Dinner.—The electric lighting staff of the Sunderland Corporation held their fourth annual dinner in the Grand Hotel, Bridge-street, on Wednesday. Amongst the toast list we note: "The Mayor and Corporation," by Mr. E. White (station superintending engineer); "The Engineering Contractors and other Visitors," Mr. J. F. Moore; "The Borough Electrical Engineer and Staff of the Electrical Department," Alderman Bruce; "The Absent Members of the Staff," by Mr. J. J. Larkin. The musical programme was contributed to by Messrs. W. A. Thompson, E. Read, S. Lyne, Dan Noble, J. Bellamy, J. W. Wrightson, J. J. Larkin, L. G. Bain, F. W. Yeaden, R. D. Grieves, J. F. Moore; the piano accompaniments being played by Mr. J. W. Donkin and Master G. F. Dodds. The entertainment also included a recitation by Mr. G. A. Ferris.

Stock Exchange.—The Stock Exchange Committee has appointed special settling days as under: Dec. 23—Metropolitan District Railway Company's partly-paid scrip of a further issue of £500,000 4 per cent. perpetual debenture stock. Dec. 29—Dick, Kerr, and Co.'s 52,000 ordinary shares of £5 each, fully paid, Nos. 1 to 52,000; 61,000 6 per cent. cumulative preference shares of £5 each, fully paid, Nos. 1 to 61,000; and £300,000 4½ per cent. debenture stock. The committee has also ordered the undermentioned securities to be quoted in the official list: British Columbia Electric Railway Company's further issue of 1,500 5 per cent. cumulative perpetual preference shares of £10 each, fully paid, Nos. 51,001 to 52,500; Dick, Kerr, and Co.'s 52,000 ordinary shares of £5 each, fully paid, Nos. 1 to 52,000; 61,000 6 per cent. cumulative preference shares of £5 each, fully paid, Nos. 1 to 61,000; and £300,000 4½ per cent. debenture stock; and Metropolitan District Railway Company's partly-paid scrip of a further issue of £500,000 4 per cent. perpetual debenture stock.

Cardiff.—The National Telephone Company, Limited, have decided to greatly reconstruct the outside wires in Cardiff, and the question arises whether the present system of overhead construction is to be adhered to or whether the Council will give consent for underground work. The company's representative is to appear before the committee and present plans of what the company propose doing in the matter. The revenue of the electric lighting department for the current year was estimated at £27,000, but it is now believed that it will be £33,000. The electrical engineer, in his last report, states that there are now 948 consumers. The total number of units generated at the lighting station during the month was 177,291, and the estimated revenue was, from street-lighting, £456. 2s.; private supply, £2,728. 18s. 6d. The Mount Stuart Dry Docks, Limited, which takes its energy from the committee, wrote stating that they were very well pleased with the result of the year's working, and the manager (Mr. T. W. Wailes) said he could see nothing to prevent the company from being similarly successful in the future.

Camera Club.—At the Camera Club on Monday, Mr. R. W. Inward in the chair, Mr. T. C. Porter, M.A., F.I.C., etc., of Eton, in his well-known lucid manner, explained to an exceptionally large audience the phenomena of radium and the investigations of Röntgen, Crookes, Bequeral, Curie, Thompson, etc., which led to their discovery. He showed on the screen a slide taken from a plate which had been placed in contact with a small piece of ore containing 60 per cent. of thorium and the radiations emanating in right angles from each face were plainly discernible. That this mode of examining mineral ore may lead to great practical results will be clear to all "prospectors." An exceedingly interesting discussion followed, in which a number of medical men and others described some of their experiments and experiences. Mr. Martin Duncan also showed a few but very fine slides of Cornish pitchblends, and of a tube containing a 30 qr. of uranium nitrate at various degrees of heat, which showed that its radiations make a good impression on the plate up to 130deg. C., but degenerates when the mineral is heated to a higher temperature. The fixtures for January include papers on the dust-raising qualities of motorcars, by Colonel Crompton, C.B., and Mr. Crawley, and a demonstration by Dr. George Redman concerning the photography of some electrical phenomena.

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Street.—The Urban District Council will not share in the guarantee as proposed at the recent meeting of the Joint Committee from the Councils of Wells, Shepton Mallet, Glastonbury, and Street, appointed to confer as to the acquisition of the telephone. It was proposed that the basis of contribution to the guarantee fund should be according to population, but if 60 subscribers could be obtained from the whole district (at a minimum subscription of £4 each) there would be no financial liability.

Lytham and St. Annes.—Application is to be made to the Local Government Board for sanction to borrow £4,000 for the extension of electricity mains and services. The electrical engineer in his last report states that satisfactory progress had been made during the past month, the output continuing to increase. The number of applications for supply was over the average. There were 46,826 units sold, as compared with 14,829 in the corresponding period last year, and the total number of units sold so far this year reached 254,208, as against 64,823.

Battersea.—The Council propose to undertake to instal the electric light in the clock tower of St. Peter's Church at an estimated cost of £56, and to maintain the installation at an estimated annual charge of £34 under the provisions of the Act in question. The Wandsworth Borough Council is to be asked to reconsider the application of the Council to light by electricity, at an annual cost of £16 per lamp per annum, the eastern portion of Nightingale-lane maintained by them under the provisions of the order of the London County Council dated July 30, 1901.

London County Council.—On Tuesday it was agreed to lend the St. Pancras Borough Council £5,764 for street-lighting purposes. The Main Drainage Committee made the following report: "On Nov. 3 last the Council referred to us several tenders for the supply and erection of electrical machinery and fittings at the Abbey Mills pumping station. Upon further consideration of the matter, however, we are of opinion that the work of providing an electric light installation at this station should be postponed for some time, and we do not therefore propose to report on the tenders at present."

Swinton.—At a meeting of the Swinton and Pendlebury District Council on Monday, the Tramways and Electricity Committee reported that instructions had been given to the clerk to communicate with the Salford Corporation and the Lancashire Tramways Company to ascertain the most favourable terms upon which a supply of electricity in bulk could be obtained by the Council. On the question of the electric supply of the district a deputation from the Swinton and Pendlebury Ratepayers' Association had a private interview with the Council at the close of the ordinary business.

Dundee.—Arrangements are being made for beginning next week the laying of the new electric mains in the centre of the city. The Council some time ago sanctioned an expenditure of £9,000 for this work, which involves the relaying of the whole of the cables. It is expected, however, that it will be possible to carry out the work without interfering in any way with the supply of current. The station is now in a position to supply any demands that may be made on it for power or for lighting purposes. With regard to the proposed power scheme recently noted by us it is reported that the total £200,000 required has been subscribed.

Pemberton.—The total current generated during October was 32,754 units, and the total sold 24,873 units, a percentage of 76. Mr. Heaton estimates that the construction of a new shaft at Nicholson's pit will cost about £350. Tenders for the work are to be advertised. Last week saw the inauguration of two new engines of 500 h.p. each, which it is hoped will have much work in the near future in the supply of electricity for motor purposes, and particularly in the development of the new system of tramways. The engines have been built by Dick, Kerr, and Co., Limited, of Preston, and have been placed alongside the first two put down by the same firm.

Watford.—In connection with the proposal referred to by us last week—viz., that an application be made to the North Metropolitan Electric Supply Company to ascertain whether they would be prepared, and if so on what terms, to acquire the electric lighting undertaking of the Watford Urban District Council, and to supply the district of the Council with electrical energy—a public meeting has been called to discuss a resolution to the effect that the ownership and control of the electric light should be retained by the town, and protesting against the Urban District Council taking any steps to dispose of the undertaking without first obtaining the sanction of a substantial majority of its constituents.

Yarmouth.—The Council have decided to spend £240 for a supply of additional transformers for the purpose of improving the lighting throughout the system. The Electric Lighting Committee have been considering the question of carrying an electric cable across the harbour. It appears from correspondence that the Port and Haven Commissioners require the trench for the cable to be 21ft. below low water. This requirement the committee did not consider reasonable, and suggested 19ft., but preferred to have the cable carried over the river by means of steel masts, or by attachment to a transporter bridge at a minimum height of 130ft. The Commissioners will now be asked for their concurrence to either method.

Belfast.—The Gas and Electric Committee have passed the following resolution: "That, in order to meet the wishes of those consumers of electric current who are of opinion that the charges made for current are excessive, the Council be recommended to apply to the Board of Trade to appoint an inspector for three months for the purpose set forth in Section 27 of the Electric Lighting Orders Confirmation Act (No. 7), 1890, as the committee is of opinion that it would be for the benefit of the undertaking, and in the interests of the public, that this step should be taken." The resolution will come before the Corporation at the meeting on Jan. 1 next. Mr. M'Cowen has obtained permission to make a short extension along the Lisburn-road, and also in Ormeau-avenue. The work will cost close on £875.

Beckenham.—The Urban District Council have adopted a report recommending the Council to exercise the power conferred upon them by Section 70 of the Crystal Palace and District Electric Lighting Order, 1890, and require the company to sell to the Council, on the terms set out in the said order, so much of their undertaking as is situated within Beckenham parish. The report further stated that tenders for free wiring had been referred to the engineers, with instructions to communicate with three of the persons tendering and arrange for the approval of the committee a uniform schedule of prices for wiring and fittings, with a view to contracts being entered into. The officers are to report in writing on the financial position of the free wiring scheme and on the proposal to wire houses during construction. A cable is to be laid in Tudor-road at an estimated cost of £60.

Paignton.—A deed of agreement has been drawn up between the National Electric Construction Company and the Council as to lighting the town, and Messrs. Enright have been provisionally appointed consulting engineers. At a meeting of the ratepayers' association on Friday it was proposed that, having regard to the financial position of the Council, to the large and uncertain expenditure upon waterworks beyond the £70,000 already sanctioned, and also to the pressing need of carrying out an expensive drainage scheme, for which plans were prepared in 1895, this meeting is of opinion that the proposed electric lighting scheme, which will impose an additional burden upon the rates without any prospect of being remunerative, ought not to be entertained. A voluntary postcard poll was suggested, but the meeting broke up late and somewhat hastily without coming to any decision.

Clydebank.—At the meeting of the Town Council on Tuesday the agreement with the Clyde Valley Electrical Power Company on the question of taking over the powers obtained by the burgh under the electric lighting provisional order was confirmed. The company agree to pay the Council in full reimbursement of the cost of the order the sum of £400, and in consideration of its transfer £100 per annum for a period of 10 years. At the end thereof such annual payment shall be subject to a reduction of £2 per annum for each arc lamp, or for every 10 incandescent lamps or their equivalent. The company agree to supply electric energy and voltage for public lighting, the Council paying £10 per annum for each arc lamp used by them for street-lighting, and £1. 2s. for each 16 c.p. incandescent lamp. The Council have power in the agreement to resume possession of the power under the order at certain periods under certain conditions.

Brixham.—At the meeting of the District Council on Monday a deputation presented a memorial, which stated that at a meeting on Saturday night it had been resolved to inform the Council that in the opinion of the ratepayers and a large number of others there would be no demand for electricity outside the Council sufficient to make the scheme a remunerative one; also, that there should be a clear majority in favour of the scheme; that it had been found by experience that crooked and narrow streets like Brixham's were unsuitable to electric lighting; that it was unwise to lay a further debt on the town, as the finances were limited until the water scheme and the widening of Fore-street had been carried out. The Council did not come to any decision, and everything was left in abeyance. The Clerk suggested that formal notice of objection should be made to the Bill, and it was decided to wait until they could learn how the inhabitants had responded to the notices served on them.

Marine Steam-Turbine.—We are informed that the American Westinghouse Company have acquired the full rights to manufacture the Parsons steam-turbine in the United States and Canada for all purposes, including that of marine propulsion. A special department is being organised at Pittsburg for building this type of engine for vessels of every class, including warships; and this work will be carried on in close touch with the shipbuilders all over the country. There are some half million horse-power of Parsons steam-turbines in daily operation in different parts of the world, 84,000 h.p. being used for steamships' propulsion. In the United States alone some 60,000 h.p. of turbine engines are employed in electricity generation, and 150,000 h.p. more are under construction. Engines as large as 8,000 h.p. are already being built at Pittsburg, and the Westinghouse Company look forward to immense developments in this new branch of industry, more especially with regard to ship work.

Tamworth.—At Saturday's meeting of the Rural District Council a notice was considered of the intention of the Tamworth Corporation to apply to the Board of Trade for a provisional order authorising the supply of electrical energy within certain parts of the rural district, and application for the Rural District Council's consent to the granting of such provisional order, and the waiver of the notice required by the Electric Lighting Act, 1882, to be given by the Council. A resolution of the Bolehall and Glascote Parish Council was read in opposition to the granting of the order. It was proposed that the Council assent to the waiver of notice, and it was pointed out that they did not want to upset the Corporation. In the meantime a committee might consider whether they should oppose the scheme wholly or in part. The reason Bolehall and Glascote Parish Council decided to oppose those powers was because at present they had no proof that the Tamworth Town Council would supply them with electric power and light. As soon as they got an undertaking from the Corporation that they would supply them in a reasonable time they would withdraw their opposition. It was agreed not to take any action whatever that day.

Bootle.—The proceedings of the Electric Power and Lighting Committee with reference to extensions of distributing mains in certain streets were approved at the last Council meeting. The Chairman referred to the fact that all the applications for the supply of electricity had been successfully attended to, and said he had to congratulate the Council on the success of the electricity undertaking. About this time last year they had 3,000 units working, and now they had the whole 5,000. They had not moved too soon in the election

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of their new works. Only for the prevention of the weather and other circumstances over which they had no control, they would have been a still greater success. He called the attention of the Council to the notice of motion, as under, and said he was in a position to give a perfect answer to the questions he was about to ask. The motion read as follows: "That the Electric Power and Lighting Committee be directed to report to the next meeting of the Council with reference to the following points in connection with the contract of Messrs. Ferranti Limited with the Corporation for the supply of electrical machinery—namely: (1) the power of the engines contracted to be supplied; (2) the power of the engines actually supplied; (3) what deviations have been made from the terms of the contract, and the necessity for such deviations." After discussion it was agreed that an electrical engineer of repute be employed to report upon the machinery they had already received, and that a sub-committee, composed of the mayor, chairman, and deputy-chairman of the Finance Committee, should take the matter into consideration.

Colchester.—At the invitation of the firm of Messrs. Davey, Paxman, and Co., a large gathering, including the Mayor and Mayoress (Councillor and Mrs. E. H. Barritt), most of the members of the Corporation, and numerous other prominent townspeople, assembled on Friday afternoon at the Colchester electric light station to witness the starting by the Mayoress of a large new 550-h.p. engine, which has recently been fixed by the firm. The Mayor gave some statistics of the growth of the electrical undertaking since its inauguration five years ago, and said that it began with a maximum of 4,500 lamps, and the plant was of 180 kw. capacity, with three dynamos and three engines of 100 h.p. each. At the end of a year 4,250 lamps were connected, and at the end of 18 months the increasing applications for current led to the instalment of a fourth engine of 220 kw., bringing the capacity up to 400 kw. and the horse-power to 660. During the second year the number of lamps connected increased to 9,350, and in November, 1901, when the pressure was doubled, the number was 13,000. In order to cope with the demand, another 260-h.p. engine, with an output of 175 kw., was installed, which had met the requirements up to the present, but it became necessary early this year to make further provision, the number of lamps connected having risen to 20,000. To-day they had 25,000, and if all the lamps were lit simultaneously, they would, without the new engine, have been unable to supply current for over 1,000. The new engine, of 550 h.p. and 375 kw. capacity, made them able once more to meet all the demands that might be made, and those demands were yet fast coming in. Mr. A. R. Sillar, the electrical engineer, said he believed the engine would prove even more satisfactory than the old engines, which had never yet broken down.

London Gazette.—Mr. Richard Davis Willis has been released from trusteeship in the estate of Lewis Bayliss (carrying on business as F. Terrill and Co., and as Cordwell and Co., also as Thames Electrical Manufacturing Company), electrical accessories manufacturers, residing at Ridding-lane, and carrying on business at Brunswick Park, Wednesbury, and at 110, Cannon-street, London, E.C., and at 1 and 2, Bucklersbury, London. Mr. William Arthur Turner has been appointed trustee in the estate of Cecil Wray, mechanical and electrical engineer, 16, Chevin-view, Eccleshill, formerly of 24, Simes-street, Bradford. The first meeting in the estate of Thomas Hyam, gas and electric light fitter and plumber, 139, Fawcett-road, Southsea, Hants, will be held on Dec. 23, at 3 p.m., at the Official Receiver's Office, Cambridge Junction, High-street, Portsmouth. At a general meeting of the shareholders of the British Electric Car Company, Limited, held at the company's works, Trafford Park, Manchester, on Dec. 7, the resolution was passed that it had been proved that the company could not continue its business, and that the company should be wound up voluntarily. Mr. Thomas Frederick Wild, chartered accountant, of 23, Broad-street-avenue, London, E., was appointed liquidator. At a general meeting of the British Schuckert Electric Company, held on Nov. 17, it was decided that the company be wound up voluntarily, and that Mr. Arthur Jacob, the general manager of the company, be liquidator. A general meeting of members of Imperial Electric Supplies, Limited, will be held at 5, Gray's-inn-square, London, on Jan. 15, 1904, at 12 o'clock noon, to have an account laid before them showing the manner in which the winding-up has been conducted and the property of the company disposed of, and of hearing any explanation that may be given by the liquidator. The partnership subsisting between Wolfram Court and Henry Taylor, electrical and motor engineers and contractors, 53, Broadway, Wimbledon, S.W., trading as Court and Taylor, has been dissolved from Nov. 14, 1903. All debts due and owing will be received and paid by Wolfram Court, who will continue the business. The partnership subsisting between Stephen Appleyard and Thomas Stather, electrical engineers, 25 and 26, Hopwood-street, Hull, trading as Appleyard and Stather, has been dissolved from Nov. 16. The partnership subsisting between Cecil Douglas Falcke and Percival West, electrical fittings manufacturers, 113, Coleshill-street, Birmingham, trading as the Birmingham Electrical Fittings Company, has been dissolved.

Brighton Telephones.—The Council have received from the Postmaster-General a letter containing the following paragraph: "As regards the offer of a free service until the number of subscribers to the Corporation system throughout the area reaches 750, which is stated by the Mayor to have been made generally throughout the area, I am to say that the Postmaster-General is advised that the Corporation are not entitled under their license to give an exchange service without charging subscribers at some rates within the specified limits. In the establishment of other corporation systems it has been recognised that some interval must elapse between the connection of the first subscriber and the opening of the exchange service for which subscribers pay subscriptions, and during this interval no question has been raised as to the moderate experimental use which has been made of the comparatively small number of lines connected with the exchange. It would appear, however, that the Corporation of Brighton intend to go beyond the limits which have been observed by other corporations, and to offer to subscribers, and especially to subscribers who at present have lines provided by the National Telephone Company, an effective exchange service without payment. The Postmaster-General regards such an arrangement as a breach of Clause 11 of the Corporation license, and I am to ask that subscriptions at rates within the specified limits may at once be collected from all subscribers who are enjoying an effective exchange service. The Postmaster-General notes the Mayor's assurance that the offers of money which have been made to subscribers of the Telephone Company at Burgess Hill have been made by the chairman of the Telephone Committee without the knowledge of the Corporation, and that there is no possibility of any disbursements in this respect being repaid to him by the Corporation. Lord Stanley cannot, however, dissociate the Corporation from responsibility for the acts of the chairman of their committee, and as those acts constitute a breach of the conditions contained in Clause 21 (1) of the Corporation license, which forbids the giving of favour or preference, he considers that the offers made to the Telephone Company's subscribers at Burgess Hill should be at once withdrawn." In their reply the Telephone Committee at once agreed to the request contained in the latter lines, and with regard to the former issue say that they regret to learn the opinion which the Postmaster-General has expressed with respect to the course the Corporation are taking with a view to establishing an effective exchange before charging rents for the services now being connected with the Corporation system of telephones, and which opinion appears to the committee to be based in a large measure on inaccurate and incomplete information. In the first place, the committee assure the Postmaster-General that the representation made to him that an offer has been made by the Corporation "to subscribers who at present have lines provided by the National Telephone Company" other than that made to all subscribers to the Corporation system, is contrary to the fact. The promise which has been made to subscribers of the National Company is exactly the same as that made to all other subscribers—namely, that no charge will be made until 750 subscribers are attached to the system— in other words, until there is what will, in the opinion of the Corporation, be an effective exchange service. The committee are informed that in adopting this course they are following the usual practice in telephone business in all countries in the world as well as that of the National Telephone Company, and they are of opinion that it is not possible to establish an exchange in any other way, as it is certain no person would pay for a telephone until he had a sufficient number of others to talk to to render the instrument useful The committee are officially informed that in Glasgow no charge was made to subscribers until after a lapse of five months after the switching-on began, and that at the date when rates were first charged the number of subscribers working was 1,450, and that at Portsmouth no charge was made until 700 had been connected. In the case of Swansea, where the Corporation system only provided for 750 lines, the number of subscribers at the date of the formal opening was 366, or nearly half the total. The Brighton Corporation are providing for an exchange of 2,000 lines, the first of which was connected on Oct. 5 last, and the committee submit that, having regard to the total number of lines being provided, 750 is not an unreasonable number to constitute an effective exchange for the borough and the other towns and parishes within the Brighton telephone area, and that in fixing that number the Corporation of Brighton are not going beyond the limits observed by other corporations. The present number of subscribers connected with the exchange is 284, nearly all of whom are situate in a very limited area closely approximate to the exchange.

PROVISIONAL PATENTS, 1903.

DEC. 7.

26687. Improvements in electric lamps for motorcars and vehicles. Robert Lee, 203, Shaftesbury-avenue, London.

26772. Improved arc lamp for high tensions. Tito Livio Carbone, 322, High Holborn, London. (Complete specification.)

26773. Improved arc lamp with convergent downwardly directed carbons. Tito Livio Carbone, 322, High Holborn, London. (Complete specification.)

26776 Improved manufacture of incandescence bodies for electric glow lamps. Charles Denton Abel, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Siemens und Halske Actien Gesellschaft, Germany.) (Complete specification.)

26783. Improvements in electrically operated railway switches. Claude Webster Breedlove and Rudolph Redell Grant, 18, Southampton-buildings, Chancery-lane, London. (Complete specification.)

26788. Improvements in electromotors of the induction type. Frank Michael Lewis, Norfolk House, Norfolk-street, Strand, London.

26792. Improvements in electric sanitary closets. James Horace Wilson, 18, Buckingham-street, Strand, London. (Complete specification.)

DEC. 8.

26808. Improvement relating to telegraph poles and the like. Wilfred Lawson Bullows, Long-street Works, Walsall.

26823. Improvements in lighting by electricity, gas, and other illuminants public throughfares, streets, and places, and appliances therefor. James Townsley Pearson, 8, St. James's Hall, Burnley.

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26825. Improved electrical device to indicate when trolley leaves the wire. George Edwin Watmough, 6, Hill Top-avenue, Roundhay-road, Leeds.

26827. Improved wind motors for the generation of electricity and for other purposes. David Burns and James Macarthur Fleming, 37, West-Nile-street, Glasgow.

26842. Improvements in electric automatic cut-outs or switches. Crompton and Co., Limited, and Arthur John Hodgson, The Arc Works, Chelmsford.

26843. Improvements in arc lamp suspension apparatus. Crompton and Co., Limited, and Arthur John Hodgson, the Arc Works, Chelmsford.

26848. Telephone systems. Wallace Fairweather, 65, Chancery-lane, London. (The Stromberg Carlson Telephone Manufacturing Company, United States.) (Complete specification.)

26849. Telephone systems. Wallace Fairweather, 65, Chancery-lane, London. (The Stromberg Carlson Telephone Manufacturing Company, United States.) (Complete specification.)

26850. Selective signalling systems. Wallace Fairweather, 65, Chancery-lane, London. (The Stromberg Carlson Telephone Manufacturing Company, United States.) (Complete specification.)

26851. Improved central exchange apparatus and connection. Wallace Fairweather, 65, Chancery-lane, London. (The Stromberg Carlson Telephone Manufacturing Company, United States.) (Complete specification.)

26856. Improvements in and relating to electric circuit-breaker mechanism. Crompton and Co., Limited, and Robert Charles Harris, 55, Chancery-lane, London.

26857. Improvements in electric arc lamps. Crompton and Co., Limited, and Arthur John Hodgson, 55, Chancery-lane, London.

26862. Instrument for determining the deviation of magnetic compasses from the true meridian. Adolph Lietz, 52, Chancery-lane, London.

26863. Telephonic recorder. Stanley Rowe, 12, Franconia-road, Clapham, London.

26873. Improvements in automatic telegraph apparatus. George Lewis Hogan, 27, Chancery-lane, London.

DEC. 9.

26912. Improvements in or connected with incandescent electric lamps. George Davis, 15, Victoria-street, London.

26913. Telephone exchange system. James Swinburne and Granville Hugh Baillie, 82, Victoria-street, London.

26915. Improvements in connection with wall sockets and switches for electric circuits. George Edwin Fletcher, 17, St. Ann's-square, Manchester.

26916. Improvements in means for advertising on electric tramcars and other electric vehicles. Albert Edward Walkden, 17, St. Ann's-square, Manchester.

26922. Improvements in connection with the laying of electric cables and the like. William Michael Rogerson, Commercial-street, Halifax.

26935. An electrical controller. David E. Evans, The Court, Pencoed, South Wales.

26947. Improvements in automatic electric street indicators for cars. Frank Henry Wehrmann, 605, Missouri Trust-building, St. Louis, Missouri, U.S.A. (Complete specification.)

26954. A mechanical device applied to the cars or cages of electrically-driven lifts and belt-driven lifts. Alexander Charles Moffatt, 67, Knatchbull-road, Camberwell, London.

26961. Improvements in switching mechanism for double-filament electric lamps. John McCullough, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents Act, 1901, Dec. 10, 1902, being date of application in United States.) (Complete specification.)

26963. Improvement in relation to the suspension of magnetic compasses and other instruments. George Charles Lilley, Billiter House, Billiter-street, London.

26965. An improved clutch for electric arc lamps. Henry Bevan Swift, 31, Waldegrave-road, Upper Norwood, London.

26967. Electric switch. Axel Theodor Wedelin, 18, Eldon-street, London.

DEC. 10.

27032. Improvements in dynamo-electric machines. Henry Chitty, 2, Norfolk-street, Strand, London.

27038. Improvements in sand valve, gear, and tramp for use on electric cars. Henry Liddle, 132, Ethel-street, Benwell, Newcastle-on-Tyne.

27079. Improvements in the construction of induction coils for medical and other purposes. Charles Chalmers Fontaine, 37, Chancery-lane, London.

COMPLETE SPECIFICATIONS ACCEPTED.

To be published Dec. 31, 1903.

1902.

27618. Devices for varying the resistance of an electric circuit. Siemens Bros. and Co., Limited, and Siemens.

27676. Form of hydraulic press for assembling the parts of electrical commutators, tightening the ends of electrical commutators, and pressing together the discs of electrical armatures. Petch.

1903.

1067. Electrical measuring instruments. Carolan. (General Electric Company.)

2695. Insulating materials and artificial substitutes for ebonite and the like. Lucas.

2879. Electrically-operated clocks. Loebl, Scott, and American Electrical Novelty and Manufacturing Company, Limited.

2963. Telegraph and telephone cables and the like. Mansbridge.

15481. Electric arc lamps. Viale.

21404. Electricity meter for alternating currents. Siemens Bros. and Co., Limited. (Siemens und Halske Aktiengesellschaft.)

21760. Electrical measuring instruments. Beez.

22365. Electromagnets. Baxter. (Date applied for under International Convention, Nov. 21, 1902.)

23057. Single-phase alternating-current motors. Lamme. (Date applied for under International Convention, Oct. 31, 1902.)

24127. Electric bath tubs and electrodes therefor. Zwiebel.

24212. Means for controlling arc lamps. Haddan. (Zielenziger.)

24302. Magneto-electric induction apparatus. Bloxam. (Schoeller.)

24396. Galvanic batteries. Risac.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.	Last price
Commercial and Industrial.—	£	£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1 ..	½-¾
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1 ..	3/16-5/16
British Insulated and Helsby Cables, Ord., 1-100,000	5 ..	6-6½
—— 6 per cent. Cum. Pref., 1-100,000	5 ..	5½-5¾
—— 4½ per cent. Mortgage Debentures	100 ..	103-108
British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red.	100 ..	103-105
British Westinghouse Elec. and Manu., 6 per cent. Pref., 275,001-375,000	5 ..	4¼-4½
—— 4 per cent. Mortgage Debenture Stock	100 ..	98-101
Brush Electrical Engineering, Ordinary, Nos. 1-105,731	2 ..	¾-1¼
—— Non. Cum., 6 per cent. Pref.	2 ..	1¼-1⅜
—— 4½ per cent. 1st Debenture Stock	100 ..	97-100
—— 4½ per cent. 2nd Debenture Stock	100 ..	84-89
Callender's Cable, Debentures	100 ..	106-110
—— Ordinary	5 ..	11-12
—— 5 per cent. Pref.	5 ..	5¼-5½
Crompton and Co.	5 ..	1¾-2¼
—— 5 per cent. Debentures	100 ..	99-103
Edison and Swan United, "A" Shares, 1-99,261	5 ..	¼
—— "A" Shares, 01-017,139	5 ..	¼-1¼
—— 5 per cent. Debentures	100 ..	76-81
—— 4 per cent. Deb. Stock, Red.	100 ..	72-77
Electric Construction, Limited, Nos. 1 to 112,100	2 —	1⅜-1⅝
—— 7 per cent. Cumulative Pref.	2 —	2¼-3
—— 4 per cent. Perp. 1st Mort. Deb.	100 —	98-101
Ferranti Limited, 5 per cent. 1st Mort. Deb. Stock, Red.	100 ..	90-95
General Electric Company (1900), 5 per cent. Cum. Pref.	10 ..	9¾-10¼
—— 4 per cent. 1st Mort. Deb. Stock	100 ..	96-99
W. T. Henley's Telegraph Works, Ordinary	5 ..	14-15
—— 4½ per cent. Preference	5 ..	5-5¼
—— 4½ per cent. Debentures	100 ..	108-112
India Rubber, Gutta Percha, and Telegraph Works	10 ..	18¼-19¼
—— 4 per cent. Debentures	100 ..	100-103
Parker, Thos., Limited, Ordinary	10 ..	14¼-15¼
Telegraph Construction and Maintenance	12 ..	34-37
—— 5 per cent. Bonds	100 ..	101-104
Electric Lighting and Supply.—		
Blackheath & Greenwich District Ordinary 1,201-101,200	1 ..	⅝-¾
—— 4½ per cent. Deb. Stk. Certs., Red. and Conv.	100 ..	116-119
Bournemouth and Poole, Ordinary	10 ..	12¼-13¼
—— 4½ per cent. Cum. Pref., 7,501-15,000	10 ..	10-11
—— 6 per cent. Cum. Second Pref., 15,001-22,500	10 ..	11-12
—— 4½ per cent. Debenture Stock, Red.	100 ..	103-106
Bromley (Kent) Electric Light and Power Co., 4½ per cent. 1st Debenture Stock, Red.	100 ..	100-103
Brompton and Kensington, Ordinary	5 ..	10¼-10⅜
—— 7 per cent. Preference	5 ..	10-10¼
Calcutta Electric Supply Corp., Ordinary, Nos. 1-40,000	5 ..	6¼-7¼
—— Nos. 20,001-30,000	5 ..	7-8⅛
Cambridge Electric Supply Company, Ltd., £10 Ord.	8 ..	14¼
—— ,, ,, ,, £10 Ord.	6 ..	10¼
Central Electric Supply, Ld., 4 per cent. Guar Deb. Stock	100 ..	105-108
Charing Cross and Strand, Nos. 1-70,000	5 ..	8¾-9¼
—— 4½ per cent. Cum. Pref.	5 ..	5¼-5⅜
—— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000	5 ..	4¾-5
—— 4 per cent. Debenture Stock, Red. (Prov. Certs.)	100 ..	103-105 xd
Chelsea Electricity Supply	5 ..	5¼-6
—— 4½ per cent. Debentures	100 ..	107-110
City of London, Ordinary	10 ..	10¼-11
—— 6 per cent. Cumulative Pref.	10 ..	13-14
—— 5 per cent. Debenture Stock	100 ..	122-127
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100 ..	102-105
County of London and Brush Provincial, Ordinary	10 ..	7¼-8¼
—— 6 per cent. Cum. Pref.	10 ..	11¼-12¼
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	100 ..	108-111
Edmundsons' Electricity Corporation, Ordinary, 1-50,000	5 ..	6-6½
—— 6 per cent. Cum. Pref.	5 ..	6-6½
—— 4½ per cent. First Mort. Deb.	100 ..	104-107
Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-30,000	5 ..	5¼-5⅜
—— 5 per cent. Debenture Stock, Red.	100 ..	96-98
Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000	5 ..	5¼-6
—— 4½ per cent. First Deb. Stock, Red.	100 ..	100-103
Hove Electric Lighting, Limited, Ord., 1-13,000	5 ..	7¼-8¼
Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000	5 ..	10⅞-11¼
—— per cent. Debenture Stock Red.	100 ..	100-105

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Name.	Amount paid. £	Last price. £
Kensington and Knightsbridge and Notting Hill	100	101-104
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	9⅜-10⅛
London Electric, Ordinary	3	1⅜-2¼
—— 6 per cent. Pref.	5	5-5½
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	97-100 xd
Metropolitan, Ordinary	10	17½-18½
—— 4½ per cent. First Mortgage Debenture Stock	100	110-114
—— 3¼ per cent. Mortgage Debenture, Red.	100	96 99
Newcastle-upon-Tyne Electric Supply, Ordinary	5	£8 101
—— Preference	4	100-103
Notting Hill Electric Lighting	10	12½-13⅝
—— 4 per cent. First Mort. Debs., Nos. 1-500 (Reg.)	100	98-101
Oxford Electric, Ordinary, 1-96 and 407-14,310	5	5½-5⅝
—— 4 per cent. Debenture Stock	100	£8 101
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	10	96-102
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5	3-3½
—— 4 per cent. Debenture Stock	100	£5-90
South London, Ordinary		3¼ 3⅜
St. James's and Pall Mall, Ordinary, 101-20,080	5	14¼-15¼
—— 7 per cent. Pref.	5	7¼-7⅝
—— 3½ per cent. Deb.	100	98-101
Urban Electric Supply Co., Ordinary, 8-30,007	5	4⅞-5⅛
—— 5 per cent. Cumulative Preference, 50,001-80,000	5	4⅞-5⅛
Westminster, Ordinary	5	12 13
—— 5 per cent. Cum. Pref., 110,101-138,351	5	6-6½

Electric Railways.—

Central London, Ordinary	100	93-96
—— 4 per cent. Pref.	100	98-102
—— ,, deferred	100	96-99
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100	115 118
City and South London, Consolidated Ordinary	100	47 50
—— 4 per cent. Debenture Stock	100	109 112
—— 5 per cent. Pref. Stock '91	100	126-129
—— ,, ,, ,, '96	100	123-126
—— ,, ,, ,, '01	100	120-125
Liverpool Overhead, 5 per cent. Pref.	—	13-13¼
—— Ordinary, 1-50,000	—	7⅞-8
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	—	102-104
Waterloo and City, Ordinary	100	91-94

Electric Tramways.—

Anglo-Argentine, 1-250,007	5	4⅜ 5
—— Permanent 6 per cent. Debenture Stock, 1888	100	125 130
Blackpool and Fleetwood Tramroad	10	13½-14½
Brisbane Tramway Invest., Lim., Ord., 1-75,000	5	2-3
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5	3⅞ 4⅛
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100	99 104
British Columbia Electric Railway Co., Ord., Nos. 1-20,000	100	79-82
—— Non-Cum. 5 per cent. Pref., Nos. 25,001-38,600	10	10-10⅛
—— 4½ per cent. 1st Mt. Debs., Nos. 1-6,250, of £40 each	40	102-104 p.c

Name.	Amount paid. £	Last price £
British Electric Traction, Ord. 1-300,000 & 60,001-90,000	10	11¾-12¼
—— 6 per cent. Cm. Pf., 30,001-60,000	10	11¼-11⅝
—— 5 per cent. Perpetual Debenture Stock	100	120-123
Buenos Ayres and Belgrano Tram., Ord., 1-100,000	5	3-3½
—— "A" 6 per cent. Cm. Pf., 1-40,000	5	5¼-5⅝
—— "B" 6 per cent. Cm. Pf., 1-27,500	5	4⅜-5⅛
—— 5 per cent. Deb. Stock, Red.	100	106-109
—— Prov. Cert., all paid	100	98-101
Cape Electric Tramways, Nos. 1-480,000	1	1⅜-2
City of Birmingham Tramways, 5 per cent. Cum. Pref.	5	5-5⅛
—— 4 per cent. 1st Mortgage Deb., 1-3,000 (1917)	100	99-102
Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red.	100	100 103
Cork Electric Tramways and Lighting Co., Ordinary	10	13-14
—— 5 per cent. Cum. Pref.	10	11-12
—— Debentures	100	96-98
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10	12-13
—— 6 per cent. Pref., Nos. within 1-60,000	10	15-16
—— 3¼ per cent. Mort. Debs., 1-3,000, Red.	100	94-97
Imperial Tramways Ordinary	all	22-22¼
—— 6 per cent. Cum. Pref.	all	14¼-15¼
—— 4½ per cent. Deb Stock	100	112-114
Isle of Thanet Electric Tramways and Lighting, 5 per cent. Cum. Pref., Nos. 30,001-60,000	5	3⅜-4⅛
—— 4 per cent. Debenture Stock	100	92-95
Kidderminster and District Lighting and Traction, Pref.	5	3¼-4
London United Trys. (1901), 5 per cent. Cum. Pref.	10	11¼-11⅜
—— 4 per cent. 1st Mt. Db. Stock, Red	100	104-106
Metropolitan Electric Trams., Deferred, 1 000 001-1,314,016	1	3/16-5/16
—— 5 per cent. Cum. Pref., 500,001-814,016	1	⅞-1⅛
New General Traction, Ordinary	5	¼
—— 6 per cent. Cum. Pref.	5	1½-2⅛
—— 5 per cent. Mortgage Debentures, 1-1,713 (Regd.)	100	89-94
Oldham, Ashton, and Hyde Tramway, Ordinary	10	10¼-10⅜
—— 5 per cent. Cum. Pref.	10	11¼-12¼
Perth Elec. Tramways (W.A.) 5 per cent. 1 Mort. Deb. Stk.	100	100 103
Potteries Electric Traction, Ordinary, 20,001-40,000	10	8¼-9¼
—— 5 per cent. Cum. Pref., 1-20,000	10	8¼-9¼
—— 4½ per cent. Debenture Stock	100	102-105
South Lancashire Electric Traction and Power Company—		
—— £250,000 Ordinary	1	1
—— £101,152 6 per cent. Preference	1	1
—— £528,093 4½ per cent. Debenture Stock	100 p.c.	100 p.c.

Telephones.—

National Telephone, Preferred	100	101-103
—— Deferred Stock	100	78 81
—— 6 per cent. Cum. First Pref.	10	13-14
—— 6 per cent. Cum. Second Pref.	10	13-14
—— 5 per cent. Non-Cum. Third Pref.	5	5¼-5⅜
—— 3¼ per cent. Deb. Stock, Red.	100	96 98
—— 4 per cent. Deb. Stock, Red.	100	102-104
Oriental Telephone and Electric Company	1	¾ 1

TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line	Traffic Returns for week: Ending	1903. £	1902. £	Increase or decrease: Week. £	Current year. £	Miles of single track open: 1903.	1902.	Accounts for past year: Ending	Total receipts £	Passengers carried.	Car miles run.	Receipts per Pas-s'nger d.	Car mile. d.	Mile of track. £	Cost per car mile. d.
Aberdeen Corporation	Dec. 19	1,083	816	+ 259	+ 6,296*h*	19¼	17¼	May 31	37,931	9,099,715	794,641	0·98	13·02	1,970	6·1
Ayr Corporation	Nov. 21	170	166	+ 4	+ 52	8	6	Sept. 25	12,503	2,979,276	290,099	1·00	10·34	1,560	4·7
Birmingham Tramways	Dec. 19	5,013	5,035	− 22	+10,036	6¼	6¼	—	—	—	—	—	—	—	—
Blackburn Corporation	,, 18	723	648	+ 75	+ 1,115	24	24	March 25*g*	40,964	7,234,105	826,558	1·36	11·87	1,705	7·44
Blackpool Corporation	,, 17	262	260	+ 2	− 144	17½	16½	,, 31	211,168	6,169,121	784,443	1·52	10·8	—	—
Blackpool-Fleetwood Tramways	,, 19	153	145	+ 8	− 100	16½	16½	Dec. 31	30,923	2,049,677	584,989	3·62	12·68	1,932	6·99
Bolton Corporation	,, 20	1,609	1,539	+ 70	+ 8,229	38	25	March 31	85,704	17,761,605	1,896,247	1·15	10·75	3,430	5·87
Bournemouth Corporation	,, 20	805	—	—	—	10½	—	—	—	—	—	—	—	—	—
Bradford Corporation	,, 13	3,321	2,935	+ 386	+16,566	41	—	—	—	—	—	—	—	—	—
Brighton Corporation	,, 20	751	730	+ 21	+ 2,725*h*	6½	—	,, 31	—	10,432,508	1,031,928	1·00	10·10	—	—
Bristol Tramways Company	,, 18	4,423	4,344	+ 81	—	51½	51½	Dec. 31	223,480	41,192,899	5,724,114	1·30	9·38	4,348	—
Burnley Corporation	,, 19	769	659	+ 110	—	—	—	—	—	—	—	—	—	—	—
Burton Corporation	,, 20	282	—	—	—	—	—	—	—	—	—	—	—	—	—
Cardiff Corporation	,, 19	1,829	1,592	+ 237	+20,149	—	—	—	—	—	—	—	—	—	—
Carlisle Tramways Company	Nov. 23	158	124	+ 34	+ 721	—	—	,, 31	—	2,216,583	320,129*h*	—	—	—	—
Central London Railway	Dec 19	7,254	7,178	+ 126	− 7,059*h*	6	—	,, 31	367,225	45,305,110	1,276,971*a*	1·87	66·6*a*	59,076	35·6*a*
City and South London Railway	,, 20	3,070	3,399	− 329	− 10,138*h*	6⅜	—	,, 31	165,003*a*	19,069,319*a*	—	—	—	—	—
Cork E. T. and L. Company	,, 17	358	331	− 3	− 3,370	—	—	—	—	—	—	—	—	—	—
Darwen Corporation	,, 18	189	202	− 3	− 235	7·23	—	March 31*g*	12,341	2,360,735	254,279	1·25	11·65	1,707	9·36
Dover Corporation	,, 19	169	176	− 7	+ 74	3	—	—	—	—	—	—	—	—	—
Dublin & Lucan Electric Railway	,, 20	95	85	+ 10	+ 191*h*	—	—	Dec. 31	5,795	364,796	102,087	3·81	13·62	359	7·68
Dublin U. T., electric cars	,, 18	3,641	3,547	+ 94	} —	46	46	March 31	126,121	24,553,133	3,429,356	1·23	8·82	2,741	5·06*h*
Dublin S. District, Electric	,, 18	701	680	+ 21											
Dundee City Tramways	,, 16	786	748	+ 38	—	22	22	May 15	35,874	9,084,522	752,814	0·93	11·276	1,630	—
East Ham Corporation	,, 19	591	474	+ 120	+ 7,451	10·75	7·52	March 31	25,341	9,971,337	650,224	0·61	9·35	2,357	—
Farnworth U.D.C.	,, 9	128	119	+ 9	—	—	—	—	—	—	—	—	—	—	—
Glasgow Corporation	,, 19	13,179	11,972	+1,207	+41,397*h*	124	101	May 31*g*	656,572	177,179,549	14,008,750	0·88	11·25	5,489*b*	7·40*d*
Halifax Corporation	,, 16	2,093	1,882	+ 210	+ 5,741	30¼	27⅔	—	—	—	—	—	—	—	—
Huddersfield Corporation	,, 19	1,103	993	+ 110	—	34	35	March 31	56,631*h*	9,738,213	1,218,539	1·4	11·14	1,618	6·38
Hull Corporation, E. S.	,, 19	1,940	1,722	+ 217	+ 4,284	19	19	,, 31	87,707*h*	21,065,999	2,218,696	1·00	9·49	5,004	5·07
Ilkeston Corporation	,, 17	114	—	—	—	—	—	—	—	—	—	—	—	—	—
Kirkcaldy Corporation	,, 16	189	—	—	—	—	—	—	—	—	—	—	—	—	—
Leeds Corporation	,, 19	4,957	4,551	+ 406	+13,010	77	—	March 25	262,656	57,239,779	5,773,651	1·11	10·91	3,283	—
Liverpool Corporation	,, 12	9,526	8,659	+ 867	+17,122	101	95	Dec. 31	504,304	108,906,472	11,705,425	1·11	10·34	5,000	6·88
Liverpool Overhead Railway	,, 20	1,589	1,511	+ 78	+ 2,687*h*	15½	15½	June 30	79,252	10,466,726	986,185*a*	1·82	19·30*a*	5,110	— *a*
London County Council	Nov. 22	9,105	6,227	+2,878	+63,648	40	26	—	—	—	—	—	—	—	—
Lowestoft Corporation	Dec. 15	134	—	—	—	—	—	—	—	—	—	—	—	—	—
Nelson Corporation	,, 12	94	—	—	—	3	—	—	—	—	—	—	—	—	—
Newcastle-on-Tyne Corporation	,, 19	3,517	3,129	+ 388	—	38½	36	March 25*g*	150,334	33,474,122	3,379,119	1·08	10·93	4,175	6·17
Portsmouth Corporation	,, 14	1,374	1,248	+ 126	+ 4,618	29	29	Sept. 30	47,651	9,168,137	868,157	1·24	13·17	1,643	—
Rochdale Corporation	,, 14	100	91	+ 9	—	4½	—	March 31	5,416	925,281	127,456	1·38	10·27	—	7·66
Rotherham Corporation	,, 17	391	—	—	—	—	—	—	—	—	—	—	—	—	—
Salford Corporation	,, 14	3,741	2,782	+ 959	+41,726	—	—	—	—	—	—	—	—	—	—
Sheffield Corporation	,, 20	4,238	—	—	—	53½	46½	Mar. 25*g*	216,309	56,812,049	4,926,083	0·904	10·428	7,510	7·0
Southampton Corporation	,, 17	844	826	+ 18	—	11	11	,, 31	35,874	9,084,522	752,814	0·946	11·436	3,760	—
Sunderland Corporation	,, 20	1,071	1,016	+ 55	+ 2,219	18·48	17·18	,, 31	59,930	13,987,121	1,270,957	1·03	11·3	3,243	6·43
Wallasey U.D.C.	,, 19	595	534	+ 61	+ 3,397	10·5	10·5	,, 31*g*	31,474	5,685,182	654,742	1·30	11·53	3,593	7·03

* Includes maintenance of permanent way and proportion of profits paid to the tramway companies for term of unexpired lease. *a* Train mile.
b Per mile of single track. *c* Include rail and tram. *d* including depreciation. *f* Including one section of horse traction. *g* 1903. *h* Half-year's figures.

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EXPERIMENTS ON EDDY CURRENTS.*

BY W. M. THORNTON, D.SC., MEMBER.

§ 1. Experiments on Massive Cast-Iron and Steel Rings.

Eddy currents are induced in solid masses of metal by any variation of a magnetic field traversing them. The loss of efficiency of dynamo-electric machines from this cause can be approximately determined from the fact that while other losses caused by hysteresis, mechanical friction, and windage vary directly with speed, eddy-current losses are proportional to its square. The usual way of conducting the separation test is to run the machine light, at the same excitation but at different speeds, as a separately excited motor, and to plot the current taken by the armature vertically, the brush voltage or speed horizontally. A line is obtained which cuts the vertical axis, and the current required to overcome the eddy-current loss is the height of the line above a horizontal through this point of intersection. Measured in this way eddy loss is found to account for 25 to 50 per cent. of the loss of efficiency at light load. (Hawkins and Wallis: "The Dynamo," third edition, p. 689.) The increased loss at full load depends very much on the construction of the machine. It is greater with poles and pole-faces of high electrical conductivity than with cast iron, because the circulation of the local eddies varies not only inversely with the specific resistance, but as the square of the permeability. It is for this reason that they are much greater in iron than in copper, for the ratio μ^2/ρ is 500,000 times greater for the former than the latter at ordinary flux densities. A comparatively small variation of magnetisation will therefore give rise to strong currents when they are permitted to flow.

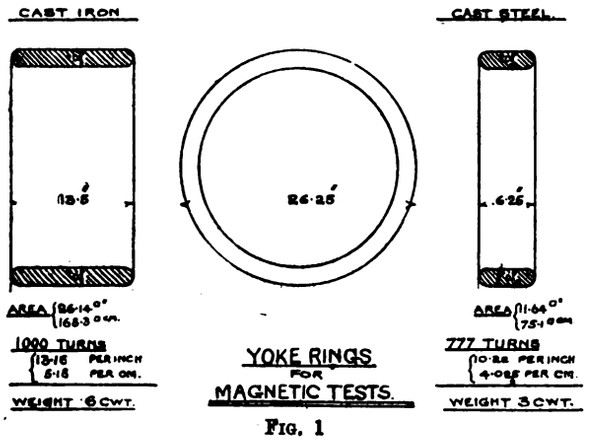

Fig. 1

Before examining in detail the losses in a machine, it is well to know how eddy-current loss is related to hysteresis and copper losses in the most perfect case—that is, of a massive closed iron ring covered with a uniform winding and excited by an alternating current. For this purpose it is only necessary to measure the current taken and watts absorbed by the coil under different conditions of excitation and at different frequencies. Tests were made on two yoke rings (Fig. 1), kindly lent by Messrs. W. H. Allen and Co., the hysteresis loops of which have been determined by a special method independent of the influence of eddy currents in the core. Each ring was connected in turn first to the supply mains at a frequency of 83, and then to experimental alternators giving either 18 or 37 periods per second. The results are recorded in Table I.

When the frequency is high it is impossible to work out the hysteresis loss from loops obtained by a slow cyclic process, but when the magnetisation is less than saturation the eddy-current and hysteresis losses can be separated by considering the latter to be proportional to the rate of change of the induction—that is, for low values to the exciting current—and the former to its square. Thus, if w represents the total watts less the copper loss it can be written

$$w = a\,i + b\,i^2,$$

where a is the watts lost by hysteresis per ampere and b those lost by eddy currents per (ampere)^2. a and b can be found from two readings:

$$w_1 = a\,i_1 + b\,i_1^2,$$

$$w_2 = a\,i_2 + b\,i_2^2;$$

so that

$$a = \frac{w_2\,i_1^2 - w_1\,i_2^2}{i_1\,i_2\,(i_1 - i_2)},$$

and

$$b = \frac{w_1\,i_2 - w_2\,i_1}{i_1\,i_2\,(i_1 - i_2)}.$$

* Paper read before the Newcastle Local Section of the Institution of Electrical Engineers, Dec. 14.

Table I.—Cast-Steel Ring.

Volts.	Amperes.	Watts.	cos φ	) (	$r i^2$	Hysteresis watts.	Eddy watts.	Eddy / hysteresis.	V / A ohms.
31·8	·71	22·6	1·0	83·5	·96	15·4	6·2	·4	44·7
42·0	1·0	41·5	·99	83·5	1·9	27·3	12·25	·45	42
60·7	1·5	84·2	·93	83·5	4·27	39·0	41	1·05	40·5
81·5	2·0	148	·91	83·5	7·6	40·4	100	2·47	40·7
100·	2·8	254	·90	83·5	14·9	43	196	4·55	30·6
25·	1·1	27·5	1·0	13·3	2·3	5·6	19·6	3·5	22·7
76·5	4·2	289	·9	15·8	14·2	14·2	241·3	17	18·1
80·5	5·39	392	·9	19·0	19·7	19·75	317	16	14·9
89·	6·25	502	·9	18·8	20·2	20·2	407·3	20·3	14·2
Cast-Iron Ring.									
100	·67	60·5	·9	83·5	1·3	21	38	1·8	149
37	·39	13	·9	37	·44	8·6	4·3	·5	95
45·2	·534	21·4	·89	37	·83	12·5	8·0	·64	85
102·5	·782	68·4	·84	37	1·78	49·6	17	·34	132

At the higher frequency the greatest value of b for the steel ring is *25* watts per (ampere)^2, and of a 31·6 watts per ampere, but these coefficients vary with the saturation, and should be determined from adjacent values for the whole range of excitation. Thus, for the lowest current b is *12·25*. In this way the eddy-current and hysteresis losses have been calculated. At the lower frequency it has been assumed that the shielding effect is not sufficient to lower the magnetisation reached at the inner parts of the core, because the long thin cross-section is very much less favourable to the flow of eddy currents than a circular area. The values of the hysteresis watts have in these cases first been found from the loops and the eddy loss deduced, but the results were also checked by the above method with an agreement within a few per cent. For example, the calculated values in Column 8 corresponding to 241·3 and 407·3 are respectively 240 and 402.

Much difficulty was experienced with the cast-iron ring in getting consistent readings. This was found to be due to the retentiveness of the iron. The highest alternating voltage available in the laboratory is 100, and not having a suitable transformer the greatest current reached at the highest frequencies was ·67 ampere. The power factor was found by the oscillograph and the watts calculated, but there is little practical interest in these very low magnetisations. Typical oscillograms are given in Curves I. and II. (Fig. 2). By an inspection of the tables and Fig. 3 it will be seen that as losses increase the power factor decreases. This cannot be due to the increase in permeability, for that is higher at the lower magnetisations. It means that with small coil currents, the eddies are sufficiently great on account of the high values of μ to prevent waves of any strength entering the core. When the whole core is magnetised by the large coil currents, the loss by eddy currents is increased, not because of their greater intensity, but of the larger area of the core brought into activity.

It is interesting to compare the behaviour of the two rings. The area of the iron ring is 2·25 times that of the steel. Its permeability is about one-half; the ratio of the turns on the windings are as 1·285 to 1. The inductance of a coil with a laminated core being

$$L = 4\,\pi\,T^2\,A\,\mu/l,$$

where T is the total turns, A the cross-sectional area of the core, μ its permeability, and l its mean length, the corresponding inductance of the iron ring is 2·84 henries, which is 1·44 times that of the steel. The resistance of the "iron" coil is 2·9 ohms, that of the steel 1·9. These are too low to affec t the impedance, and the inductance would with laminated cores be in the ratio 1·44 to 1. They are actually 5 to 1.

Table II.

—	Cast iron.	Cast steel.
Mean permeability from loops	$\mu_1 = 360$	*520*
Calculated inductance	2·84	1·98
Observed impedance	149	30·58
Resistances of windings	2·9	1·9
Frequency	83·5	83·5
Observed inductance	·445	·058
Actual permeability of cores as a whole	$\mu_2 = 40$	*19·8*
Ratio μ_1/μ_2	6·5	26·3
Frequency	37	13·3
Observed impedance	132	18·1
Observed inductance	·57	·034
μ_2	51·5	11·7
Ratio μ_1/μ_2	5·05	44·5

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